

MAINE TURNPIKE AUTHORITY

MAINE TURNPIKE

CONTRACT DOCUMENTS

CONTRACT 2026.07

CROSBY MAINTENANCE OFFICE BUILDING

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.

TABLE OF CONTENTS

	<u>PAGE</u>
NOTICE TO CONTRACTORS	N-1
PROPOSAL	P-1
CONTRACT AGREEMENT	C-1
CONTRACT BOND	CB-1
FINAL LIEN AND CLAIM WAIVER AND AFFIDAVIT	F-1
 <u>ARRANGEMENT OF SPECIFICATIONS</u>	
PART I – SUPPLEMENTAL SPECIFICATIONS	SS-1
PART II – SPECIAL PROVISIONS	SP-1
PART III – DIVISION 800 – DIVISION 01 THRU 28	
PART IV – APPENDIX 1	

MAINE TURNPIKE AUTHORITY

NOTICE TO CONTRACTORS

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

CONTRACT 2026.07

CROSBY MAINTENANCE OFFICE BUILDING

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 December 9, 2025 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.

Contractors not currently prequalified by MaineDOT for Building projects can seek prequalification for this project prior to the award by submitting the prequalification application included with this notice directly to the Authority at the above address. Contractors not currently prequalified by MaineDOT for Building Projects or Contractors not prequalified by the MTA for Building projects may not be awarded a contract for this project.

This Project includes a wage determination developed by the State of Maine Department of Labor.

The work consists of the following:

1. Construction of an approximate 6,000 square foot wood-framed building consisting of offices, a crew room with kitchenette, locker and toilet rooms.
2. Construction includes, but is not necessarily limited to, the following:
The work includes all building structure, mechanical, electrical, and plumbing, as well as all site work, grading, pavement, lighting, utilities, and all other work incidental thereto in accordance with the Plans and Specifications.
3. Construction of reinforced concrete footings, piers, foundation walls, and slabs-on-grade including exterior concrete aprons and entry foundation/slab systems.
4. Construction of the building proper, including all equipment and interior and exterior finishes.
5. Furnishing and installing plumbing, heating, and electrical, complete with all appurtenances and accessories.
6. Coordinating with the utility to provide transformers and connections.
7. Coordinating with the utility to relocate existing underground power and telecom connections to the Police Garage located on the campus, to overhead lines include new

poles, service drops to underground conduit and wire, and new underground manholes with spliced connections.

Plans and Contract Documents may be examined by prospective Bidders weekdays between 8:00 a.m. and 4:30 p.m. at the office of the Maine Turnpike Authority, 2360 Congress Street, Portland, Maine. The Plans and Contract Documents may be obtained from the Authority upon payment of **Four Hundred Fifty Dollars and Zero Cents (\$450.00)** 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/projects/Construction-Contracts.aspx>.

For general information regarding Bidding and Contracting procedures, contact:

Nathaniel F. Carll, Purchasing Manager
Maine Turnpike Authority
2360 Congress Street, Portland, ME 04102.
Phone: (207) 482-8115; Email: ncarll@maineturnpike.com.

For information regarding Schedule of Items, plan holders list and bid results, visit our website at <http://www.maineturnpike.com/projects/Construction-Contracts.aspx>. For Project specific information, all questions to Nate Carll, Purchasing Manager email ncarll@maineturnpike.com. 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 March 2014", "Standard Details, Revision of March 2020" 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 November 4, 2025 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.

Very Truly Yours,
MAINE TURNPIKE AUTHORITY

Nate Carll
Purchasing Manager
Maine Turnpike Authority

Maine Turnpike Authority

MAINE TURNPIKE

PROPOSAL

CONTRACT 2026.07

CROSBY MAINTENANCE OFFICE BUILDING

MAINE TURNPIKE AUTHORITY

PROPOSAL

CONTRACT 2026.07

CROSBY MAINTENANCE OFFICE BUILDING

TO MAINE TURNPIKE AUTHORITY:

The work consists of the following:

1. Construction of an approximate 6,000 square foot wood-framed building consisting of offices, a crew room with kitchenette, locker and toilet rooms.
2. Construction includes, but is not necessarily limited to, the following:
The work includes all building structure, mechanical, electrical, and plumbing, as well as all site work, grading, pavement, lighting, utilities, and all other work incidental thereto in accordance with the Plans and Specifications.
3. Construction of reinforced concrete footings, piers, foundation walls, and slabs-on-grade including exterior concrete aprons and entry foundation/slab systems.
4. Construction of the building proper, including all equipment and interior and exterior finishes.
5. Furnishing and installing plumbing, heating, and electrical, complete with all appurtenances and accessories.
6. Coordinating with the utility to provide transformers and connections.
7. Coordinating with the utility to relocate existing underground power and telecom connections to the Police Garage located on the campus, to overhead lines include new poles, service drops to underground conduit and wire, and new underground manholes with spliced connections.

This Work will be done under a Contract known as Contract 2026.07 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. 2026.07
CROSBY MAINTENANCE OFFICE BUILDING**

Item No	Item Description	Units	Approx. Quantities	Unit Prices in Numbers		Bid Amount in Numbers	
				Dollars	Cents	Dollars	Cents
202.81	REMOVING STRUCTURES AND OBSTRUCTIONS	Lump Sum	1				
202.202	REMOVING PAVEMENT SURFACE	Square Yard	2,300				
203.20	COMMON EXCAVATION	Cubic Yard	3,075				
203.25	GRANULAR BORROW	Cubic Yard	300				
203.2312	HEALTH AND SAFETY PLAN	Lump Sum	1				
203.2333	DISPOSAL AND TREATMENT OF SPECIAL EXCAVATION	Ton	50				
203.234	TREATMENT OR DISPOSAL OF CONTAMINATED GROUNDWATER	Gallon	500				
203.35	CRUSHED STONE 3/4 INCH	Cubic Yard	150				
304.10	AGGREGATE SUBBASE COURSE - GRAVEL	Cubic Yard	1,100				
304.105	STRUCTURAL FILL	Cubic Yard	1,475				
304.14	AGGREGATE BASE COURSE - TYPE A	Cubic Yard	550				

CARRIED FORWARD:

Item No	Item Description	Units	Approx. Quantities	Unit Prices in Numbers		Bid Amount in Numbers	
				Dollars	Cents	Dollars	Cents
BROUGHT FORWARD:							
403.207	HOT MIX ASPHALT - 19.0 MM NOMINAL MAXIMUM SIZE	Ton	350				
403.208	HOT MIX ASPHALT - 12.5 MM NOMINAL MAXIMUM SIZE	Ton	200				
403.209	HOT MIX ASPHALT - 9.5 MM NOMINAL MAXIMUM SIZE	Ton	50				
409.15	BITUMINOUS TACK COAT RS-1 OR RS1h - APPLIED	Gallon	375				
419.30	SAWCUT BITUMINOUS PAVEMENT	Linear Foot	325				
502.701	CONCRETE EQUIPMENT PAD	Each	1				
502.702	CONCRETE PROPANE TANK PAD	Each	1				
604.15	MANHOLE	Each	1				
604.151	MANHOLE COVER 57" INTERIOR DIAMETER	Each	1				
604.158	UTILITY VAULT - 4' X 6'	Each	2				
605.072	4 INCH PERFORATED SDR-35 UNDERDRAIN	Linear Foot	375				
606.356	UNDERDRAIN DELINEATOR POST	Each	1				

CARRIED FORWARD:

Item No	Item Description	Units	Approx. Quantities	Unit Prices in Numbers		Bid Amount in Numbers	
				Dollars	Cents	Dollars	Cents
BROUGHT FORWARD:							
615.07	LOAM	Cubic Yard	325				
618.14	SEEDING METHOD NUMBER 2	Unit	17				
619.1201	MULCH - PLAN QUANTITY	Unit	17				
619.1202	TEMPORARY MULCH	Lump Sum	1				
620.58	EROSION CONTROL GEOTEXTILE	Square Yard	1,800				
629.05	HAND LABOR, STRAIGHT TIME	Hour	40				
631.12	ALL PURPOSE EXCAVATOR (INCLUDING OPERATOR)	Hour	40				
631.172	TRUCK-LARGE (INCLUDING OPERATOR)	Hour	40				
631.221	SMALL FRONT END LOADER (INCLUDING OPERATOR)	Hour	20				
631.36	FOREMAN	Hour	20				
633.031	PROPANE SERVICE	Lump Sum	1				
634.1943	4" SCHEDULE 80 PVC CONDUIT	Linear Foot	125				

CARRIED FORWARD:

Item No	Item Description	Units	Approx. Quantities	Unit Prices in Numbers		Bid Amount in Numbers	
				Dollars	Cents	Dollars	Cents
BROUGHT FORWARD:							
634.1945	2" SCHEDULE 80 PVC CONDUIT	Linear Foot	925				
634.1946	3" SCHEDULE 80 PVC CONDUIT	Linear Foot	350				
634.3122	#2/0 COPPER WIRE - 12 KV RATED (4 WIRE)	Linear Foot	275				
634.3152	#4 GND WIRE	Linear Foot	275				
634.3153	#6 GND WIRE	Linear Foot	125				
634.3335	MANHOLE - FIBER OPTIC - STANDARD	Each	1				
639.19	FIELD OFFICE - TYPE B	Each	1				
656.632	SILT FENCE	Linear Foot	370				
659.1	MOBILIZATION	Lump Sum	1				
670.10	SUBSURFACE WASTEWATER DISPOSAL SYSTEM	Lump Sum	1				
800.01	CROSBY MAINTENANCE BUILDING	Lump Sum	1				
801.14	4 INCH PVC SANITARY SEWER	Linear Foot	15				

CARRIED FORWARD:

Item No	Item Description	Units	Approx. Quantities	Unit Prices in Numbers		Bid Amount in Numbers	
				Dollars	Cents	Dollars	Cents
BROUGHT FORWARD:							
822.322	6 INCH CLASS 52 DUCTILE IRON WATER MAIN	Linear Foot	30				
822.34	8 INCH CLASS 52 DUCTILE IRON WATER MAIN	Linear Foot	500				
823.325	8 INCH GATE VALVE	Each	5				
823.331	6 INCH GATE VALVE	Each	1				
824.32	REMOVE/RESET HYDRANT	Each	1				
825.4222	2 INCH GATE VALVE WITH BOX	Each	3				
825.423	2 INCH HDPE CTS	Linear Foot	250				
825.4311	1 1/2 INCH HDPE CTS	Linear Foot	75				
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)

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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)

SURETY

_____ (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
(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

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<u>SECTION</u>	<u>TITLE</u>	<u>PAGE</u>
	GENERAL DESCRIPTION OF WORK	SP-5
	PLANS	SP-5
101.2	DEFINITION	SP-6
103.4	NOTICE OF AWARD	SP-6
104.3.8	WAGE RATES AND LABOR LAWS	SP-6
104.4.6	UTILITY COORDINATION	SP-9
104.4.6.1	TEMPORARY UTILITIES	SP-10
104.4.7	COOPERATION WITH OTHER CONTRACTORS	SP-11
105.8.2	PERMIT REQUIREMENTS	SP-11
105.11	AS-BUILT PLANS	SP-12
105.11.1	AS-BUILT PLAN SUBMITTALS	SP-12
105.11.2	AS-BUILT PLAN REQUIREMENTS	SP-12
107.1	CONTRACT TIME AND CONTRACT COMPLETION DATE	SP-13
107.1.1	SUBSTANTIAL COMPLETION	SP-13
107.1.2	LIMITATIONS OF OPERATIONS	SP-13
108.2.1	GENERATION OF PROGRESS PAYMENTS	SP-14
108.2.3	MOBILIZATION PAYMENT	SP-14
108.3	RETAINAGE	SP-14
202	REMOVING STRUCTURES AND OBSTRUCTIONS (Removing Buildings) (Removing Generator)	SP-15

203	EXCAVATION AND EMBANKMENT	SP-19
203	EXCAVATION AND EMBANKMENT (CONTAMINATED SOIL AND GROUNDWATER MANAGEMENT)	SP-23
304	AGGREGATE BASE AND SUBBASE GRAVEL (Structural Fill)	SP-29
403	HOT MIX ASPHALT PAVEMENT	SP-31
409	BITUMINOUS TACK COAT	SP-33
419	SAWING AND SEALING JOINTS IN BITUMINOUS PAVEMENT (Sawing Bituminous Pavement)	SP-35
502	STRUCTURAL CONCRETE (Concrete Generator Pad) (Concrete Propane Tank Pad)	SP-37
603	PIPE CULVERTS AND STORM DRAINS (4 Inch PVC Pipe) (6 Inch PVC Pipe)	SP-41
605	UNDERDRAINS (4 Inch Perforated SDR-35 Underdrain)	SP-43

619	MULCH (Mulch – Plan Quantity) (Temporary Mulch)	SP-45
633	PROPANE GAS UTILITY (Propane Service)	SP-47
655	ELECTRICAL (PVC Conduit)	SP-49
670	SEPTIC SYSTEM	SP-51
800	CROSBY MAINTENANCE OFFICE BUILDING	SP-55
825	WATER SERVICE SUPPLY LINES	SP-59
832	SITE BOLLARDS	SP-65

(See Part III- Division 800 for Divisions 01 Thru 28)

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MAINE TURNPIKE AUTHORITY

SPECIFICATIONS

PART II - SPECIAL PROVISIONS

All work shall be governed by the Maine Department of Transportation Standard Specifications, Revision of March 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

New Building:

- a. The proposed building is a single story wood framed structure of approximately 6,000 square feet that houses offices, a crew room with kitchenette, locker and toilet rooms. The attic contains a platform to accommodate mechanical equipment. The exterior is primarily brick clad with a metal shed roof and aluminum windows and entrances.

Site/Civil:

- a. All site work as shown on the plans including paving, gravels, grading, loam, seed, storm drain, water, and sewer pipe, and all other work necessary to restore all disturbed portions of the site.
- b. Paving the area between the maintenance garage and new building.
- c. Install onsite subsurface wastewater disposal system comprised of precast concrete septic tank and concrete chambers able to withstand H-20 loading.
- d. Remove existing generator and adjacent heater and stack onsite, and install new exterior generator with new generator pad, new electrical building with pad, and new service drop, entrance, and transfer switch.
- e. Construct new concrete pad and provide (1) new exterior propane tank adjacent to the (2) existing tanks. Establish a connection to the new building.

Install new and rerouted underground power to serve MTA Crosby Maintenance Office Building via the 8-Bay Garage, including service transformer upgrade to the 8-Bay Garage and new poles to provide aerial feed. In addition, existing underground power and data currently serving State Police Garage at the back of the campus to be relocated to new poles via aerial feed, and brought down from poles to reconnect with underground distribution. Two (2) new manholes to be provided, one each for Power and Telecommunications. Existing wires to be spliced to new within manholes.

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 2026.07 – CROSBY MAINTENANCE OFFICE BUILDING”**. 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

Holidays

The following is added after Memorial Day in the Supplemental Specifications:

Christmas 2025	12:01 p.m. (Noon) preceding Wednesday to 6:00 a.m. the following Monday
New Years 2026	12:01 p.m. (Noon) preceding Wednesday to 6:00 a.m. the following Friday
Independence Day 2026	12:01 p.m. (Noon) preceding Thursday to (Fourth of July) 6:00 a.m. the following Monday.

103.4 Notice of Award

The following sentence is added:

The Maine Turnpike Authority Board is scheduled to consider the Contract Award on December 18, 2025.

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:

THIS DOCUMENT MUST BE CLEARLY POSTED AT ALL CONSTRUCTION SITES FUNDED IN PART WITH STATE FUNDS

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.

2025 Fair Minimum Wage Rates – Building 2 Cumberland County (other than 1 or 2 family homes)

Occupational Title	Minimum Wage	Minimum Benefit	Total
Brickmasons And Blockmasons	\$33.00	\$11.13	\$44.13
Bulldozer Operator	\$34.90	\$2.24	\$37.14
Carpenter	\$28.72	\$19.38	\$48.10
Cement Masons And Concrete Finisher	\$43.67	\$34.75	\$78.42
Construction And Maintenance Painters	\$27.00	\$1.39	\$28.39
Construction Laborer	\$21.90	\$19.72	\$41.62
Crane And Tower Operators	\$40.00	\$12.41	\$52.41
Crushing Grinding And Polishing Machine Operators	\$27.50	\$5.64	\$33.14
Earth Drillers - Except Oil And Gas	\$23.30	\$0.99	\$24.29
Electrical Power - Line Installer And Repairers	\$43.26	\$16.55	\$59.81
Electricians	\$37.43	\$20.07	\$57.50
Elevator Installers And Repairers	\$71.21	\$43.75	\$114.96
Excavator Operator	\$32.00	\$4.29	\$36.29
Fence Erectors	\$26.00	\$2.63	\$28.63
Flaggers	\$20.50	\$0.40	\$20.90
Floor Layers - Except Carpet/Wood/Hard Tiles	\$25.75	\$3.73	\$29.48
Glaziers	\$46.26	\$22.61	\$68.87
Grader/Scraper Operator	\$31.00	\$6.86	\$37.86
Hazardous Materials Removal Workers	\$20.00	\$0.94	\$20.94
Heating And Air Conditioning And Refrigeration Mechanics And Installers	\$35.00	\$5.62	\$40.62
Heavy And Tractor - Trailer Truck Drivers	\$25.25	\$3.96	\$29.21
Highway Maintenance Workers	\$22.85	\$4.79	\$27.64
Industrial Machinery Mechanics	\$30.00	\$4.60	\$34.60
Industrial Truck And Tractor Operators	\$26.17	\$3.49	\$29.66
Insulation Worker - Mechanical	\$24.00	\$4.63	\$28.63
Ironworker - Ornamental	\$31.37	\$25.82	\$57.19
Light Truck Or Delivery Services Drivers	\$27.86	\$1.95	\$29.81
Loading Machine And Dragline Operators	\$27.50	\$6.43	\$33.93
Millwrights	\$31.45	\$15.17	\$46.62
Mobile Heavy Equipment Mechanics - Except Engines	\$30.00	\$5.67	\$35.67
Operating Engineers And Other Equipment Operators	\$28.50	\$3.54	\$32.04
Paving Surfacing And Tamping Equipment Operators	\$28.60	\$12.03	\$40.63
Pile-Driver Operators	\$36.00	\$2.87	\$38.87
Pipe/Steam/Sprinkler Fitter	\$43.76	\$25.44	\$69.20
Pipelayers	\$27.48	\$4.72	\$32.20
Plumbers	\$38.75	\$22.96	\$61.71
Pump Operators - Except Wellhead Pumps	\$56.03	\$34.76	\$90.79
Radio Cellular And Tower Equipment Installers	\$30.00	\$4.85	\$34.85
Reinforcing Iron And Rebar Workers	\$56.69	\$2.27	\$58.96
Riggers	\$31.95	\$25.00	\$56.95
Roofers	\$29.00	\$0.00	\$29.00
Sheet Metal Workers	\$28.38	\$5.82	\$34.20
Structural Iron And Steel Workers	\$31.95	\$25.00	\$56.95
Tapers	\$29.00	\$2.02	\$31.02
Telecommunications Equipment Installers And Repairers - Except Line Installers	\$33.44	\$9.75	\$43.19
Telecommunications Line Installers And Repairers	\$40.99	\$20.56	\$61.55

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
Wage & Hour Director
Bureau of Labor Standards

Expiration Date: 12-31-2025
Revision Date: 2-3-2025

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104.4.6 Utility Coordination

This Subsection is amended by the addition of the following: General

Utility working days are Monday through Friday, conditions permitting. Times are estimated on the basis of a single crew for each utility. Any times and dates mentioned are estimates only and are dependent upon favorable weather, working conditions, and freedom from emergencies. The Contractor shall have no claim against the Authority if they are exceeded.

The Contractor shall plan and conduct his operations in accordance with the following utility schedule. The Contractor must comply with all OSHA regulations pertaining to work adjacent to utility wires. The Contractor shall plan and conduct his work accordingly.

The following utilities are located within the Project limits. The Contractor shall ascertain the location of the existing utilities and any other necessary information by direct inquiry at the office of the following utility owners:

AERIAL AND UNDERGROUND UTILITIES

COMMUNICATIONS:

Fidium Fiber
Patrick Morrison
600 Sable Oaks Dr.
South Portland, ME 04106
(207) 745-9363

CABLE TELEVISION

Spectrum
118 Johnson Road
Portland, ME 04102
(207) 253-2324

ELECTRIC:

Central Maine Power Company
Attn: James Cough & Anthony Boucher
57 Old Winthrop Road
Augusta, ME 04333
(207) 578-2062

CMP will rework existing aerial primary lines around the new building by setting a new pole and routing the overhead primary lines to the existing utility pole feeding the 8-bay garage. The three 10kva transformers shall be replaced by CMP with three 50kva transformers. Coordinate connection of secondary conductors to transformers with CMP.

CMP is estimated to require seven working days to rework the aerial electrical lines and two additional working days to remove the existing overhead lines and pole work.

The contractor shall notify CMP thirty working days prior to the utility coordination meeting with details on the change in aerial route. The pre-construction utility coordination effort is to relay contractor's construction schedule. The contractor shall notify CMP sixty working days prior to the need to deenergize the existing service and energize the new service

FIDIUM FIBER

Fidium Fiber is estimated to require two working days to install new service.

The contractor shall notify Fidum Fiber ten (10) working days prior to the utility coordination meeting with details on the change in service location. The coordination effort is to relay contractor's construction schedule and schedule of the new service. The contractor shall notify Fidium Fiber and Maine State Police sixty (60) working days prior to the need to remove the existing service and install the new service.

SPECTRUM CABLE

Spectrum is estimated to require two working days to install new service.

The contractor shall notify Spectrum ten (10) working days prior to the utility coordination meeting with details on the change in service location. The coordination effort is to relay contractor's construction schedule and schedule of the new service. The contractor shall notify Spectrum sixty (60) working days prior to the need to remove the existing service and install the new service.

MAINE STATE POLICE

Outages will affect the Maine State Police Garage and the representative noted above must be coordinated with during planned outages.

104.4.6.1 Temporary Utilities

The Contractor will be required to maintain access and all services/utilities, including backup power systems to the existing MTA facilities on site throughout construction. Existing services and utilities include, but are not necessarily limited to, permanent, temporary, and backup power, telephone, internet, water, sewer, propane, heat, and site/roadway lighting.

The Contractor shall be responsible for all temporary connections, service runs, relocations, disconnections, reconnections, temporary holding tanks, coordination with the MTA's propane supplier, coordination with the MTA's maintenance supervisors, etc. required to maintain these services for the duration of the project or until the permanent facilities are reconnected and properly working. This includes any required temporary services for the new building, maintenance garages, and any other MTA Facility within the vicinity of the project. Temporary propane services and holding tanks shall be protected by jersey barriers during construction. Temporary power may be provided on wooden poles located outside the clear zone or protected. The contractor shall coordinate with the MTA on temporary service locations as to not interfere with MTA maintenance activities during

construction.

Prior to start of construction, the Contractor shall submit a plan and schedule for maintaining existing services and utilities. No work on the project shall commence until this plan is approved by the MTA. 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 existing services and utilities and all temporary utility work, including proposed temporary connections, service runs, relocations, disconnections, reconnections, temporary tanks, coordination efforts, etc. shall be incidental to Contract 2026.07.

104.4.7 Cooperation With Other Contractors

This Subsection is amended by the addition of the following:

The Contractor for Contract 2026.07 shall be responsible for working cooperatively with adjacent contractors and the Maine Turnpike Authority to reasonably accommodate and allow all approved operations on site.

105.8.2 Permit Requirements

The Project is subject to the Stormwater Memorandum of Agreement for Stormwater Management Between the Maine Department of Transportation, Maine Turnpike Authority, and Maine Department of Environmental Protection (Stormwater MOA). Under the Stormwater MOA, all MTA construction, operation, and maintenance activities are subject to Maine Stormwater Law Basic Standards through implementation of MaineDOT's Best Management Practices for Erosion and Sedimentation Control (MaineDOT BMP Manual), which are the Contractor's responsibility to implement.

All wetland fills authorized by the Army Corps of Engineers permit must be in-place by October 14, 2026.

The Project is being constructed under Section 404 of the Clean Water Act, pursuant to the U.S. Army Corps of Engineers (Corps) General Permits for the State of Maine. Maine Turnpike Authority has obtained Self-Verification Notification authorization from the Corps under the General Permits for the State of Maine, and a copy of the authorization/ permit is provided in Attachment A. Permanent or temporary/ construction-phase disturbance to wetlands must be limited to those areas identified on the project plan set for Contract 2026.07. Under Contract 2026.07, the Contractor will be required to adhere to the conditions and requirements of the U.S. Army Corps of Engineers authorization/ permit, including but not limited to the General Conditions specified on pages 5 to 19 of the authorization/ permit provided in Attachment A.

The Contractor shall prepare a LOD plan illustrating the Contractor's proposed limit of earthwork disturbance. The LOD plan shall show all construction access locations, field office locations, material and temporary waste storage locations, as well as include the Contract limits of earthwork disturbance. All applicable erosion and sedimentation control devices needed shall be detailed on the Contractor's LOD plan and are not limited to those devices shown on the Contract LOD plan. **This Plan shall be submitted for review and approval, to the Resident within 14 days of Contract award.** Payment

for creating, revising, and completing this plan shall be incidental to Item 659.10, Mobilization.

If at any time during the Contract, the Limit of Disturbance needs to be adjusted to accommodate construction activities, the Contractor shall resubmit the LOD plan (including any additional erosion and sedimentation control measures needed) to the Resident for review and approval prior to any additional disturbance taking place:

- If the cumulative area of disturbance is less than one acre, the Resident shall have a minimum of five (5) working days to approve the revised LOD plan.
- If the cumulative area of disturbance exceeds one acre, the Resident shall first approve of the plan and then possibly submit a MCGP NOI to Maine DEP for approval. The approval may take a minimum of 14 working days from the date of submittal to Maine DEP.

Compliance with the erosion and sedimentation control requirements outlined in this Contract is required by the Contractor.

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

All work for Contract 2026.07 shall be completed by the following dates:

- Substantial Completion – Site and Building: November 20, 2026
- Final Completion: December 18, 2026

The MTA will entertain a start date for this work after a successful MTA Board Approval on November 20, 2025. The contractor shall anticipate long lead time items and move immediately into the design and shop drawing submittal phase of such items, including but not limited to the building. Liquidated damages will occur for each day after the above noted dates.

107.1.1 Substantial Completion

This subsection is amended by the addition of the following:

Substantial Completion is defined as having completed the following work:

- New building is complete including construction of all building foundation, framing and insulation, roofing, siding, doors, interior finish carpentry, interior and exterior painting, and commissioning of all building electrical, mechanical, heating, and plumbing systems. Building shall be released to the MTA for occupancy.
- All base and surface pavement placed to line and grade as shown on the plans.
- Propane service, generator, domestic water system, and subsurface wastewater disposal system operational.

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

107.1.2 Limitations of Operations

Construction of the new building shall not, in the opinion of the Resident, prohibit the safe and reasonable operations of MTA maintenance crews. The Contractor shall provide clear access to the refueling station and all existing buildings, including the sand and salt sheds, at all times during

construction.

The Contractor shall submit their proposed staging, storage and construction areas for approval to the Resident. The Contractor shall be responsible for minimizing the footprint of the project, and resulting impacts to the MTA, to the extent practical. The Authority will allow the contractor to store materials on site prior to starting work. Site access and final area used for storage shall be coordinated and approved by the Resident.

The Contractor shall be responsible for maintaining all utility services, including backup power at all times during construction, except as noted herein. The following system outages are allowed and shall be scheduled and approved by the MTA at least two weeks prior to the beginning of any outage:

- Backup power: Not to exceed three weeks. Limited to between June 1st and October 15th.
- Domestic water service: Not to exceed one week.

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 underground 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.

SPECIAL PROVISION

SECTION 202

REMOVING STRUCTURES AND OBSTRUCTIONS

(Removing Meter Pit)

202.01 Description

The following paragraphs are added:

The work shall also consist of removing and disposing of the concrete meter pit and all associated items.

All materials shall become the property of the Contractor, except as specified below, and shall be removed from the site prior to the completion of the Project. The Contractor shall provide the Resident with an affidavit stating the final location of all disposed material and that the material was disposed of in accordance with the Maine Department of Environmental Protection Solid Waste Regulations.

202.02 Removing Meter Pit

The following paragraphs are added:

The meter pit shall be completely removed and disposed of off-site. The resulting hole shall be backfilled and compacted to surrounding levels as required under the provisions regarding excavations below.

Excavations shall be filled with Granular Borrow, meeting specifications of Granular Borrow – Underwater Backfill and compaction requirements for embankment construction – layer method, up to the bottom of the final Bituminous Pavement Section subgrade shown on the plans. Aggregate subbase gravel, aggregate base gravel, and hot mix asphalt shall then be applied per Bituminous Pavement Section or to match existing grade for a temporary condition. Surface treatment shall be pavement millings to maintain vehicle and equipment travel during construction. The contour and grades of site plan and sections are to be followed. Granular borrow, aggregates, and temporary surface treatment up to the existing grade shall be incidental to the removing building pay item.

All materials and items contained therein shall become the property of the Contractor and shall be completely removed from the project site. All debris and unusable materials shall be removed to an approved transfer station or approved landfill. Under no circumstances shall any material or debris be disposed of by burning on the premises nor shall the debris be burned at an off-premise site.

The Contractor shall provide and maintain all temporary barricades, signs or other safety measures necessary for the completion of the work.

The Contractor shall remove all utility service connections prior to demolition of the meter pit. All existing connections shall be cutoff and sealed with a water and gas tight seal to the satisfaction of the Authority's Engineer before such connections are covered by any fill material. Water connections or services shall be cut and completely capped or plugged in a manner to prevent any flow or seepage of water into any excavated area.

Removing the meter pit shall include full decommissioning, removal of all connected utilities back to the subject source.

The Contractor shall obtain any and all permits or licenses necessary for the performance of the work and shall familiarize himself with and conform to all local, State and Federal laws, regulations or ordinances applicable to the work.

Excavation required for the removing meter pit pay item, including all related removals, shall be incidental to the removing meter pit pay item.

202.05 Method of Measurement

The first, second, and third sentences of the first paragraph are deleted and replaced with the following:

Removing Meter Pit will be measured by the lump sum.

Excavation, granular borrow, and all aggregates required within the removing meter pit pay item will not be measured for payment but shall be incidental to the removing meter pit pay item.

202.06 Basis of Payment

This Subsection is amended by the addition of the following:

Removing Meter Pit will be paid for at the Contract lump sum price which price shall be full compensation for the legal removal and disposal the meter pit, including removal of structures, termination of utilities, removal of any wiring back to source, and shall include all excavation, backfill, granular borrow, aggregates, temporary surface treatment, materials, labor, tools and equipment necessary to restore area to existing grade and complete this work. Aggregates and final hot mix asphalt to create final grade shall be paid under the appropriate pay items.

Payment will be made under:

Pay Item

Pay Unit

202.81

Removing Meter Pit

Lump Sum

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SPECIAL PROVISION

SECTION 203

EXCAVATION AND EMBANKMENT

203.01 Description

The following paragraph is added:

The work shall consist of cutting, removing, and disposing of full depth existing bituminous concrete pavement as shown on the Plans, or as approved by the Resident. The pavement shall be sawcut to the full depth of pavement at the limits of the excavation to provide a clean, vertical cut surface. The surface pavement adjacent to the sawcut shall then be milled 1½” as shown in the Pavement Sawcut detail included in the plans.

Common excavation shall include all excavation (including over excavation) within the project limits. This shall include the complete removal and disposal of all material unsuitable for re-use on the project, existing pavement, topsoil, organics, foundations, utilities, relic materials, and structures that are located under the proposed building footprint including as defined in the Geotechnical Report and as noted on the Typical Sections.

During excavation if suitable material is encountered, it may be left in place or re-used on other portions of the project with approval from the Resident, and in accordance with the Plans and these Specifications.

Fill to raise grades in landscaped and/or seeded areas shall be compactable earth meeting the requirements of Maine DOT Standard Specification 703.18, Common Borrow.

Fill to raise grades in paved areas, and in areas of backfill for over excavations, shall meet the requirements of Maine DOT Standard Specification 703.19, Granular Borrow for Embankment Construction, except that portion passing the No. 200 sieve shall be 7.0% or less.

Crushed Stone as noted on the plans, used for underdrain aggregate shall be washed ¾ inch crushed stone meeting the requirements of Maine DOT Standard Specification 703.22, Underdrain Backfill Material, Type C.

203.04 General

The following sentence is added to the end of the third paragraph.

There are no approved waste storage areas or waste areas within the Project limits unless shown on the Plans. Unsuitable materials shall be disposed of off-site in accordance with Subsection 203.06.

All excavations shall be accomplished in accordance with the applicable OSHA Standards. The Resident reserves the right to request the Contractor to prepare an excavation plan. This plan shall include, but not necessarily be limited to, the limit and depth of excavation, side slope, shoring, trench box and utility support.

The on-site soils may be suitable for reuse on site. Materials meeting the requirements for Common Borrow may be used as fill in landscaped and/or seeded areas, provided they are at a compactable moisture content at the time of reuse. Materials meeting the requirements for Granular Borrow may be used as fill provided, they are free of organics and deleterious material and are at a compactable moisture content at the time of reuse. The Contractor shall have test pits performed by a certified soil scientist to assess suitability for reuse of existing material. Test pits to determine the suitability of existing materials will be considered incidental to the project. Relic buried organic materials are unsuitable for reuse.

203.10 Embankment Construction - General

The thirteenth and fourteenth paragraphs are deleted and replaced with the following:

All portions of the embankment shall be compacted in accordance with the designated embankment compaction requirements specified for the Project.

The existing slopes shall be benched as shown on the drawings prior to placing additional fill of any kind. Embankment fill of any kind, should be placed in lifts which extend laterally beyond the limits of the design side slopes such that the specified degree of compaction is achieved within the limits of the completed embankment. The slopes should then be trimmed back to design dimensions.

Fill and backfill shall be compacted to at least 95% of its maximum dry density as determined by ASTM D-1557.

203.16 Winter Construction of Embankments

The word "core" is deleted from the first and second sentences in the first paragraph.

203.18 Method of Measurement

Pay Item

Pay Unit

203.20 Common Excavation

Cubic Yard

203.25 Granular Borrow

Cubic Yard

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SPECIAL PROVISIONSECTION 203EXCAVATION AND EMBANKMENT

(Contaminated Soil and Groundwater Management)

203.01 General

The work under this Specification shall be performed in conformance with the procedures and requirements described herein for the following activities: contaminated soil handling, reuse, temporary stockpiling, transportation, storage and disposal and contaminated water handling, storage, treatment, and disposal. This Specification also addresses contaminated soil location, identification and classification. The intent of this Specification is to ensure that contaminated soil and/or water encountered during construction will be managed in a manner that protects worker health and safety, public welfare and the environment.

A representative from the Authority's Environmental Services Department shall be notified at least five (5) working days prior to beginning any excavation of the contaminated soil. The representative shall be on site to observe and document the work. For unanticipated contaminated areas see Subsection 203.10.

203.02 General Procedure for Excavating Contaminated Soils and Groundwater

- The MTA and RE will engage an environmental professional including a Maine C.G. to oversee facility removal work, provide field screening services with a PID and oleophilic dye tests in accordance with DEP SOP TS004, and prepare appropriate UST closure reports for MTA to submit to DEP in accordance with Chapter 691.
- The contractor shall assume any groundwater encountered during excavation is contaminated and properly containerize and dispose of the groundwater offsite at a licensed disposal facility.
- Based on field screening results, the contractor shall segregate soils for reuse onsite or offsite disposal. In accordance with TS004, the following criteria shall be used to characterize soils (based on using a MniRAE PID):
 - o Soils for unrestricted reuse (i.e. “clean” soil)
 - Any soil with no visual indications of contamination
 - Any soil with an oleophilic dye test yielding a “negative” result, and
 - Any soil with a PID reading less than 40 parts per million (ppm), i.e. the leaching to groundwater field screening guideline
 - o Lightly contaminated soil
 - Any soil with slight discoloration related to contamination
 - Any soil with an oleophilic dye test yielding a “positive or slightly positive” result
 - Any soil with a PID reading exceeding 40 ppm but less than 1,500 ppm
 - o Highly contaminated or petroleum saturated soil
 - Any soil with visible gross contamination
 - Any soil with an oleophilic dye test yielding a “saturated” result
 - Any soil with a PID reading exceeding 1,500 ppm

Note that these field screening guidelines may be adjusted by the Resident and their environmental planner using TS004 based on the PID instrument in use:

Table 1: Approved PID Field Cleanup and Notification Guidelines

Cleanup Scenario	Soil size [grams]	Ion	Thermo	Passport	Foxboro	MiniRAE	Photon
Leaching to GW/ Notification	200	80	60	60	50	40	40
Resident/ Park User	20	700	275	500	250	350	300
Outdoor Commercial Worker/ Excavation-Construction Worker	5	1200	500	850	375	1500	400

Note: No adjustment is made for set points; the response factor should be 1.0 for all instruments.

Based on these characterizations, the following soil management practices shall be employed:

- Soil characterized for unrestricted use can be relocated and reused as general construction material anywhere on the service plaza. If excess soil is generated that cannot be reused this soil should be appropriately evaluated and/or sampled for laboratory analysis prior to reuse.
- Soil characterized as lightly contaminated should be properly stockpiled, covered, and managed as a contaminated material, but can be reused in the vicinity of the fueling systems and this project's borrow needs. Any excess lightly contaminated soil that is not to be reused should be properly characterized and disposed or recycled offsite.
- Soil characterized as highly contaminated or petroleum saturated should either be live loaded or temporarily stockpiled until sufficient volume has been accumulated and shipped offsite for proper disposal or recycling. The contractor may request Resident approval for on-site reuse of this material. A final determination will be made in concert with the MTA and MaineDEP Project Manager as to the level of contamination.
- Stockpiled contaminated soils shall be placed on an impervious surface atop polyethylene sheeting, be properly covered with poly sheeting at the end of each work day or during inclement weather, and appropriate erosion/sedimentation controls should be used in the vicinity of the stockpiles to prevent stormwater from leaching or washing contaminants to nearby impervious surfaces or stormwater management systems.

The Authority's designated representative is responsible for signing any manifests or bills of lading required to transport and dispose of contaminated soil. All documentation and paperwork associated with the transport and disposal of Group 2 and Group 3 soils (i.e., manifests/bills of lading, weigh slips, invoices, permits, etc.) shall be forwarded to the Maine Turnpike Authority's Environmental Services Coordinator at 2360 Congress Street, Portland, Maine 04102 within 30 days of the last shipment of soil to the licensed facility.

203.03 Secured Stockpile Area

Should the Contractor utilize a Temporary Secured Stockpile Area (hereafter referred to as a "Secured Stockpile"), they shall install a continuous one-foot (0.30 m) high compacted soil berm around the Secured Stockpile (see Secured Stockpile Area — Materials below for Specifications pertaining to soil berm, liner, cover and barricades). The Secured Stockpile shall be placed on a liner of 20-mil polyethylene and securely covered with 20-mil polyethylene. The polyethylene liner and cover shall be placed over the soil berm and be installed to ensure that precipitation water drains directly to the outside of the berm perimeter while leachate from the contaminated soil is retained within the stockpile by covering with a polyethylene. The Secured Stockpile and soil

berm shall be enclosed within a perimeter of temporary concrete barriers or security fence. The area within the temporary concrete barriers (or security fence) shall be identified as a "restricted area" to prevent unauthorized access to the contaminated soils. The Contractor shall submit to the Resident a plan (sketch and sections) of the proposed secured stockpile area.

203.04 Secured Stockpile Area - Materials

- A. Polyethylene. Polyethylene used for liner and cover in the Secured Stockpile Area shall have a minimum of 20-mil thickness and shall meet the requirements of ASTM D3020.
- B. Common Borrow. Fill used in the construction of the Temporary Secured Stockpile Area soil berm shall consist of Common Borrow and meet the requirements of Subsection 703.18.
- C. Concrete Barriers or Security Fence. Concrete Barriers or Security Fence to form the sides of the Temporary Secured Stockpile Area shall meet the requirements of Section 526 or Subsection 607.

203.05 Health and Safety/Right-to-Know

Contractors and subcontractors are required to notify their workers of the history of the area and contamination that may be present and to be alert for evidence of contaminated soil and groundwater. The Contractor shall notify the Resident at least 72-hours prior to commencing any excavation.

The Contractor shall prepare a site specific Health and Safety Plan (HASP) for its workers and subcontractors who may work in the contaminated area of the site. A Qualified Health and Safety Professional shall complete the HASP. The HASP shall be submitted to the Authority in accordance with the Submittal section below. The Qualified Health and Safety Professional will be an expert in field implementation of the following federal regulations:

- 29 CFR 1910.120 or Hazardous Waste Operations, and
29 CFR 1926.65 Emergency Response
- 29 CFR 1910.134 Respiratory Protection
- 29 CFR 1926.650 Subpart D - Excavations
- 29 CFR 1926.651 General Requirements
- 29 CFR 1926.652 Requirements for Protective Systems

The Contractor shall designate a person to provide direct on-site supervision of the work in the contaminated area. This person shall have the training and medical surveillance under OSHA 1910.120 (e) and (f) respectively, as detailed above and in addition be qualified as a construction Competent Person [OSHA 1926.32 (I) and (1)]. It is the responsibility of this designated person to make those inspections necessary to identify situations that could result in hazardous conditions (e.g., possible cave-ins, indications of failure of protective systems, hazardous atmospheres, or other hazardous conditions), and then to insure that corrective measures are taken.

Work inside contaminated trench sections may be subject to OSHA's permit-required confined space regulations under 29 CFR 1910.146.

Submittals. The Contractor shall submit for Authority and the Authority's Environmental Services Coordinator, review a site specific Health and Safety Plan (HASP) to the Resident at least two weeks in advance of any excavation work on the Project.

Health and Safety Monitoring. Within the contaminated area of the Project, the Contractor's designated person shall monitor the worker breathing zone for those constituents specified in the Contractor's HASP. The Contractor shall provide all required health and safety monitoring equipment.

203.06 Dewatering

It is likely that groundwater will be encountered during excavation and should its removal become necessary to complete work, it will be treated as “contaminated” water. The Contractor shall inform the Resident before any dewatering commences. The “contaminated” water shall be pumped into a temporary holding tank(s). The Contractor will be responsible for the procurement of any holding tank(s). Any testing, treatment and/or disposal of the stored, petroleum contaminated water shall be undertaken by the Contractor in accordance with applicable Federal, State and local regulatory requirements.

203.07 On-Site Water Storage Tanks - Materials

If dewatering within the identified contaminated area becomes necessary the holding tanks used for temporary storage of contaminated water pumped from excavations shall be contamination-free and have a minimum capacity of 2,000 gallons

203.08 Dust Control

The Contractor shall employ dust control measures to minimize the creation of airborne dust during construction within the contaminated area. As a minimum, standard dust control techniques shall be employed where heavy equipment and the public will be traveling. These may include techniques such as watering-down the site or spreading hygroscopic salts.

203.10 Unanticipated Contamination.

If the Contractor encounters previously undiscovered contamination or potentially hazardous conditions related to contamination, the Contractor shall suspend work and secure the area. The Contractor will then notify the Resident immediately. The Resident will then notify the Authority. These potentially hazardous conditions include, but are not limited to, buried fuel piping, vapor recovery piping, “oil saturated soils”, strong odors or the presence of petroleum sufficient to cause a sheen on the groundwater. The area of potential hazard shall be secured to minimize health risks to workers and the public and to prevent a release of contaminants into the environment. The source of the suspected contamination will be evaluated by the Resident (or MTA Environmental representative). As appropriate, the Resident will notify the Maine Department of Environmental Protection's Response Services Unit in Augusta, and the Authority's Environmental Services Coordinator. The South Portland Fire Department must also be notified prior to removal of buried storage tanks and associated piping. The Contractor will evaluate the impact of the hazard on construction, amend the HASP if necessary, and with the Resident's approval, restart work in accordance with the procedures of

this Special Provision.

203.11 Method of Measurement.

Health and Safety Plan (HASP) will be measured for payment by the lump sum.

Disposal/Treatment of Special Excavation will be measured for payment by the ton.

Disposal/Treatment of Contaminated Groundwater will be measured for payment by the lump sum.

203.012 Basis of Payment.

Health and Safety Plan (HASP) will be paid for at the Contract lump sum price which payment shall be full compensation for development of a Health and Safety Plan (HASP) and providing health and safety equipment and personnel.

Disposal/Treatment of Special Excavation (contaminated soils) will be paid for at the Contract unit price per ton which payment shall be full compensation for excavating, loading, hauling, treatment, placing, grading and compacting, and all necessary equipment and labor. Only soil excavated from within the area shown on the plans or as designated by the Resident will be paid under this pay item.

Disposal/Treatment of Groundwater will be paid for at the Contract unit price per Lump sum which payment shall be full compensation for pumping excavations, loading, hauling, treatment, and all necessary equipment and labor. Only groundwater pumped from excavations with this project will be paid under this pay item.

There will be no measurement for identification and environmental screening of contaminated soil material or groundwater (this will be done by the Resident or Authority's Environmental Services Coordinator).

Construction of a Temporary Secured Stockpile Area, or groundwater holding tank, if necessary, will not be measured separately for payment, but shall be incidental to Items 203.2312, 203.2333, and 203.2334.

Hauling Surplus contaminated soils to the Temporary Secure Stockpile area or placement and removal of contaminated soils in or out of the Temporary Secure Stockpile area will not be measured separately for payment, but shall be incidental to Items 203.2312 and 203.2333.

All hauling and any subsequent management/placement of contaminated soils and/or groundwater shall be incidental to Items 203.2312, 203.2333, and 203.2334.

There will be no separate measurement for additional laboratory testing of contaminated soil that is required by the landfill or treatment facility. Testing shall be incidental to Item 203.2333, and 203.2334.

Payment will be made under:

<u>Pay Item</u>		<u>Pay Unit</u>
203.2312	Health and Safety Plan	Lump Sum
203.2333	Disposal/Treatment of Special Excavation	Ton
203.2334	Disposal/Treatment of Contaminated Groundwater	Lump Sum

SPECIAL PROVISION
SECTION 304
AGGREGATE BASE AND SUBBASE COURSES

(Structural Fill)

304.02 General

Sources of Aggregate and preliminary test results shall be submitted ten working days prior to any placement of material on the job. Failure of these preliminary tests will be grounds for rejection of material from that source. Aggregates will be tested on the job and shall meet these specifications as the material is incorporated into the work.

Back fill for foundations, slab base material and material below the footings and exterior entrance slabs and within the frost transition zone as shown in the typical sections should be clean, non-frost susceptible sand and gravel meeting the graduation requirements for structural fill.

Structural Fill	
Sieve Size	Percent Finer by Weight
4 inch	100
3 inch	90 to 100
¾ inch	25 to 90
No. 40	0 to 30
No. 200	0 to 6

304.06 Method of Measurement

Structural Fill will be measured by the cubic yard in place.

304.07 Basis of Payment

The accepted quantities of structural fill will be paid for at the respective contract unit price per cubic yard complete in place.

The costs for laboratory testing and source documentation shall be incidental to the project. The costs for all failing tests shall be the responsibility of the Contractor.

No additional payment will be made for the temporary placement of gravels during construction.

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
304.105 Structural Fill	Cubic Yard

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SPECIAL PROVISIONSECTION 403HOT MIX ASPHALT PAVEMENTProject PavementFull Depth

Course	HMA Grading	Item Number	Total Thickness	No. of Layers	Complimentary Notes
Base	19.0mm	403.207	2 ½"	1	C,I
Wearing	12.5mm	403.208	1 ½"	1	C,I

Mill, Shim, and Overlay

Course	HMA Grading	Item Number	Total Thickness	No. of Layers	Complimentary Notes
Shim	4.75mm	403.212	½"	1	C,I
Wearing	12.5mm	403.208	1 ½"	1	C,I

COMPLEMENTARY NOTES

- A. The required PGAB for this mixture shall be **64E-28**.
- B. RAP may not be used.
- C. The Maine DOT will conduct the job mix verification. The aggregate qualities shall meet the design traffic level of 3 to <10 million ESALS for mix placed under this contract. Minimum and Maximum PGAB content limits from 401.21 shall not apply.
- D. The MTA will conduct the job mix verification. The aggregate qualities shall meet the design traffic level of 10 to <30 million ESALS for mix placed under this contract. The design verification, Quality Control, and Acceptance tests for this mix will be performed at **75 gyrations**. (N design)
- E. A material transfer vehicle (MTV) shall be used for the placement of Hot Mix Asphalt wearing surface on all roadways including acceleration and deceleration lanes and all ramps.
- F. Joints shall be constructed as the “notched wedge” type in accordance with Subsection 401.17.
- G. Joint density will be measured in accordance with Subsection 401.165.

- H. PGAB shall conform to the provisions of 403.02 – Polymer Modified PGAB for HMA.
- I. The contractor shall furnish a quality control technician equipped with an approved densometer to ensure density requirements are met.
- J. Hydrated Lime shall be incorporated into the mixture.
- K. The antistrip additive Zycotherm manufactured by Zydex Industries shall be incorporated into the PGAB at a rate of 0.1%.

SPECIAL PROVISION

SECTION 409

BITUMINOUS TACK COAT

409.01 Description

This Subsection is deleted and replaced with the following:

This work consists of furnishing and applying one uniform application of Emulsified Asphalt RS-1 or RS-1h conforming to the specifications of AASHTO M-140. The application rate shall be 0.04 gal/yd²

A tack coat is required between pavement lifts as well as on all sawcut butt joints.

409.05 Equipment

Add “or as determined by the Resident”, after the words “gal/yd²” in the fourth line of the second paragraph of this Subsection.

409.06 Preparation of Surface

The following paragraph is added:

All existing pavement and shoulder areas on which bituminous concrete mixtures are to be placed shall receive a tack coat. The surface area where the tack coat is to be applied shall be dry and cleaned of all dirt, sand, and loose material. Cleaning shall be accomplished by use of revolving brooms or mechanical sweepers. Undesirable material not removed by the above means shall be cleaned by hand sweeping or scraping, or a combination of both. Small areas otherwise inaccessible may be swept with hand brooms. The tack coat shall be applied only when the existing surface is dry.

409.08 Method of Measurement

The following paragraphs are added:

Measurement will be based on delivery slips made out in duplicate by the Contractor and signed by the Resident, or his representative, at the point of delivery. One of these slips shall be retained by the Resident and one by the Contractor. Delivery slips shall be furnished by the Contractor and shall provide space for identifying the vehicle and driver, for stating the volume of material carried, the source of the material, the date, and the Resident or his representative's signature.

Material included in the delivery slips and not used or rejected shall be deducted from the amount being measured for payment. Each day's delivery slips shall be reconciled by the Contractor and the Resident within 24-hours.

Cleaning of the surface area where tack coat is to be applied shall be incidental to Item 409.15, Bituminous Tack Coat - Applied.

409.09 Basis of Payment

The following pay items are added:

<u>Pay Item</u>	<u>Pay Unit</u>
409.15 Bituminous Tack Coat RS-1 or RS1h – Applied	Gallon

SPECIAL PROVISIONSECTION 419SAWING AND SEALING JOINTS IN BITUMINOUS PAVEMENT

(Sawing Bituminous Pavement)

419.01 Description

This work consists of sawing and milling of pavement edges bituminous concrete pavement as shown on the Plans, as specified herein or as approved by the Resident.

419.02 General

The bituminous concrete pavement to be sawed and milled shall be accurately marked before cutting. The marking shall be in accordance with the locations as shown on the Plans or as approved by the Resident. Cutting shall be with an approved power-driven saw with an abrasive blade.

Unless otherwise noted or directed, the sawcut shall be vertical, a minimum of 3/8 inch wide, and extend to the depth as shown on the Plans.

Residue or debris from the sawing and milling operation shall be removed immediately and legally disposed of by the Contractor.

419.03 Method of Measurement

Sawing and Milling Bituminous Pavement will be measured by the linear foot of pavement actually cut and accepted. No additional payment will be made for variations in the pavement thickness.

419.04 Basis of Payment

Sawing Bituminous Pavement will be paid for at the Contract unit price per linear foot which shall be full compensation for all materials, tools, equipment labor, and all incidentals necessary for the completion of the work to the satisfaction of the Resident. The disposal of sawcut residue shall be incidental to this item.

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
419.30 Sawing Bituminous Pavement	Linear Foot
413.305 Milling Bituminous Pavement	Linear Foot

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SPECIAL PROVISION

SECTION 502

STRUCTURAL CONCRETE

(Concrete Generator Pad)
(Concrete Propane Tank
Pad) (Concrete Electrical
Building Pad)

502.01 Description

The following paragraphs are added:

The work shall consist of designing, fabricating and installing cast-in-place or precast concrete pads for the backup generator, relocated propane tanks, and electrical building in accordance with these Specifications and in conformity with the lines, grades, and dimensions shown on the Plans.

All work shall be completed in accordance with Supplemental Specifications, Section 502, for cast-in-place concrete, and Standard Specifications, Section 534, for precast concrete.

The design and shop drawings for each slab shall be developed and stamped by a professional engineer licensed to practice in the State of Maine and shall be submitted to the Resident for review and approval. The Contractor shall have approved shop drawings prior to beginning any construction relative to this section.

All top and vertical surfaces of the slabs shall be coated with an approved Protective Coating for Concrete Surfaces meeting the requirements of the MTA's Supplemental Specifications, Section 515.

502.02 Materials

All concrete, whether precast or cast-in-place, shall be Class "AAA" meeting the requirements of the MTA's Supplemental Specifications, Section 502.

All reinforcing steel shall be epoxy coated meeting the requirements of Standard Specification, Section 503.

All anchorages and components permanently embedded in the slabs shall be hot dip galvanized after fabrication.

502.09 Design and Construction Requirements

The following subsection is added:

The slab and anchorage designs, whether precast or cast-in-place, shall be in accordance with the provisions of Standard Specification 534, Section 534.04. A subgrade modulus of 100 pounds per cubic inch shall be used unless an alternate value is submitted and approved.

For precast components all lifting devices on the top surface of the slab shall be hot dip galvanized and recessed into the slab. The lifting device recess shall be filled with an approved non-shrink repair material approved by the Resident.

502.18 Method of Measurement

The following sentences are added:

Generator Pads, Propane Tank Pads, and Electrical Building Pad, will be measured for payment for each slab satisfactorily constructed and accepted.

Reinforcing Steel will not be measured for payment and shall be incidental to the related work.

Protective Coating for Concrete Surfaces will not be measured for payment and shall be incidental to the related work.

All costs associated with obtaining, testing and evaluating drilled specimens for dispute resolution will not be paid for separately, but shall be considered incidental to the related items.

502.19 Basis of Payment

The following paragraph is added:

The unit price payment for each Concrete Generator Pad, Propane Tank Pad, and Electrical Building Pad shall be full compensation for the cost of design and submittals and furnishing all materials, equipment, reinforcing steel, anchorages, clear protective coating, supplies, tools, equipment incidentals, and labor and supervision necessary to satisfactorily complete all work.

Payment will be made under:

<u>Pay Item</u>		<u>Pay Unit</u>
502.701	Concrete Generator Pad	Each
502.702	Concrete Propane Tank Pad	Each
502.703	Concrete Electrical Building Pad	Each

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SPECIAL PROVISION

SECTION 603

PIPE CULVERTS AND STORM DRAINS

(4 Inch PVC
Pipe)

603.01 Description

The following paragraph is added:

This work shall also consist of furnishing and installing four-inch gravity foundation drain pipes at the locations as shown on the Plans or as approved by the Resident.

This work shall also consist of furnishing and installing six-inch gravity sewer pipes at the locations as shown on the Plans or as approved by the Resident.

603.02 Materials

Gravity foundation and sewer pipes (solid) and fittings shall be PVC conforming to ASTM D1785, Schedule 80 or SDR 35. All PVC pipe as shown in the plans shall meet the requirements of Subsection 706.08.

603.11 Method of Measurement

4 Inch PVC Pipe will be measured by the linear foot, actually installed and accepted by the resident.

603.12 Basis of Payment

The accepted quantities of PVC Pipe will be paid for at the contract unit price per linear foot, for the types and sizes specified, complete in place.

Payment will be made under:

Pay Item

Pay Unit

603.04 4 Inch PVC Pipe

Linear Foot

SPECIAL PROVISION

SECTION 605

UNDERDRAIN

(4 Inch Perforated SDR-35 Underdrain)

605.01 Description

The following paragraph is added:

This work shall consist of the construction and placement of an underdrain system to be installed on the outside edge of perimeter footings as well as the outlet drainpipe from the building foundation. The underdrain pipe should consist of 4-inch diameter, perforated SDR-35 foundation drainpipe bedded in Crushed Stone and wrapped in non-woven geotextile fabric. The underdrain pipe must have a positive gravity outlet protected from freezing, clogging and backflow. Surface grades should be sloped away from the building for positive surface water drainage.

605.02 Materials

The following paragraphs are added:

The material used for all 4-inch foundation drains shall be perforated SDR-35.

Underdrain bedding material shall be well graded, clean, coarse gravel, free from organic matter and meeting Subsection 703.22, Type B with no more than two percent by weight passing the #200 sieve.

605.04 Underdrain Construction

The following paragraph is added:

The underdrain system consists of a series of 4-inch perforated SDR-35 lateral underdrain pipes connected to an outlet pipe as shown on the Plans. The underdrain pipe system shall be surrounded by underdrain bedding. A drainage geotextile (as specified in Section 620) shall be placed below the underdrain bedding on a graded, compacted and level base. Drainage geotextile shall also extend vertically along the walls of the underdrain bedding. A underdrain cleanout shall be located at the upstream end of the outlet pipe.

605.06 Method of Measurement

The following paragraph replaces the last paragraph:

All elbows, tees, wyes, or other special fittings required for connecting and fabricating the underdrain will not be measured for payment but shall be incidental to the Underdrain Item.

The following paragraph is added:

The underdrain bedding and drainage geotextile required for the underdrain will not be measured for payment but shall be incidental to the Underdrain Item.

605.07 Basis of Payment

The following paragraph is added:

Payment for 4-inch SDR-35 Underdrain will be made at the Contract unit price per linear foot in place. Payment will be full compensation for furnishing and placing bedding, drainage geotextile, 4 Inch SDR-35 Underdrain, all fittings and connections, cutting and connecting the underdrain, all excavation, backfill, compaction and all labor and equipment necessary to complete the work.

Payment will be made under:

Pay Item

Pay Unit

605.072 4 Inch Perforated SDR-35 Underdrain

Linear Foot

SPECIAL PROVISION

SECTION 619

MULCH

(Mulch – Plan Quantity)
(Temporary Mulch)

619.01 Description

The first paragraph is modified by the addition of the following:

“as a temporary or permanent erosion control measure” after the word

“mulch”. Add the following sentence at the end of the first paragraph:

Refer to Section 656 Temporary Soil and Water Pollution Control, for more information on Temporary Mulch.

619.03 General

The first paragraph is deleted and replaced with the following:

Cellulose fiber mulch shall not be used within 200 feet of a wetland or stream. The limits shall be 200 feet up station and down station of the wetland or streams as well as the slopes adjacent to the stream. The application of hay or straw mulch with an approved binder shall be used at these locations to prevent erosion.

The use of cellulose fiber mulch will only be allowed at other areas with the approval of the Resident. The Contractor may be required to demonstrate that the material may be applied in a manner that will prevent erosion and will aid in the establishment of permanent vegetation. The Resident reserves the right to require the use of hay or straw mulch at all locations if he determines that the cellulose mulch is ineffective. Cellulose fiber mulch is not acceptable for winter stabilization.

619.06 Method of Measurement

The following sentence is added:

Temporary Mulch will be paid for by the lump sum.

619.07 Basis of Payment

Temporary Mulch will be paid for at the Contract price per lump sum which shall be full compensation for furnishing and spreading the Temporary Mulch as many times as necessary as determined by the Contractor's operations and staging. The price shall also include the additional mulch netting and snow removal necessary during the winter months.

Payment will be made under:

Pay Item

619.1201 Mulch – Plan Quantity
 619.1202 Temporary Mulch

Pay Unit

Unit
 Lump Sum

SPECIAL PROVISIONSECTION 633PROPANE GAS UTILITY

(Propane Service)

633.01 Description

This work shall include emptying the existing tanks, removing the existing propane tanks from their foundation, safely storing them on site during construction, installing and maintaining a temporary propane service, and reinstalling of the 1000 gallon above ground propane tanks in the northwest corner of the new Auburn Vehicle Storage Garage, manifold piping between the propane tanks including a primary regulator, High Density Polyethylene (HDPE) propane service line from the tanks to the proposed 8-Bay garage and system testing. The Contractor shall install a complete and functioning system as approved by the MTA propane supplier.

633.02 Materials

The Propane Service Line shall be ½" HDPE distribution pipe meeting the requirements of ASTM D2513.

Backfilling shall consist of placing sand borrow bedding around utility line per plan details and suitable material in all other spaces excavated and not occupied by the utility lines and sand borrow up to the loam elevation. Backfill shall be granular borrow placed at or near optimum moisture content and shall not contain stones larger than three inches, frozen lumps, chunks of clay, organic matter or other objectionable material.

Sand borrow bedding material shall meet the requirements of Subsection 703.01.

633.03 Construction

The Contractor shall coordinate the construction of the Propane Service with the Authority's propane supplier, through the Resident. Backfill of the propane gas piping shall be in accordance with Section 206, Structural Excavation.

The Contractor shall provide a minimum 10-day notice before any backfilling of piping and before system testing. Contractor shall complete all system testing, including but not limited to propane pressure tests (regulator, manifold running, lockup, etc.), leak test, and appliance startup, in the presence of the MTA's Director of Building Maintenance.

The Contractor is responsible for inspecting the existing tanks for defects prior to re-installing them. All pipes shall be new and free of defect. This work shall include the complete removal of the existing propane tank foundations, gas lines, and all miscellaneous items that are a part of the complete and working system.

Warning tapes shall be a metallic/detectable type made of solid yellow film with

continuously printed black-letter caption: "CAUTION—PROPANE GAS BURIED BELOW". The warning tape shall be metallic warning tape manufactured for marking and identifying underground utilities, six inches wide and a minimum of four mils thickness, continuously inscribed with a description of the utility.

633.04 Method of Measurement

Propane Service shall be measured by the Lump Sum complete and accepted.

633.05 Basis of Payment

Propane Service shall be paid for at the Contract unit price per lump sum, which shall be full compensation for relocating propane tanks,, removal of existing propane tank foundations and piping, piping, regulators, shut off valves, system and component testing, and all excavation, backfill, compaction, coordination, materials, equipment and incidental items necessary to complete the work to the satisfaction of the Resident.

Payment will be made under:

Pay Item

Pay Unit

633.031 Propane Service

Lump Sum

SPECIAL PROVISIONSECTION 655ELECTRICAL

(PVC Conduit)

655.01 Description

This task shall include providing and the installation of PVC Conduit as shown on the Plan drawings and described herein. All conduit shall be installed per NEC specification. Connections to specialized fittings are to be compatible with adjoining conduit.

655.03 General

See attached Division 26 – Electrical Specifications and related Specifications for details.

655.05 Method of Measurement

All conduit will be measured by the number of linear feet installed and accepted.

655.06 Basis of Payment

Measurement and payment for installing PVC Conduit as shown on the Plan drawings and described herein will be per linear foot of each type of underground or exposed conduit actually furnished, installed, and accepted at the Contract price per linear foot. This price shall include the furnishing, installing, supporting and connection of the conduit and all various hardware necessary for the installation, the cost of hand digging, trenching, excavating or plowing; furnishing and installing the conduit; furnishing special backfilling materials, pull string, fittings, groundings and bonding; test cleaning interiors of conduits and all materials, labor, equipment and incidentals necessary to complete the work. Temporary patching of trenches shall be incidental to the conduit pay item. Final hot mix asphalt shall be paid for under the appropriate pay item.

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
655.2021 1" Schedule 80 PVC Conduit	Linear Foot
655.2031 2" Schedule 80 PVC Conduit	Linear Foot
655.2041 3" Schedule 80 PVC Conduit	Linear Foot
634.193 4" Schedule 80 PVC Conduit	Linear Foot

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SPECIAL PROVISION

SECTION 670

SEPTIC SYSTEM

The following Section is added:

670.01 Description

This work shall consist of construction of subsurface sewage disposal system to serve the Crosby Maintenance Office Building. The work shall include furnishing and installing sanitary sewer piping, proprietary-type distribution system (piping, fittings, adapters, etc.), sewage pump and suitable fill materials. The work shall also include all testing and all other work necessary to complete the construction, all in accordance with these Specifications and as shown on Subsurface Wastewater Disposal System Application (Appendix E) or as directed by the Resident.

All materials, construction methods and details, and approvals shall conform to these Specifications, the Maine Subsurface Wastewater Disposal Rules, Maine Plumbing Code and all other applicable State and Local Laws and Ordinances.

Before beginning work, the Contractor shall verify that all site conditions and elevations that will have a bearing on the work are as shown on the Plans. If any discrepancies are found, the Contractor shall notify the Resident immediately.

Before any portion of the work can be backfilled, the Contractor shall make arrangements to have the Local Plumbing Inspector inspect the work. Backfilling shall proceed pursuant to approval of the work by the Local Plumbing Inspector.

Coordinate work with that of all other trades affecting or affected by work of this Section.
Cooperate with such trades to assure the steady progress of all Project work.

The septic tank shall be H-20 rated \ consistent with the details presented in the contract Plans. The tank shall have a liquid capacity of at least 1,500 gallons and conform to the applicable requirements of ASTM C478. The tank shall be constructed of concrete with a minimum compressive strength of 5,000 psi at 28 days and use either wire fabric reinforcing meeting the requirements of ASTM A185 or deformed steel reinforcement meeting the requirements of ASTM A615. Reinforcing shall have a minimum yield strength of 40,000 psi.

The work shall also include the application of a Clear Protective Coating for Concrete Surfaces to the top and vertical surfaces of the concrete slab prior to backfilling and paving. All joints shall be watertight and sealed with Tylox superseal rubber gasket or equivalent. Layout design and Shop Drawings for the Holding Tank shall be completed, submitted to, and accepted by the Resident or the MTA prior to any work being completed relative to this section.

Septic tanks shall be located under the parking lots as shown on the plans, and shall have risers and 30" manholes with rim elevations matching the adjacent parking lot elevations.

670.02 Submittals

Shop and working drawing submittals shall include details of all piping, pipe fittings, subsurface disposal system materials, precast concrete structures with risers and manhole and details of interfaces, connections, dimensions, layouts and other pertinent data, including:

Certificates of Compliance for all pipe and precast concrete structures.

670.03 Materials

Gravity sewer pipe (solid) and fittings shall be four inch PVC conforming to ASTM D1785, Schedule 40. Joints shall be integrally formed bell and spigot type, push-on joints conforming to ASTM D3139 with elastomeric gasket conforming to ASTM F477.

The frames and covers shall be 18" and 24" in diameter (See details in the plans) for the 1,500 gallon septic tank. The 18" manhole shall be a Universal Model 98 – Multi-Purpose Manhole and cover or approved equal.

All frames and covers shall be cast iron conforming to the requirements of AASHTO M105 for Class No. 30 gray iron castings suitable for H-20 loading. Frames and covers shall be machined to ensure true bearing surfaces. Cover(s) for the septic tank shall be cast with the word "SEWER" on it. Frame flanges shall have a minimum four-inch width.

The holding tank shall be designed in accordance with the drawings shown in the plans or shall be an approved equal. Distribution piping, fittings, and adapters for the sewage disposal field shall be as an approved equal as determined by the Resident and as approved by the Rules.

The force main pipe and fittings for the NB toll plaza shall be two inch SDR 21 conforming to ASTM D2241 between the septic tank, sewage pump and leach field.

670.04 Sewage Pump

The sewage pump shall be a Goulds Pump Model 3885WE0511H - single phase (115V) 2" discharge pump, with all the needed components for system operation. The pump will be enclosed in a 4 foot diameter 6 foot deep effluent tank located directly downstream from the septic tank. The effluent tank shall contain a Conery BERS-0200 SST 316 Stainless Steel Base Elbow Rail System 2.00" X 2.00", with stainless steel rail guides and brackets for pump removal and maintenance. The effluent tank shall have a 30 inch diameter riser frame and manhole cover and shall conform to the Catch Basin Frames and Grates as outlined in the 604 SP and be manufactured by EJ Company of Brockton, Massachusetts or an approved equal and shall meet or exceed the AASHTO M306 Loading Requirements. The riser shall be installed to match the adjacent proposed parking lot installation.

The pump and control wiring shall be enclosed in a 1 inch schedule 80 conduit running from the effluent tank to a junction box affixed to the side of the toll building. The pump and control wiring shall be spliced within this junction box and run to the control panel located in the toll utility room. The control panel shall be an Ohio Electric Control individual discrete component control panel and shall be located in the Toll Administration Building toll utility room.

670.05 Special Fill for Disposal Bed

Soil material needed for fill beneath, above and adjacent to the system, including fill extensions, shall be a coarse sand to gravel and meet the requirements of the Maine Subsurface Wastewater Disposal Rules. Crushed stone beneath and adjacent to the chambers as shown on the Plan shall conform to the Rules. The Contractor, prior to bringing the stone and fill material on-site, shall submit a representative five-gallon bucket sample of the disposal bed material to the Resident for approval.

670.06 Insulation

Thermal insulation for the top of the chambers shall be rigid cellular polystyrene in accordance with ASTM C578, Type VII, a minimum two inches thick.

670.07 Bedding Material

Bedding material for pipe and structure subgrades shall be gravel borrow per Subsection 703.20 of the Standard Specifications, except that the largest size particle shall be two inches.

670.08 General Construction

Maintain all excavations in proper condition for carrying on the work, and performing all bailing, draining, or pumping as necessary to keep the excavation free of water.

It shall be the Contractor's responsibility to obtain all necessary permits and pay all fees at no additional cost to the Authority.

Excavation, bracing and sheeting for excavations, dewatering and backfilling shall conform to the requirements of Section 203, Excavation and Embankment, of the Standard Specifications. Trench widths shall be as shown on the Plans. Bedding for the pipes and structures shall be as shown on the Subsurface Wastewater Disposal System Application and as specified herein.

670.09 Excavation

Excavation for trenches and structures shall be as specified in Section 203, Excavation and Embankment, of the Standard Specifications.

Contractor shall provide adequate bracing and shoring of all excavations in accordance with the requirements of all governing codes and regulations.

All existing piping and structures exposed during excavation shall be adequately supported, braced or otherwise protected during construction activities.

670.10 Backfilling

Backfill and compaction for trenches and structures shall be as specified in Subsection 206.03, Backfilling, of the Standard Specifications.

670.11 Disposal Bed

The disposal bed shall be constructed as detailed on the Subsurface Wastewater Disposal System Application, as defined by the "Rules". If unsuitable material is encountered and removed at and below the disposal bed surface, granular fill shall be placed and compacted to bring the grade up to the required bed elevation. The Local Plumbing Inspector shall inspect and approve the prepared leaching bed before placement of fill for the disposal bed. Coarse sand to gravel shall be placed below and adjacent to the stone surrounding the chambers as detailed on the Subsurface Wastewater Disposal System Application.

670.12 Installation of Pipe

Pipe and fittings shall be installed in conformance with ASTM D2321 and as detailed on the drawings and per manufacturer recommendations. Pipe shall be laid on a firm compacted gravel borrow foundation at the line and grade designated. A recess shall be excavated to receive the bell or coupling at each joint if necessary. The piping shall be jointed as specified by the manufacturer to form a watertight joint.

Immediately before laying any pipe, the interior surfaces and ends of sections of pipe shall be cleaned by wiping or other procedure as necessary. All pipe shall be firmly bedded in the underlying soil for its entire length. Joints shall be watertight, adjoining sections of pipe shall form a continuous and smooth invert, spigots shall be fully entered, and the joints shall be slightly flexible. Broken or otherwise damaged pipe shall be replaced at the Contractor's own expense. Pipes shall be kept free

of any deposit or debris. The sewer pipe as laid shall be approved by the Resident before any trench is backfilled or embankment is placed.

Any pipe which is not in true alignment, or which shows any settlement after laying, shall be taken up and re-laid without additional cost to the Authority. Any cribbing or subgrade treatment necessary to prevent settlement shall be placed at the Contractor's own expense.

Any damage to the pipe or invert from any cause shall be promptly repaired by the Contractor at his own expense, before backfill is commenced or water passes through the pipe.

Wherever water piping must cross sewer piping, a vertical separation of 18 inches shall be maintained. In no case shall a water pipe cross under a sewer pipe.

670.13 Testing

Testing/acceptance procedures for the sanitary sewer system shall equal or exceed all state and local requirements.

In case leakage exceeds the above specified amount, the Contractor shall locate the leaks and shall repair them at his own expense. Pipelines with shear-type breaks, fishmouths or damaged gaskets, cracked bells or couplings, hairline fractures, or structural damage of any type shall be replaced in kind. Mechanical sleeve couplings poured concrete collars or similar repairs are not permitted. The use of pressure grouting repair techniques will not be allowed without the written consent of the Resident.

After repairs have been made, the line shall be re-tested and the process of repairing and re-testing shall be repeated until results within the above specified limits are obtained.

670.14 Method of Measurement

All the Sewerage Disposal System work, including but not necessarily limited to, all labor, components, materials, equipment and incidental work necessary for the satisfactory completion of the system will be measured for payment as a lump sum, complete and accepted.

670.15 Basis of Payment

Payment will be made for the accepted Sewerage Disposal System, including all excavation, bedding material, special fill, pipes, fittings, septic tank, effluent pump tank, sewage pump, control panel and wiring, pump guide rail system, backfill, and associated work at the Contract lump sum price, which price shall be full compensation for all labor, materials, equipment and incidental work necessary for the satisfactory completion of the work.

Loam, seed and mulch placed on the completed and accepted sewage disposal system will be paid under their respective pay items.

Payment will be made under:

Pay Item

670.11 Subsurface Wastewater
Disposal System

Pay Unit

Lump Sum

SPECIAL PROVISION

SECTION 800

CROSBY MAINTENANCE OFFICE BUILDING

800.01 Description

Section 800 and Divisions 01 through 28 specifies materials, procedures, and requirements for the construction of the new building, complete with all appurtenances, including any and all associated utilities and services within the limits as shown on the Drawings.

The Contractor shall submit to the Resident for approval a cost breakdown of the major components of work for the new building, by Division, for divisions 01 through 28. This breakdown will be used as a basis for monthly pay estimates.

A building walk-thru shall occur 30 days prior to anticipated completion and MTA occupancy of the building. Contractor shall allow the MTA access to the new building to furnish and install necessary equipment. This shall be one week prior to the completion of the building.

The Contractor shall ensure and be responsible for the total and complete coordination of all work in the new building. The Contractor shall generate coordination drawings for the building. Coordination drawings shall:

1. Be computer generated.
2. Show a dimensionally accurate representation of all equipment that was approved by the shop drawing process.
3. Show architectural features, structural features, piping, conduit, ductwork and any other items that require coordination which shall be accurately sized.
4. Be submitted to and approved by the MTA prior to the purchasing of any approved equipment.

800.02 General

The work consists of the following:

- Construction of an approximate 6,000 square foot wood-framed building consisting of offices, a crew room with kitchenette, locker and toilet

rooms.

Construction includes, but is not necessarily limited to, the following:

- The work includes all building structure, mechanical, electrical, and plumbing, as well as all site work, grading, pavement, lighting, utilities, and all other work incidental thereto in accordance with the Plans and Specifications.
- Construction of reinforced concrete footings, piers, foundation walls, and slabs-on-grade including exterior concrete aprons and entry foundation/slab systems.
- Construction of the building proper, including all equipment and interior and exterior finishes.
- Furnishing and installing plumbing, heating, and electrical, complete with all appurtenances and accessories.

800.05 Method of Measurement

The new building, including the work described above, will be measured for payment by the lump sum, complete and accepted.

All earthwork required for building construction, inclusive of earthwork located within the building footprint, including excavation and the placement and compaction of Granular Borrow, Structural Fill, and Crushed Stone will be measured for payment under the appropriate pay items.

Mobilization related to construction of the new building shall be measured for payment under Pay Item 659.10.

800.06 Basis of Payment

The Lump Sum payment for the new building 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:

Pay Item

Pay Unit

800.01 Crosby Maintenance Office Building

Lump Sum

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SPECIAL PROVISION

SECTION 825

WATER SERVICE SUPPLY LINES

825.01 Description

This section shall replace SECTION 625 of the State of Maine Department of Transportation Standard Specifications Revision of November 2014 for the purposes of this Contract.

This work shall consist of installing water service supply lines in close conformity with the lines and grades shown on the plans or established. The installation shall include the assembly of all components and materials shown on the plans or as directed.

The work in this Section shall also include the following:

- Furnishing and installation of pipe, tubing, valves, service boxes, fittings, insulation, and any required accessories for a complete water service supply.
- Connections to existing water systems.
- Resetting service boxes and covers to finish grade.
- Disinfection and testing.

825.02 General

This work shall be done with as little interruption of water service as possible. Ample notification shall be given to the users of the water before any disruption of water service.

825.03 Materials

Water Service Supply Lines

Water service supply lines less than 3 inches shall be high density polyethylene plastic tubing and conform to AWWA standard C901-02 (PE 3608 Pressure Class 200), ASTM D3350, ASTM D2737 and be clearly marked. The product shall be rated for a minimum 200 working PSI and the standard dimension ratio (SDR) shall not exceed 9 for tubing size.

Tubing shall be approved for potable water service by the National Sanitation Foundation (NSF) and bear the NSF seal. Stainless steel inserts shall be used at all connections.

Necessary fittings, adaptors, and reducers shall be furnished as required.

Curb Stops

Curb stops shall be ball valve type construction with compression type fittings on both ends. Curb stops shall open left (counterclockwise) and shall conform to AWWA/ANSI C800, manufactured by Ford, Hayes, Mueller, or an approved equivalent.

Curb stops shall be sized to receive the service tubing without the use of enlargement/reduction fittings.

Fittings

All fittings shall be compression type, designed for use with high density polyethylene plastic tubing (CTS).

Service Boxes, Covers and Rods

Service boxes shall be Erie style, cast iron improved extension type with arch pattern base. Covers shall be held in place with bronze bolts, and the word WATER shall be cast into the top surface of the cover. Service box shafts shall have a minimum inside diameter of 2-1/2 inches. Service boxes shall be adjustable in length from five to six feet and have 1/2-inch diameter stainless steel rod 36-inches in length with brass cotter pins. Service boxes shall be as manufactured by Mueller Co., or an approved equivalent.

Bedding

Bedding material for water service supply lines shall be screened sand consisting of clean, inert, hard, durable grains of quartz or other hard, durable rock, free from loam, clay, surface coatings, frozen or deleterious materials and in conformance with the following gradation:

<u>Sieve (ASTM D422)</u>	<u>Percent Passing by Weight</u>
No. 4	100
No. 8	80 - 95
No. 16	55 - 85
No. 50	0 - 35
No. 200	0 - 5

Bedding material for water service supply lines shall be compacted to a minimum of 92% of the laboratory derived Maximum Density Values at optimum moisture content as

determined by ASTM D1557, Method C.

Insulation

Water service line insulation shall be two layers of 2-inch thick polystyrene plastic insulation in conformance with Section 653 of the Standard Specifications, installed at the locations shown on the plans or as directed.

825.04 Installation

Service Pipe

Care shall be exercised in placing and laying of services to prevent kinks or sharp bends and to prevent contact with sharp stones or ledge which would damage the pipe. At least 6 inches of sand shall be placed adjacent to, under, and above the pipe, and no stone larger than 2 inches shall be placed over the pipe until the depth of backfill above the pipe is in excess of 1 foot. Curb Stop and Curb Boxes

Curb stop and curb boxes shall be of a size equal to the size of the service pipe and shall be installed in the locations shown on the Drawings or as ordered by the Engineer. The boxes shall be set in a vertical position and flush with the proposed finish grade.

Separation from Structures

Whenever possible, water pipes shall maintain a minimum distance of three (3) feet from underground adjacent unheated structures, such as manholes, catch basins, retaining walls, bridge abutments, parking garages, etc.

When spacing described above is not possible, Contractor shall provide insulation for the water pipe for a minimum of three (3) feet beyond the limits of the adjacent structure.

825.05 Testing

Hydrostatic pressure and leakage tests shall be conducted in accordance with AWWA Standard C600 Standards. Domestic water service lines without attached fire service supply shall meet the latest edition of AWWA C600 series leakage requirements for the type of pipe being installed. A certified independent water testing company shall conduct testing.

825.06 Disinfection

Before being placed in service, all new water pipe shall be chlorinated in accordance with ANSI/AWWA C651 Standard for Disinfecting Water Mains.

The location of the chlorination and sampling points will be determined by the

Engineer in the field. Taps for chlorination and sampling shall be installed by the Contractor. The Contractor shall uncover and backfill the taps as required.

The pipe section being disinfected shall be flushed to remove discolored water and sediment from the pipe. A 25 mg/l chlorine solution in approved dosages shall be inserted through a tap at one end while water is being withdrawn at the other end of the pipe section. The chlorine concentration in the water in the pipe shall be maintained at a minimum 25 mg/l available chlorine during filling. To ensure that this concentration is maintained, the chlorine residual shall be measured at regular intervals in accordance with procedures described in Standard Methods and AWWA M12, Simplified Procedure for Water Examination, Section K.

During the application of the chlorine, valves shall be manipulated to prevent the treatment dosage from flowing back into the pipe supplying the water. Chlorine application shall not cease until the entire pipe section is filled with chlorine solution. The chlorinated water shall be retained in the pipe for at least a twenty-four hour period. The treated water shall contain a chlorine residual throughout the length of the pipe section as indicated in AWWA C651.

Following the chlorination period, all treated water shall be flushed from the pipe section and replaced with water from the distribution system. Prior to disposal of treated water, the Contractor shall check with local authorities to determine if the discharge will cause damage to the receiving body or sewer and, if required, the Contractor shall neutralize the chlorinated water in accordance with Appendix B, AWWA C650. Bacteriological sampling and analysis of the replacement water shall then be made by the Contractor in full accordance with AWWA Specification C651. A minimum of three samples shall be taken by the Contractor at locations directed by the Engineer along the length of water pipe being chlorinated and sent to a state- approved private laboratory for analysis. The Contractor shall re-chlorinate if the samples show presence of coliform, and the pipe section shall not be placed in service until all the repeat samples show no presence of coliform.

Furnish two (2) copies of a Certificate of Disinfection Report to the Engineer.

The Contractor shall pay all costs for all testing, flushing, chlorinating, laboratory analyses, sampling, water supply, and municipal charges.

825.06 Method of Measurement

Water service supply lines will be measured by the linear foot installed, to the nearest foot.

825.07 Basis of Payment

The accepted quantity of water service supply lines will be paid for at the contract

unit price, complete in place, which shall be full compensation for all materials, labor, and incidentals required to complete the work.

Excavation, backfill, bedding, compaction, sheeting and shoring, insulation, dewatering, restoration of existing service connections, curb stops, curb boxes, fittings, stainless steel inserts, insulation, pressure testing, disinfection, flushing, maintaining water service, connections to existing water services, restoration of property, loam and seed, as-built drawings and any and all other work necessary or required for a complete operational water supply service shall be considered included in the work of the pay items. Payment for final hot mix asphalt shall be under the appropriate pay item.

Payment will be made under the following:

<u>Pay Item</u>	<u>Pay Unit</u>
822.322 6 Inch Class 52 Ductile Iron Water Main	Linear Foot
822.34 8 Inch Class 52 Ductile Iron Water Main	Linear Foot
824.32 Remove/Reset Hydrant	Each
825.423 2 Inch HDPE Plastic Service	Linear Foot
825.4311 1-1/2 Inch HDPE Plastic Service	Linear Foot

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SPECIAL PROVISIONSECTION 832SITE BOLLARDS832.01 Description

This work shall consist of furnishing and installing Type A Steel Site Bollards consisting of a cast in place concrete base, 6" schedule 80 concrete-filled galvanized steel pipe, and plastic yellow sleeve in accordance with these specifications, and as shown on the Plans.

Shop drawings for the site bollards shall be completed, submitted to, and accepted by the Resident prior to any work being completed relative to this section.

832.02 Materials

Concrete shall be Class "A" concrete and shall meet the requirements of Section 502.

Yellow sleeves are available from the sources noted on the plans or an approved equal.

832.03 Method of Measurement

Type A Steel Site Bollard will be measured for payment by each unit satisfactorily constructed, installed, and accepted. Excavation and concrete will not be measured for payment but shall be incidental to the work under this item.

832.04 Basis of Payment

All work under Section 832.41, Type A Steel Site Bollard, shall be paid for at the contract unit price per each, which shall be full compensation for all materials, labor, and incidentals required to complete the work.

Payment will be made under:

Pay ItemPay Unit

832.41 Type A Steel Site Bollard

Each

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MAINE TURNPIKE AUTHORITY

SPECIFICATIONS

PART III – DIVISION 800

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MAINE TURNPIKE AUTHORITY
CROSBY MAINTENANCE BUILDING
CONTRACT 2026.07

TABLE OF CONTENTS

DIVISION 01 - GENERAL REQUIREMENTS

014533 Code-Required Special Inspections and Procedures
Statement of Special Inspections

DIVISION 02 - NOT USED

DIVISION 03 - CONCRETE

033000 Cast-In-Place Concrete

DIVISION 04 - MASONRY

042000 Unit Masonry Assemblies

DIVISION 05 – METALS

055000 Metal Fabrications

DIVISION 06 - WOOD, PLASTICS, AND COMPOSITES

061000 Rough Carpentry
061200 Structural Insulated Panels (SIPS)
061753 Shop-Fabricated Wood Trusses
062000 Finish Carpentry

DIVISION 07 - THERMAL AND MOISTURE PROTECTION

072100 Building Insulation
072119 Foamed-In-Place Insulation
072300 Under-slab Vapor Retarders
072500 Weather Barriers
072726 Fluid-Applied Air/Vapor Barrier System
074113 Metal Roof Panels
075323 Ethylene-Propylene-Diene-Monomer (EPDM) Roofing
076200 Sheet Metal Flashing and Trim
079200 Joint Sealants

DIVISION 08 - OPENINGS

080671 Door Hardware Schedule
081110 Hollow Metal Doors and Frames
081416 Wood Doors
083113 Access Doors and Frames
084113 Aluminum-Framed Entrances and Storefronts
087100 Door Hardware
088000 Glazing

DIVISION 09 - FINISHES

092110 Gypsum Board Assemblies
093100 Tile

095113 Acoustical Panel Ceilings
099000 Painting and Coating

DIVISION 10 - SPECIALTIES

102800 Toilet, Bath, and Laundry Accessories
104400 Fire-Protection Specialties
105113 Phenolic Lockers

DIVISION 11 – NOT USED

DIVISION 12 - FURNISHINGS

122413 Roller Window Shades
124813 Entrance Floor Mats and Frames

DIVISION 13- NOT USED

DIVISION 21 – FIRE SUPPRESSION

210500 Common Work Results for Fire Suppression
211313 Wet-Pipe Sprinkler System

DIVISION 22 - PLUMBING

220500 Common Work Results for Plumbing
220519 Meters and Gages for Plumbing Piping
220523 General-duty Valves for Plumbing Piping
220529 Hangers and Supports for Plumbing Piping and Equipment
220553 Identification for Plumbing Piping and Equipment
220700 Plumbing Insulation
221116 Domestic Water Piping
221119 Domestic Water Piping Specialties
221123 Domestic-Water Pumps
221316 Sanitary Waste, Vent and Condensate Piping
221319 Sanitary Waste Piping Specialties
221616 Facility Liquified-Petroleum Gas Piping
221619 Soil Gas Venting
223400 Fuel-Fired Domestic Water Heaters
224000 Plumbing Fixtures
224700 Drinking Fountains and Water Coolers

DIVISION 23 - HEATING VENTILATING AND AIR CONDITIONING

230500 Common Work Results For HVAC
230513 Common Motor Requirements for HVAC Equipment
230517 Sleeves and Escutcheons for HVAC Piping
230519 Meters and Gauges for HVAC Piping
230529 Hangers and Supports for HVAC Piping and Equipment
230553 Identification for HVAC Piping and Equipment
230593 Testing, Adjusting, and Balancing for HVAC
230713 Duct Insulation
230719 HVAC Piping Insulation
230900 Instrumentation and Control for Mechanical Systems
232113 Hydronic Piping
232118 Hydronic Specialties

232123	Hydronic Pumps
232300	Refrigerant Piping
232500	HVAC Water Treatment
233113	HVAC Ducts
233300	Air Duct Accessories
233400	HVAC Fans
233700	Air Outlets and Inlets
233813	Commercial-Kitchen Hoods
235100	Breechings, Chimneys, and Stacks
235216	Condensing Boilers
236200	Packaged Compressor and Condenser Units
237300	Indoor Central-Station Air Handling Units
238126	Split-System Air-Conditioners
238200	Convection Heating and Cooling Units
238316	Radiant-Heating Hydronic Piping

DIVISION 24-25 – NOT USED

DIVISION 26 – ELECTRICAL

260010	Supplemental Requirements for Electrical
260519	Low-Voltage Electrical Power Conductors and Cables
260526	Grounding and Bonding for Electrical Systems
260529	Hangers and Supports for Electrical Systems
260533	Raceway and Boxes for Electrical Systems
260543	Underground Ducts and Raceways for Electrical Systems
260544	Sleeves and Sleeve Seals for Electrical Raceways and Cabling
260553	Identification for Electrical Systems
260923	Lighting Control Devices
262416	Panelboards
262726	Wiring Devices
262813	Fuses
262816	Enclosed Switches and Circuit Breakers
265119	LED interior Lighting
265213	Emergency and Exit Lighting
265619	LED Exterior Lighting

DIVISION 27 - COMMUNICATIONS

270010	Supplemental Requirements for Communications
270528	Pathways for Communications Systems
271513	Communications Copper Horizontal Cabling

DIVISION 28 - ELECTRONIC SAFETY AND SECURITY

284621.11	Addressable Fire-Alarm Systems

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SECTION 014533 - CODE-REQUIRED SPECIAL INSPECTIONS AND PROCEDURES

PART 1 GENERAL

1.1 INTENT AND CONDITIONS

A. Intent

1. Define and coordinate special inspection and testing services.
2. Provide confidence that the specified work is constructed in compliance with the contract documents and the intent of applicable codes and Chapter 17 of the 2021 International Building Code (IBC) as adopted by the current Maine Uniform Building and Energy Code.
3. Special inspection and testing services are intended to assist in determining probable compliance of the Work with requirements specified. These services do not relieve the Contractor of responsibility for compliance with the requirements of the Contract Documents.

B. Conditions

1. If inspection of a fabricator's work is required, the Owner or Architect may require testing and inspection of the Work at the plant, before shipment. Owner and Architect reserve the right to reject material not complying with the Contract Documents.
2. Refer to individual technical specification sections for specific qualifications, inspections, tests, frequency and standards required. Testing and inspection shall be performed in accordance with the referenced standard for the specific material or procedure unless other criteria are specified. In the absence of a referenced standard, tests shall be performed in accordance with generally accepted industry standards.
3. Work shall be checked as it progresses. Failure to detect any defective Work or materials shall not prevent later rejection if defective Work or materials are discovered, nor shall it obligate Owner to accept such Work.
4. Special inspection, testing, and periodic inspections by the Building Official do not preclude the normal field involvement and site observations by Architect or SER.
5. Special inspection, testing, and periodic inspections by the Building Official do not relieve the Contractor of any responsibility to complete the Work in accordance with the approved Drawings and Specifications.
6. Testing agents and/or Special Inspectors may not waive or alter Contract Document requirements, or approve, accept, or reject any portion of the Work unless specifically authorized by the Architect or SER. They may not assume any duties of the Contractor, and they have no authority to stop or reject Work.

1.2 RELATED REQUIREMENTS

- ##### A.
- Drawings and general provisions of the Contract, including Division 1 Specifications apply to this Section.

1.3 DEFINITIONS

- A. Testing: Evaluation of systems, primarily requiring physical manipulation and analysis of materials, in accordance with approved standards.
- B. Inspection: Evaluation of systems, primarily requiring observation and judgment.
- C. Special Inspections: Special inspections include inspections of items required by the 2015 IBC, as adopted by the Maine Uniform Building and Energy Code, or its referenced standards.
- D. Testing: Testing includes those tests of items required by the 2015 IBC, as adopted by the Maine Uniform Building and Energy Code, or its referenced standards.
- E. Architect of Record: The prime consultant in charge of overall design and coordination of the Project.
- F. Structural Engineer of Record (SER): The licensed professional engineer in responsible charge of the structural design for the Project.
- G. Licensed Structural Engineer: A professional engineer with education and experience in the design of structures similar to this Project licensed to practice in the state in which the Project is located.
- H. Testing Agency (TA): The properly qualified firm performing testing services.
- I. Special Inspector (SI): A properly qualified individual or firm performing special inspections.
- J. Building Official: The officer or their duly authorized representative charged with the administration and enforcement of the building code for the Project.

1.4 REFERENCES

- A. ASTM C1077-02 – Practice for Laboratories Testing Concrete and Concrete Aggregates for Use in Construction and Criteria for Laboratory Evaluation.
- B. ASTM C1093-95 - Practice for the Accreditation of Testing Agencies for Unit Masonry.
- C. ASTM D3740-01 - Practice for Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction.
- D. ASTM E329-02 - Specification for Agencies Engaged in the Testing and/or Inspection of Materials Used in Construction.
- E. ASTM E543-02 - Practice for Agencies Performing Nondestructive Testing.
- F. International Building Code (IBC), 2015.
- G. Maine State Building Code (MUBEC).

1.5 QUALIFICATIONS

- A. Testing Agency: An approved independent testing agency acceptable to the Owner, Architect, and SER and meeting the following:
 - 1. Authorized to operate in the State in which the Project is located and experienced with the requirements and testing methods specified in the Contract Documents.
 - 2. Meet applicable requirements of references.
 - 3. Have available testing equipment that is calibrated, at reasonable intervals, by devices of accuracy traceable to either the National Bureau of Standards, or to accepted values of natural physical constants.
 - 4. Provide individuals performing tests and taking samples with appropriate certifications for Work performed.
- B. Special Inspector: Either an appropriately certified inspector or a civil/structural engineer performing under the direct supervision of a licensed civil/structural engineer (as defined earlier in this Section) and acceptable to the SER and Building Official. Unique Special Inspector requirements, for specific materials and systems, are noted in related technical Specification Sections.

1.6 RESPONSIBILITIES

- A. Special Inspectors:
 - 1. Inspect the Work assigned for conformance with the building department approved Drawings, Specifications, and applicable material and workmanship provisions of the code. Perform inspection in a timely manner to avoid delay of Work.
 - 2. Bring nonconforming items to the immediate attention of the Contractor for correction. If not corrected within 24 hours or if Inspector will not be on site the following day, bring to the attention of the SER by the end of the business day. If uncorrected after a reasonable period of time, bring to the attention of the Building Official, the Architect and the Owner. Notify SER immediately if non-conforming items are enclosed, embedded, or obscured prior to verification of correction.
 - 3. Submit inspection reports to the Building Official, Contractor, the Architect, the SER, the Owner and other designated persons in accordance with the Special Inspection and Testing Schedule.
 - 4. Submit a final signed report stating whether the Work requiring special inspection was, to the best of his/her knowledge, in conformance with the approved Drawings, Specifications and the applicable workmanship provisions of the code.
 - 5. Sign the Special Inspection and Testing Schedule in conjunction with other responsible parties.
 - 6. Attend Preconstruction meeting to review scope of special inspections.
- B. Testing Agency:
 - 1. Test the Work assigned for conformance with the building department approved Drawings, Specifications, and applicable material provisions of the documents. Perform tests in a

timely manner to avoid delay of Work.

2. Submit test reports to the Building Official, Contractor, the Architect, the SER, the Owner, and other designated persons in accordance with the Special Inspection and Testing Schedule.
3. Sign the Special Inspection and Testing Schedule in conjunction with other responsible parties.
4. Attend a Preconstruction meeting to review scope of testing.

C. Contractor:

1. Attend a Preconstruction meeting to review scope of special inspection and testing.
2. Schedule and coordinate Preconstruction and Construction testing and inspections.
3. Post or make available the Special Inspection and Testing Schedule within its office at the job site. Also, provide adequate notification to those parties designated on the Schedule so they may properly prepare for and schedule their work.
4. Provide Special Inspectors access to the approved Drawings and Specifications at the job site.
5. Review all reports issued by Special Inspectors.
6. Retain, at the job site, all reports submitted by the Special Inspectors for review on the Building Official's request.
7. Correct deficiencies identified in inspection or testing reports in a timely manner.
8. Provide safe access to the Work requiring inspection or testing.
9. Provide labor and facilities to provide access to the Work, to obtain, handle and deliver samples, to facilitate testing and inspection and for storage and curing of test samples.
10. Verify conformance of the Work with specified construction tolerances.
11. Immediately remove all rejected materials from the site. Do not incorporate any rejected materials into the Work.
12. Inspections by Building Official: Provide adequate notice for inspections performed by the building official, as required by IBC Section 110, the Maine Uniform Building and Energy Code, and local ordinances.
13. Sign the Special Inspection and Testing Schedule in conjunction with other responsible parties prior to commencing construction.

D. Fabricator:

1. Submit a Certificate of Compliance to the Building Official, Special Inspector, and SER that the Work was performed in accordance with the approved Drawings and Specifications.
2. Sign the Special Inspection and Testing Schedule in conjunction with other responsible parties prior to commencing construction.

E. Owner:

1. Establish direct funding to provide for cost of special inspection and testing services.
2. Provide Special Inspector with approved Drawings, Specifications and approved shop drawings.
3. Provide Special Inspectors and testing agencies with full access to the site at all times.
4. Sign the Special Inspection and Testing Schedule in conjunction with other responsible parties.

1.7 PAYMENT

- A. The Owner will employ and pay for services of the Special Inspectors and testing agency to perform required special inspections and tests as mandated by code.
- B. The Contractor shall provide and pay for all materials, samples, mock-ups, and assemblies required for testing and inspection and shall pay for shipping costs related to delivery of such items to the Owner's testing agency testing facility.
- C. If items requiring testing or inspection are enclosed, embedded or obscured prior to testing or inspection or if such items are placed without tests or inspections, the Contractor shall pay for the costs of any exploratory work deemed necessary by the Architect/SER to verify compliance with the Contract Documents.
- D. When any testing or observations indicate the Work is non-compliant with the Contract Documents, all retesting and re-observations shall be performed by the Owner's testing or observation agencies. All costs for retesting and re-observations, including additional services of the design professionals, the design professional's consultants and the Owner's consultants are the Contractor's responsibility and shall be deducted from the Contract Sum by Change Order.

1.8 INSPECTION NOTICE

- A. Contractor shall provide minimum of 5 working days prior to starting work and 3 working days prior to continuing work for all items requiring testing or inspection. Items requiring testing and inspection services prior to or during placement shall not be placed until testing and inspection services are available. Items requiring testing and inspection services after placement shall not be enclosed or obscured until testing and inspection services are performed. If the Work is covered up prior to any required testing or observation, it shall be uncovered for review at the Contractor's expense.

1.9 REPORTS

- A. Special Inspectors and Testing Agency shall submit reports for special inspections and tests in a timely manner to the Owner, Contractor, Building Official, SER, and Architect of Record. Provide reports of daily activities to the SER and Contractor. Submit reports to the Contractor on a daily basis and to the SER on a daily or weekly basis. Provide summary reports to the Owner, Building Official and Architect on a monthly basis unless they request otherwise.
- B. Provide reports for ongoing work, containing the following information:
 - 1. Date issued.
 - 2. Project title and number.
 - 3. Firm name and address.
 - 4. Name and signature of tester or inspector.
 - 5. Date and time of sampling, test, or inspection.
 - 6. Identification of product and Specification Section.
 - 7. Location in Project, including elevations, grid locations and details.

8. Type of test or inspection.
9. Whether test specimens, test results or observations indicate compliance with Contract Documents. Specifically state any discrepancies
10. Types and locations of discrepancies found in the Work
11. Work required to correct discrepancies and Work performed to correct previously noted discrepancies. Discrepancies corrected during an inspection need not be reported.
12. Submit certified final special inspection report stating that, to the best of the Special Inspector's knowledge, the Work requiring special inspection conformed to the Contract Documents.

1.10 FREQUENCY OF TESTING AND INSPECTION

- A. For detailed requirements, see individual technical Specification Sections and the Special Inspection and Testing Schedule, copy included after this Section.

1.11 PROTECTION AND REPAIR

- A. Upon completion of testing, sample-taking, or inspection, the Contractor shall repair damaged Work and restore substrates and finishes to eliminate deficiencies, including deficiencies in the visual qualities of exposed surfaces, as judged solely by the Architect/SER. Protect Work exposed by or for testing and/or inspection and protect repaired work. Repair and protection is the Contractor's responsibility, regardless of the assignment of responsibility for testing and/or inspection.

1.12 TESTS TO DEMONSTRATE QUALIFICATION

- A. Any tests required to qualify the Contractor or the workers for any phase of the Work, shall be performed at no additional cost to the Owner.
- B. If the Contractor proposes a product material, method, or other system that has not been pre-qualified, the Architect/SER may require applicable tests to establish a basis for acceptance or rejection. The Contractor shall pay for these tests.
- C. The Architect/Engineer of Record reserves the right to require certification or other proof that the system proposed is in compliance with specified tests, criteria or standards. A representative of an independent testing agency shall sign the certificate.

1.13 SPECIAL INSPECTION AND TESTING SCHEDULE

- A. The parties involved shall complete and sign the Special Inspection and Testing Schedule. Schedule to be complete at time of permit issuance.
- B. The completed Schedule is an element of the Contract Documents and after permit issuance, becomes part of the building department approved Drawings and Specifications

PART 2 – PRODUCTS

- A. Not Used

PART 3 – EXECUTION

3.1 QUALIFICATIONS

- A. Minimum category of special inspector required to perform services outlined below are noted by qualifications in parentheses.

END OF SECTION 014553

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Statement of Special Inspections

Project: **Maine Turnpike Authority Crosby Maintenance Building**
Location: South Portland, Maine
Owner: Maine Turnpike Authority
Owner's Address: 2360 Congress St, Portland, Maine

This Statement of Special Inspections encompasses the following disciplines: ☒ Structural ☐ Architectural
☐ M, E, & P

This *Statement of Special Inspections* is submitted as a condition for permit issuance in accordance with the Special Inspections and Tests requirements of the 2015 International Building Code. It includes a schedule of Special Inspection services applicable to this project as well as the name of the Special Inspection Coordinator (SIC) and the identity of other approved agencies to be retained for conducting these inspections and tests.

The Special Inspection Coordinator shall keep records of all Structural inspections and shall furnish inspection reports to the Building Code Official (BCO), the Registered Design Professional in Responsible Charge (RDP). Discovered discrepancies shall be brought to the immediate attention of the Contractor for correction. If such discrepancies are not corrected, the discrepancies shall be brought to the attention of the Building Official and the Registered Design Professional in Responsible Charge. The Special Inspection program does not relieve the Contractor of his or her responsibilities.

Interim reports shall be submitted to the Building Official and the Registered Design Professional in Responsible Charge at an interval determined by the SIC and the BCO.

A *Final Report of Special Inspections* documenting completion of all required Special Inspections, testing and correction of any discrepancies noted in the inspections shall be submitted to the BCO prior to issuance of a Certificate of Use and Occupancy.

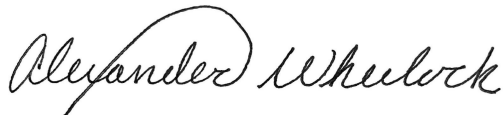
Job site safety and means and methods of construction are solely the responsibility of the Contractor.

Interim Report Frequency: ☒ Upon request of Building Official, ☐ Per attached schedule

Prepared by:

Alexander Wheelock, P.E.

Registered Design Professional in Responsible Charge



Signature

October 3, 2025

Date



Owner's Authorization:

Building Code Official's Acceptance:

Signature

Date

Signature

Date

Statement of Special Inspections

Project: Maine Turnpike Authority Crosby Maintenance Building
Location: South Portland, Maine
Owner: Maine Turnpike Authority
Owner's Address: 2360 Congress St, Portland, Maine

List of Agents

This Statement of Special Inspections / Quality Assurance Plan includes the following building systems:

☒ Soils and Foundations	☐ Masonry	☐ Spray-Applied Fire-Resistant Material
☒ Cast-in-Place Concrete	☐ Structural Steel	☐ Special Cases
☐ Precast Concrete	☒ Wood Construction	

Special Inspection Agencies	Firm	Address, Telephone, e-mail
1. Special Inspections Coordinator (SIC)	TBD	
2. Special Inspector (SI 1)	TBD	
3. Special Inspector (SI 2)	TBD	
4. Testing Agency (TA 1)	TBD	
5. Testing Agency (TA 2)		
6. Other (O1)		

Note: The inspectors and testing agencies shall be engaged by the Owner or the Owner's Agent, and not by the Contractor or Subcontractor whose work is to be inspected or tested. Any conflict of interest must be disclosed to the Building Official, prior to commencing work.

Statement of Special Inspections

Project: Contract 2026.07 - Crosby Maintenance Office Building
Date Prepared: October 3, 2025

Project: Maine Turnpike Authority Crosby Maintenance Building
Location: South Portland, Maine
Owner: Maine Turnpike Authority
Owner's Address: 2360 Congress St, Portland, Maine

Final Report of Special Inspections (SSIC/SI 1)

To be completed by the Structural Special Inspections Coordinator (SSIC/SI 1). Note that all Agent's Final Reports must be received prior to issuance.

Architect of Record: _____
(name) (firm)

Registered Design
Professional In
Responsible Charge _____
(name) (firm)

To the best of my information, knowledge, and belief, the Special Inspections required for this project and itemized in the *Statement of Special Inspections* submitted for permit have been performed and all discovered discrepancies have been reported and resolved.

Interim reports submitted prior to this final report form a basis for and are to be considered an integral part of this final report.

Respectfully submitted,
Special Inspection Coordinator

(name)

(firm)

Signature Date



Statement of Special Inspections

Project: Maine Turnpike Authority Crosby Maintenance Building
Location: South Portland, Maine

Project: Contract 2026.07 - Crosby Maintenance Office Building
Date Prepared: October 3, 2025

Owner: Maine Turnpike Authority
Owner's Address: 2360 Congress St, Portland, Maine

Special Inspector's/Agent's Final Report (SI 2)

Project Special
Inspector or Agent:

(name)

(firm)

Designation: _____

To the best of my information, knowledge, and belief, the Special Inspections or testing required for this project and designated for this Inspector/Agent in the *Statement of Special Inspections* submitted for permit have been performed and all discovered discrepancies have been reported and resolved.

Respectfully submitted,
Special Inspector or Agent

(name)

(firm)

Signature

Date

**Licensed Professional Seal or
Certification Number**

Statement of Special Inspections

Project: Maine Turnpike Authority Crosby Maintenance Building
Location: South Portland, Maine

Project: Contract 2026.07 - Crosby Maintenance Office Building
Date Prepared: October 3, 2025

Owner: Maine Turnpike Authority
Owner's Address: 2360 Congress St, Portland, Maine

Special Inspector's/Agent's Final Report (TA 1)

Project Special
Inspector or Agent:

(name)

(firm)

Designation: _____

To the best of my information, knowledge, and belief, the Special Inspections or testing required for this project and designated for this Inspector/Agent in the *Statement of Special Inspections* submitted for permit have been performed and all discovered discrepancies have been reported and resolved.

Respectfully submitted,
Special Inspector or Agent

(name)

(firm)

Signature

Date

**Licensed Professional Seal or
Certification Number**

Structural Observations – Seismic and Wind

Where required as determined by the sections below, the owner or the owner's authorized agent shall employ a registered design professional to perform structural observations. Structural observation does not include or waive the responsibility for the inspections outlined in sections 110 and 1705 of the *International Building Code*.

Structural Observations for Seismic Resistance (ref: IBC-15 Section 1704.6.1)

Structural observations shall be provided for those structures assigned to Seismic Design Category D, E, or F where one or more of the following conditions exist:

Seismic Design Category	Choose an item.	
Risk Category III or IV	☐ Yes	☒ No
Structure height exceeds 75'	☐ Yes	☒ No
Seismic Design Category E, Risk Category I or II, and more than two stories above grade	☐ Yes	☒ No
Required by the structural registered design professional in responsible charge	☐ Yes	☒ No
Specifically required by the building official	☐ Yes	☒ No

Structural observations for seismic resistance **are not** required.

Structural Observations for Wind Resistance (ref: IBC-15 Section 1704.6.2)

Structural observations shall be provided for those structures where V_{asd} exceeds 110 mph and one or more of the following conditions exist:

V_{asd}	90 mph	
Risk Category III or IV	☐ Yes	☒ No
Structure height exceeds 75'	☐ Yes	☒ No
Required by the structural registered design professional in responsible charge	☐ Yes	☒ No
Specifically required by the building official	☐ Yes	☒ No

Structural observations for wind resistance **are not** required.

Prepared by:

Building Code Official's Acceptance:

Signature

Date

Signature

Date

Contractor's Statement of Responsibility

Each contractor responsible for the construction of a main wind or seismic force resisting system or a designated wind or seismic force resisting component must submit a Statement of Responsibility to the Building Official and the Owner prior to the commencement of work on the system or component per section 1704.4 of the International Building Code. Make additional copies of this form as required.

Project: _____

Company
Name: _____

Address: _____

License No.: _____

Description of designated building systems and components included in the Statement of Responsibility:

Concrete Foundation System (Concrete Sub-Contractor)

This form to be completed by the Concrete Sub-Contractor, ~~Masonry Sub-Contractor, and Steel Erector.~~

Contractor's Acknowledgment of Special Requirements

I hereby acknowledge that I have received, read, and understand the *Statement of Special Inspections*

I hereby acknowledge that control will be exercised to obtain conformance with the construction documents approved by the Building Official.

Printed Name

Company Name

Signature

Date

Contractor's Provisions for Quality Control

Procedures for exercising control within the contractor's organization, the method and frequency of reporting and the distribution of reports is attached to this Statement.

Identification and qualifications of the person(s) exercising such control and their position(s) in the organization are attached to this Statement.

Fabricator's Certificate of Compliance

Each approved fabricator that is exempt from Special Inspection of shop fabrication and implementation procedures per section 1704.2.5 of the International Building Code must submit a *Fabricator's Certificate of Compliance* at the completion of fabrication.

Project: _____

Company
Name: _____

Address: _____

Certification or Approval Agency: _____

Certification Number: _____

Date of Last Audit or Approval: _____

Description of structural members and assemblies that have been fabricated:

I hereby certify that items described above were fabricated in strict accordance with the approved construction documents.

Signature

Date

Title

Attach copies of fabricator's certification or building code evaluation service report and fabricator's quality control manual.

Schedule of Special Inspections and Tests

Qualifications of Inspectors and Testing Technicians

The qualifications of all personnel performing Special Inspection and testing activities are subject to the approval of the Building Official. The credentials of all Inspectors and testing technicians shall be provided to the Special Inspector for their records. *NOTE VERIFICATION THAT QUALIFIED INDIVIDUALS ARE AVAILABLE TO PERFORM STIPULATED TESTING AND/OR INSPECTION SHOULD BE PROVIDED PRIOR TO SUBMITTING STATEMENT. AGENT QUALIFICATIONS IN SCHEDULE ARE SUGGESTIONS ONLY; FINAL QUALIFICATIONS ARE SUBJECT TO THE DISCRETION OF THE REGISTERED DESIGN PROFESSIONAL PREPARING THE SCHEDULE.*

Key for Minimum Qualifications of Inspection Agents:

When the Registered Design Professional in Responsible Charge or Special Inspector of Record deems it appropriate that the individual performing a stipulated test or inspection have a specific certification, license or experience as indicated below, such requirement shall be listed below and shall be clearly identified within the schedule under the Agent Qualification Designation.

PE/SE	Structural Engineer – a licensed SE or PE specializing in the design of building structures
PE/GE	Geotechnical Engineer – a licensed PE specializing in soil mechanics and foundations
EI	Engineer Intern – a graduate engineer who has passed the Fundamentals of Engineering examination

Experienced Testing Technician

ETT	Experienced Testing Technician – An Experienced Testing Technician with a minimum 5 years' experience with the stipulated test or inspection

American Concrete Institute (ACI)

ACI-CFTT	Concrete Field-Testing Technician – Grade 1
ACI-CCI	Concrete Construction Inspector
ACI-LTT	Laboratory Testing Technician – Grade 1 & 2
ACI-STT	Strength Testing Technician

American Welding Society (AWS) Certification

AWS-CWI	Certified Welding Inspection
AWS/AISC-SSI	Certified Structural Steel Inspector

American Society of Non-Destructive Testing (ASNT) Certification

ASNT	Non-Destructive Testing Technician – Level II or III

International Code Council (ICC) Certification

ICC-SMSI	Structural Masonry Special Inspector
ICC-SWSI	Structural Steel and Welding Special Inspector
ICC-SFSI	Spray-Applied Fireproofing Special Inspector
ICC-PCSI	Prestressed Concrete Special Inspector
ICC-RCSI	Reinforced Concrete Special Inspector

National Institute for Certification in Engineering Technologies (NICET)

NICET-CT	Concrete Technician – Levels I, II, III & IV
NICET-ST	Soils Technician - Levels I, II, III & IV
NICET-GET	Geotechnical Engineering Technician - Levels I, II, III & IV

Other

Schedule of Special Inspections and Tests

SOILS AND FOUNDATION CONSTRUCTION

Test or Special Inspection	Y/N	Continuous	Periodic	Agent	Agent Qualification
Soils (ref: IBC-15 Table 1705.6)					
1. Verify materials below shallow foundations are adequate to achieve the required bearing capacity.	Y	-	X	SI2	PE/GE, EI, or ETT
2. Verify excavations are extended to proper depth and have reached proper material.	Y	-	X	SI2	PE/GE, EI, or ETT
3. Perform classification and testing of compacted fill materials.	Y	-	X	SI2	PE/GE, EI, or ETT
4. Verify use of proper materials, densities and lift thicknesses during placement and compaction of compacted fill.	Y	X	-	SI2	PE/GE, EI, or ETT
5. Prior to placement of controlled fill, observe subgrade and verify that site has been prepared properly.	Y	-	X	SI2	PE/GE, EI, or ETT
Driven Deep Foundation Elements (ref: IBC-15 Table 1705.7)					
1. Verify materials, sizes, and lengths.	N	X	-	SI2	PE/GE, EI, or ETT
2. Determine capacities of test elements and conduct additional load tests when required. Refer to project specifications.	N	X	-	SI2	PE/GE, EI, or ETT
3. Observe driving operations and maintain complete and accurate records for each element.	N	X	-	SI2	PE/GE, EI, or ETT
4. Verify element locations and plumbness.	N	X	-	SI2	PE/GE, EI, or ETT
a. Verify type and size of hammer.	N	X	-	SI2	PE/GE, EI, or ETT
b. Record number of blows per foot of penetration.	N	X	-	SI2	PE/GE, EI, or ETT
c. Determine required penetration to achieve specified capacity.	N	X	-	SI2	PE/GE, EI, or ETT
d. Record pile tip and butt elevations.	N	X	-	SI2	PE/GE, EI, or ETT
e. Document any damage to any foundation element.	N	X	-	SI2	PE/GE, EI, or ETT
5. For steel piling, perform additional inspection in accordance with Section 1705.2 and AISC 341-10, Table J10-1.	N	X	-	SI2	PE/GE, EI, or ETT
6. For concrete elements and concrete-filled elements, perform additional inspections in accordance with Section 1705.3.	N	X	-	SI2	PE/GE, EI, or ETT
7. For specialty elements, perform additional inspections as required in the project specifications.	N	X	-	SI2	PE/GE, EI, or ETT
Cast-In-Place Deep Foundations (ref: IBC-15 Table 1705.8)					
1. Observe drilling operations and maintain complete and accurate records for each element.	N	X	-	SI2	PE/GE, EI, or ETT
2. Verify element locations and plumbness.	N	X	-	SI2	PE/GE, EI, or ETT
a. Verify element diameter.	N	X	-	SI2	PE/GE, EI, or ETT
b. Verify bell diameter (if applicable).	N	X	-	SI2	PE/GE, EI, or ETT
c. Verify element lengths.	N	X	-	SI2	PE/GE, EI, or ETT
d. Verify embedment depth into bedrock (if applicable).	N	X	-	SI2	PE/GE, EI, or ETT
e. Verify adequate end-bearing strata capacity.	N	X	-	SI2	PE/GE, EI, or ETT
f. Record concrete or grout volumes.	N	X	-	SI2	PE/GE, EI, or ETT
3. For concrete elements, perform additional inspections in accordance with Section 1705.3.	N	X	-	SI2	PE/GE, EI, or ETT
Helical Piles (ref: IBC-15 Section 1705.9)					
1. Verify pile locations	N	X	-	SI2	PE/GE, EI, or ETT
a. Verify installation equipment used.	N	X	-	SI2	PE/GE, EI, or ETT
b. Verify pile dimensions.	N	X	-	SI2	PE/GE, EI, or ETT
c. Verify tip elevations.	N	X	-	SI2	PE/GE, EI, or ETT
d. Verify final depth.	N	X	-	SI2	PE/GE, EI, or ETT
e. Verify final installation torque.	N	X	-	SI2	PE/GE, EI, or ETT
f. Other data as required by the project specifications.	N	X	-	SI2	PE/GE, EI, or ETT

Schedule of Special Inspections and Tests

CONCRETE CONSTRUCTION

Test or Special Inspection	Y/N	Continuous	Periodic	Agent	Agent Qualification
Concrete Construction (ref: IBC-15 Table 1705.3)					
1. Inspect reinforcing steel and placement, including prestressing tendons.	Y	-	X	TA1	PE/SE, EI, or ETT
2. Inspection of reinforcing steel welding in accordance with Steel Construction section above.					
a. Verify weldability of reinforcing bars other than ASTM A706.	N		X	TA1	PE/SE, EI, or ETT
b. Inspect single pass fillet welds, maximum 5/16".	N		X	TA1	PE/SE, EI, or ETT
c. Inspect all other welds.	N	X		TA1	PE/SE, EI, or ETT
3. Inspection of anchors cast in concrete.	Y	-	X	TA1	PE/SE, EI, or ETT
4. Inspection of anchors post-installed in hardened concrete members.					
a. Adhesive anchors installed in horizontally or upwardly inclined orientations to resist sustained loads.	N	X	-	TA1	PE/SE, EI, or ETT
b. Mechanical anchors and adhesive anchors not defined in 4.a.	Y	-	X	TA1	PE/SE, EI, or ETT
5. Verify use of approved design mix.	Y	-	X	TA1	PE/SE, EI, or ETT
6. Prior to placement fabricate specimens for strength tests, perform slump and air content tests, and determine the temperature of the concrete.	Y	X	-	TA1	PE/SE, EI, or ETT
7. Inspect concrete and shotcrete placement for proper application techniques.	Y	X	-	TA1	PE/SE, EI, or ETT
8. Inspect for maintenance of specified curing temperature and techniques.	Y	-	X	TA1	PE/SE, EI, or ETT
9. Inspection of Prestressed Concrete					
a. Application of prestressing forces	N	X	-	TA1	PE/SE, EI, or ETT
b. Grouting of bonded prestressing tendons in the seismic-force-resisting system.	N	X	-	TA1	PE/SE, EI, or ETT
10. Erection of precast structural members					
a. Inspect in accordance with construction documents.	N	X	X	TA1	PE/SE, EI, or ETT
b. Perform inspections of welding and bolting in accordance with IBC 2015 section 1705.2.	N	X	X	TA1	PE/SE, EI, or ETT
11. Verification of in-situ concrete strength, prior to stressing of tendons in post-tensioned concrete and prior to removal of shores and forms from beams and structural slabs.	N	-	X	TA1	PE/SE, EI, or ETT
12. Inspection formwork for shape, location and dimensions of the concrete member being formed.	Y	-	X	TA1	PE/SE, EI, or ETT

Supplement to Inspection Items Above: SI1 may conduct periodic reviews of reinforcing steel placement and anchor installation prior to the placement of concrete within forms. These reviews are supplemental to the required inspections to be completed by the TA1 representative and shall serve only to confirm that the drawing requirements are clearly understood and are being followed.

Schedule of Special Inspections and Tests

MASONRY CONSTRUCTION

Test or Special Inspection	Y/N	Continuous	Periodic	Agent	Agent Qualification
Level A Quality Assurance					
Tests: None.	-	-	-	-	-
Inspection: Verify compliance with the approved submittal and project specifications.	N	-	X	TA1	PE/SE, EI, or ETT
Level B Quality Assurance					
Tests:					
1. Verify slump flow and Visual Stability Index (VSI) as delivered to the project site in accordance with TMS 602-13/ACI 530.1-13/ASCE 6-13 Specification Article 1.5B.1.b.3 for self-consolidating grout.	N	-	X	TA1	PE/SE, EI, or ETT
2. Verify f'm and f'aac in accordance with TMS 602-13/ACI 530.1-13/ASCE 6-13 Specification Article 1.4B prior to construction, except where specifically exempted.	N	-	X	TA1	PE/SE, EI, or ETT
Inspection:					
1. Verify compliance with the approved submittals and project specifications.	N	-	X	TA1	PE/SE, EI, or ETT
2. At the start of masonry construction, verify:					
a. Proportions of site-prepared mortar.	N	-	X	TA1	PE/SE, EI, or ETT
b. Construction of mortar joints.	N	-	X	TA1	PE/SE, EI, or ETT
c. Grade and size of prestressing tendons and anchorages.	N	-	-	TA1	PE/SE, EI, or ETT
d. Location of reinforcement, connectors, prestressing tendons, and anchorages.	N	-	X	TA1	PE/SE, EI, or ETT
e. Prestressing technique.	N	-	X	TA1	PE/SE, EI, or ETT
f. Properties of thin-bed mortar for AAC masonry. (Continuous inspection is required for the first 5000 square feet of AAC masonry. Periodic inspection is required after the first 5000 square feet of AAC masonry.)	N	X	-	TA1	PE/SE, EI, or ETT
3. Prior to grouting, verify:					
a. Grout space is clean.	N	-	X	TA1	PE/SE, EI, or ETT
b. Grade, type and size of reinforcement and anchor bolts, and prestressing tendons and anchorages.	N	-	X	TA1	PE/SE, EI, or ETT
c. Placement of reinforcing and connectors, and prestressing tendons and anchorages.	N	-	X	TA1	PE/SE, EI, or ETT
d. Proportions of site-prepared grout and prestressing grout for bonded tendons.	N	-	X	TA1	PE/SE, EI, or ETT
e. Construction of mortar joints.	N	-	X	TA1	PE/SE, EI, or ETT
4. During masonry construction, verify:					
a. Size and location of structural members.	N	-	X	TA1	PE/SE, EI, or ETT
b. Type, size, and location of anchors, including other details of anchorage of masonry to structural members, frames, or other construction.	N	-	X	TA1	PE/SE, EI, or ETT
c. Welding of reinforcement.	N	-	-	TA1	PE/SE, EI, or ETT
d. Preparation, construction, and protection of masonry during cold weather (temperature below 40°F) or hot weather (temperature above 90°F).	N	-	X	TA1	PE/SE, EI, or ETT
e. Application and measurement of prestressing force.	N	X	-	TA1	PE/SE, EI, or ETT
f. Placement of grout and prestressing grout for bonded tendons is in compliance.	N	-	-	TA1	PE/SE, EI, or ETT
g. Placement of AAC masonry units and construction of thin-bed mortar joints. (Continuous inspection is required for the first 5000 square feet of AAC masonry. Periodic inspection is required after the first 5000 square feet of AAC masonry.)	N	-	-	TA1	PE/SE, EI, or ETT
5. Observe preparation of grout specimens, mortar specimens and/or prisms.	N	-	X	TA1	PE/SE, EI, or ETT

Supplement to Inspection Items Above: SI1 may conduct periodic reviews of reinforcing steel placement and anchor installation prior to the placement of grout within masonry cells. These reviews are supplemental to the required inspections to be completed by the TA1 representative and shall serve only to confirm that the drawing requirements are clearly understood and are being followed.

Schedule of Special Inspections and Tests

STEEL CONSTRUCTION

Test or Special Inspection	Y/N	Continuous	Periodic	Agent	Agent Qualification
Steel Construction (ref: IBC-15 Section 1705.2, AISC 360-10 Chapter N, AISC 341-10 Chapter J)					
Prior to Welding (AISC 360-10 Table N5.4-1)					
1. Welding procedure specifications (WPSs) available	N	X	-	TA1	AWS CWI/ AWS AISC-SSI
2. Manufacturer certifications for welding consumables available	N	X	-	TA1	AWS CWI/ AWS AISC-SSI
3. Material identification (type/grade)	N	-	X	TA1	AWS CWI/ AWS AISC-SSI
4. Welder certification	N	X	-	TA1	AWS CWI/ AWS AISC-SSI
5. Welder identification system	N	-	X	TA1	AWS CWI/ AWS AISC-SSI
6. Fit-up of groove welds (including joint geometry)					
a. Joint preparation	N	-	X	TA1	AWS CWI/ AWS AISC-SSI
b. Dimensions (alignment, root opening, root face, bevel)	N	-	X	TA1	AWS CWI/ AWS AISC-SSI
c. Cleanliness (condition of steel surfaces)	N	-	X	TA1	AWS CWI/ AWS AISC-SSI
d. Tacking (tack weld quality and location)	N	-	X	TA1	AWS CWI/ AWS AISC-SSI
e. Backing type and fit (if applicable)	N	-	X	TA1	AWS CWI/ AWS AISC-SSI
7. Configuration and finish of access holes (if applicable)	N	-	X	TA1	AWS CWI/ AWS AISC-SSI
8. Fit-up of fillet welds					
a. Dimensions (alignment, gaps at root)	N	-	X	TA1	AWS CWI/ AWS AISC-SSI
b. Cleanliness (condition of steel surfaces)	N	-	X	TA1	AWS CWI/ AWS AISC-SSI
c. Tacking (tack weld quality and location)	N	-	X	TA1	AWS CWI/ AWS AISC-SSI
9. Check welding equipment	N	-	X	TA1	AWS CWI/ AWS AISC-SSI
During Welding (AISC 360-10 Table N5.4-2)					
Complete and Partial Penetration Welds Only					
1. Use of qualified welders	N	-	X	TA1	AWS CWI/ AWS AISC-SSI
2. Control and handling of welding consumables					
a. Packaging	N	-	X	TA1	AWS CWI/ AWS AISC-SSI
b. Exposure control	N	-	X	TA1	AWS CWI/ AWS AISC-SSI
3. No welding over cracked tack welds	N	-	X	TA1	AWS CWI/ AWS AISC-SSI
4. Environmental conditions					
a. Wind speed within limits	N	-	X	TA1	AWS CWI/ AWS AISC-SSI
b. Precipitation and temperature	N	-	X	TA1	AWS CWI/ AWS AISC-SSI
5. Welding Procedure Specification (WPS) followed					
a. Settings on welding equipment	N	-	X	TA1	AWS CWI/ AWS AISC-SSI
b. Travel speed	N	-	X	TA1	AWS CWI/ AWS AISC-SSI
c. Selected welding materials	N	-	X	TA1	AWS CWI/ AWS AISC-SSI
d. Shielding gas type/flow rate	N	-	X	TA1	AWS CWI/ AWS AISC-SSI
e. Preheat applied	N	-	X	TA1	AWS CWI/ AWS AISC-SSI
f. Interpass temperature maintained (min. /max.)	N	-	X	TA1	AWS CWI/ AWS AISC-SSI
g. Proper position (F, V, H, OH)	N	-	X	TA1	AWS CWI/ AWS AISC-SSI
h. Intermix of filler metals avoided unless approved (ref: AISC 341-10)	N	-	X	TA1	AWS CWI/ AWS AISC-SSI
6. Welding techniques					
a. Interpass and final cleaning	N	-	X	TA1	AWS CWI/ AWS AISC-SSI
b. Each pass within profile limitations	N	-	X	TA1	AWS CWI/ AWS AISC-SSI
c. Each pass meets quality requirements	N	-	X	TA1	AWS CWI/ AWS AISC-SSI

Schedule of Special Inspections and Tests

STEEL CONSTRUCTION (CONTINUED)

Test or Special Inspection	Y/N	Continuous	Periodic	Agent	Agent Qualification
After Welding (AISC 360-10 Table N5.4-3)					
1. Welds cleaned	N	-	X	TA1	AWS CWI/ AWS AISC-SSI
2. Size, length and location of welds	N	-	X	TA1	AWS CWI/ AWS AISC-SSI
3. Welds meet visual acceptance criteria					
a. Crack prohibition	N	-	X	TA1	AWS CWI/ AWS AISC-SSI
b. Weld/base-metal fusion	N	-	X	TA1	AWS CWI/ AWS AISC-SSI
c. Crater cross section	N	-	X	TA1	AWS CWI/ AWS AISC-SSI
d. Weld profiles	N	-	X	TA1	AWS CWI/ AWS AISC-SSI
e. Weld size	N	-	X	TA1	AWS CWI/ AWS AISC-SSI
f. Undercut	N	-	X	TA1	AWS CWI/ AWS AISC-SSI
g. Porosity	N	-	X	TA1	AWS CWI/ AWS AISC-SSI
4. Arc strikes	N	-	X	TA1	AWS CWI/ AWS AISC-SSI
5. k-area	N	-	X	TA1	AWS CWI/ AWS AISC-SSI
6. Backing removed, and weld tabs removed (if required)	N	-	X	TA1	AWS CWI/ AWS AISC-SSI
7. Repair activities	N	-	X	TA1	AWS CWI/ AWS AISC-SSI
8. Document acceptance or rejection of welded joint or member	N	-	X	TA1	AWS CWI/ AWS AISC-SSI
9. Placement of reinforcing or contouring fillet welds (if required) (ref: AISC 341-10)	N	-	X	TA1	AWS CWI/ AWS AISC-SSI
10. Backing removed, weld tabs removed and finished, and fillet welds added (if required) (ref: AISC 341-10)	N	-	X	TA1	AWS CWI/ AWS AISC-SSI
Nondestructive Testing (AISC 360-10 Section N5.5)					
1. Risk Category II Structures - Perform Ultrasonic Testing on 10% of CJP groove welds in butt, T- and corner joints subject to transversely applied tension loading, in materials 5/16 in. thick or greater.	N	-	X	TA1	AWS CWI/ AWS AISC-SSI
2. Risk Category III or IV Structures - Perform Ultrasonic Testing on all CJP groove welds subject to transversely applied tension loading in butt, T- and corner joints, in materials 5/16 in. thick or greater.	N	X	-	TA1	AWS CWI/ AWS AISC-SSI
3. Access Holes – Perform Magnetic Particle Testing or Liquid Penetrant Testing when the flange thickness exceeds 2 in. for rolled shapes, or when the web thickness exceeds 2 in. for built-up shapes.	N	-	X	TA1	AWS CWI/ AWS AISC-SSI
4. Welded Joints Subject to Fatigue	N	-	X	TA1	AWS CWI/ AWS AISC-SSI
Nondestructive Testing (AISC 341-10 Section J6.2)					
1. k-area – Perform Magnetic Particle Testing where welding of double plates, continuity plate or stiffeners has been performed in the k-area.	N	-	X	TA1	AWS CWI/ AWS AISC-SSI
2. CJP Groove weld – Perform Ultrasonic Testing on 100% of CJP groove welds in materials 5/16 in thick or greater. Perform Magnetic Particle Testing on 25% of all beam-to-column CJP groove welds.	N	-	X	TA1	AWS CWI/ AWS AISC-SSI
3. Base Metal– Perform Ultrasonic testing where base metal thicker than 1 ½ in loaded in tension in the through-thickness direction in tee and corner joints, where the connected material is greater than ¾ in and contains CJP groove welds.	N	-	X	TA1	AWS CWI/ AWS AISC-SSI
4. Beam cope and access hole – Perform Magnetic Particle or Penetrant Testing at welded splices and connections where surfaces of beam copes and access holes have been thermally cut when the flange thickness exceeds 1 ½ in for rolled shapes or when the web thickness exceeds 1 ½ in for built-up shapes.	N	-	X	TA1	AWS CWI/ AWS AISC-SSI
5. Reduced beam section repair – Perform Magnetic Particle Testing on any weld and adjacent area of the reduced beam section cut surface that has been repaired by welding, or on the base metal of the reduced beam section cut surface if a sharp notch has been removed by grinding.	N	-	X	TA1	AWS CWI/ AWS AISC-SSI
6. Weld tab removal – Perform Magnetic Particle Testing on the same beam-to-column receiving UT as required under section J6.2b. at the ends of welds where weld tabs have been removed	N	-	X	TA1	AWS CWI/ AWS AISC-SSI

Schedule of Special Inspections and Tests

STEEL CONSTRUCTION (CONTINUED)

Test or Special Inspection	Y/N	Continuous	Periodic	Agent	Agent Qualification
Prior to Bolting (AISC 360-10 Table N5.6-1)					
These inspections are not required for snug-tight joints (Project anticipates used of twist-off-type tension control fasteners)					
1. Manufacturer's certifications available for fastener materials	N	-	X	TA1	AWS AISC-SSI
2. Fasteners marked in accordance with ASTM requirements	N	-	X	TA1	AWS AISC-SSI
3. Proper fasteners selected for the joint detail (grade, type, bolt length if threads are to be excluded from shear plane)	N	-	X	TA1	AWS AISC-SSI
4. Proper fasteners selected for the joint detail (grade, type, bolt length if threads are to be excluded from shear plane)	N	-	X	TA1	AWS AISC-SSI
5. Connecting elements, including the appropriate faying surface condition and hole preparation, if specified, meet applicable requirements	N	-	X	TA1	AWS AISC-SSI
6. Pre-installation verification testing by installation personnel observed and documented for fastener assemblies and methods used	N	-	X	TA1	AWS AISC-SSI
7. Proper storage provided for bolts, nuts, washers, and other fastener components	N	-	X	TA1	AWS AISC-SSI
During Bolting (AISC 360-10 Table N5.6-2)					
These inspections are not required for snug-tight joints.					
These inspections are not required for pretensioned joints and slip-critical joints, when the installer is using the turn-of-nut method with matchmarking techniques, the direct-tension-indicator method, or the twist-off-type tension control bolt method.					
1. Fastener assemblies, of suitable condition, placed in all holes and washers (if required) are positioned as required	N	-	X	TA1	AWS AISC-SSI
2. Joint brought to the snug-tight condition prior to the pre-tensioning operation	N	-	X	TA1	AWS AISC-SSI
3. Fastener component not turned by the wrench prevented from rotating	N	-	X	TA1	AWS AISC-SSI
4. Fasteners are pretensioned in accordance with the RCSC Specification, progressing systematically from the most rigid point toward the free edges	N	-	X	TA1	AWS AISC-SSI
After Bolting (AISC 360-10 Table N5.6-3)					
Document acceptance or rejection of bolted connections	N	X	-	TA1	AWS AISC-SSI
Other Inspection Tasks (AISC 360-10 Section N5.7)					
1. Verify compliance of fabricated steel with the details shown on the approved shop drawings.	N	-	X	SI1	PE/SE or EI
2. Verify compliance of the erected steel frame with the details shown on the approved erection drawings, including braces, stiffeners, member locations and joint details.	N	-	X	SI1	PE/SE or EI
3. Anchor rods and other embedments support structural steel					
a. Verify the diameter, grade, and type of the anchor rod or embedded item.	N	-	X	TA1	PE/SE, EI, or ETT
b. Verify the extent or depth of embedment into the concrete (by confirming protrusion)	N	-	X	TA1	PE/SE, EI, or ETT
4. RBS requirements, if applicable (ref: AISC 341-10)					
a. Contour and finish	N	-	X	TA1	AWS AISC-SSI
b. Dimensional tolerances	N	-	X	TA1	AWS AISC-SSI
5. Protected zone—no holes and unapproved attachments made by fabricator or erector, as applicable (ref: AISC 341-10)	N	-	X	TA1	AWS AISC-SSI
6. H-piles - Protected zone—no holes and unapproved attachments made by the responsible contractor, as applicable (ref: AISC 341-10)	N	-	X	TA1	AWS AISC-SSI

Schedule of Special Inspections and Tests

STEEL CONSTRUCTION (CONTINUED)

Test or Special Inspection	Y/N	Continuous	Periodic	Agent	Agent Qualification
Cold-formed Steel Deck (IBC-15 1705.2.2)					
1. Special inspections in accordance with QA/QC-2011 Standard for Quality control and Quality assurance for Installation of Steel Deck					
a. Prior to Deck Placement:					
i. Verify compliance of materials (deck and all deck accessories) with construction documents, including profiles, material properties, and base metal thickness.	N	-	X	TA1	PE/SE, EI, or ETT
ii. Document acceptance or rejection of deck and deck accessories	N	-	X	TA1	PE/SE, EI, or ETT
b. After Deck Placement:					
i. Verify compliance of deck and all deck accessories installation with construction documents.	N	-	X	TA1	PE/SE, EI, or ETT
ii. Verify deck materials are represented by the mill certifications that comply with the construction documents.	N	-	X	TA1	PE/SE, EI, or ETT
iii. Document acceptance or rejection of installation of deck and deck accessories.	N	-	X	TA1	PE/SE, EI, or ETT
c. Prior to Welding:					
i. Welding procedure specifications (WPS) available	N	-	X	TA1	PE/SE, EI, or ETT
ii. Manufacturer certifications for welding consumables available	N	-	X	TA1	PE/SE, EI, or ETT
iii. Material identification (type/grade)	N	-	X	TA1	PE/SE, EI, or ETT
iv. Check welding equipment	N	-	X	TA1	PE/SE, EI, or ETT
d. During Welding:					
i. Use of qualified welders	N	-	X	TA1	PE/SE, EI, or ETT
ii. Control and handling of welding consumables	N	-	X	TA1	PE/SE, EI, or ETT
iii. Environmental conditions (wind speed, moisture, temperature)	N	-	X	TA1	PE/SE, EI, or ETT
iv. WPS followed	N	-	X	YA1	PE/SE, EI, or ETT
e. After Welding:					
i. Verify size and location of welds, including support, sidelap, and perimeter welds	N	-	X	TA1	PE/SE, EI, or ETT
ii. Welds meet visual acceptance criteria	N	-	X	TA1	PE/SE, EI, or ETT
iii. Verify repair activities	N	-	X	TA1	PE/SE, EI, or ETT
iv. Document acceptance or rejection of welds.	N	-	X	TA1	PE/SE, EI, or ETT
f. Prior to Mechanical Fastening:					
i. Manufacturer installation instructions available for mechanical fasteners	N	-	X	TA1	PE/SE, EI, or ETT
ii. Proper tools available for fastener installation	N	-	X	TA1	PE/SE, EI, or ETT
iii. Proper storage for mechanical fasteners	N	-	X	TA1	PE/SE, EI, or ETT
g. During Mechanical Fastening:					
i. Fasteners are positioned as required	N	-	X	TA1	PE/SE, EI, or ETT
ii. Fasteners are installed in accordance with manufacturer's instructions	N	-	X	TA1	PE/SE, EI, or ETT
h. After Mechanical Fastening:					
i. Check spacing, type, and installation of support fasteners	N	-	X	TA1	PE/SE, EI, or ETT
ii. Check spacing, type, and installation of sidelap fasteners	N	-	X	TA1	PE/SE, EI, or ETT
iii. Check spacing, type, and installation of perimeter fasteners	N	-	X	TA1	PE/SE, EI, or ETT
iv. Verify repair activities	N	-	X	TA1	PE/SE, EI, or ETT
v. Document acceptance or rejection of mechanical fasteners.	N	-	X	TA1	PE/SE, EI, or ETT
Open-Web steel Joists and Joist Girders (IBC-15 Table 1705.2.3)					
1. Installation of open-web steel joists and joist girders					
a. End connections – welding or bolted	N	-	X	TA1	PE/SE, EI, or ETT
Bridging – horizontal or diagonal					
1. Standard bridging	N	-	X	TA1	PE/SE, EI, or ETT
2. Bridging that differs from the SJI specifications listed in Section 2207.1	N	-	X	TA1	PE/SE, EI, or ETT

Schedule of Special Inspections and Tests

STEEL CONSTRUCTION (CONTINUED)

Test or Special Inspection	Y/N	Continuous	Periodic	Agent	Agent Qualification
Inspection of Composite Structures Prior to Concrete Placement (AISC 341-10 Table J9-1)					
1. Material identification of reinforcing steel (Type/Grade)	N	-	X	TA1	PE/SE, EI, or ETT
2. Determination of carbon equivalent for reinforcing steel other than ASTM A706	N	-	X	TA1	PE/SE, EI, or ETT
3. Proper reinforcing steel size, spacing and orientation	N	-	X	TA1	PE/SE, EI, or ETT
4. Reinforcing steel has not been re-bent in the field	N	-	X	TA1	PE/SE, EI, or ETT
5. Reinforcing steel has been tied and supported as required	N	-	X	TA1	PE/SE, EI, or ETT
6. Required reinforcing steel clearances have been provided	N	-	X	TA1	PE/SE, EI, or ETT
7. Composite member has required size	N	-	X	TA1	PE/SE, EI, or ETT
Inspection of Composite Structures During Concrete Placement (AISC 341-10 Table J9-2)					
1. Concrete: Material identification (mix design, compressive strength, maximum large aggregate size, maximum slump)	N	X	-	TA1	PE/SE, EI, or ETT
2. Limits on water added at the truck or pump	N	X	-	TA1	PE/SE, EI, or ETT
3. Proper placement techniques to limit segregation	N	X	-	TA1	PE/SE, EI, or ETT
Inspection of Composite Structures After Concrete Placement (AISC 341-10 Table J9-3)					
1. Achievement of minimum specified concrete compressive strength at specified age	N	-	X	TA1	PE/SE, EI, or ETT
Cold-formed Steel Trusses Spanning 60-feet or Greater (ref: IBC-15 Section 1705.2.4)					
1. Verify temporary installation restraint/bracing installed in accordance with the approved shop drawings.	N	-	X	TA1	PE/SE, EI, or ETT
2. Verify permanent individual truss member restraint/bracing installed in accordance with the approved shop drawings.	N	-	X	TA1	PE/SE, EI, or ETT

Schedule of Special Inspections and Tests

WOOD CONSTRUCTION

Test or Special Inspection	Y/N	Continuous	Periodic	Agent	Agent Qualification
Wood Construction (ref: IBC-15 Section 1705.5)					
1. Inspection of the fabrication process of wood structural elements and assemblies in accordance with IBC-15 Section 1704.2.5.	Y	-	X	SI1	PE/SE or EI
2. High load diaphragms:					
a. Verify sheathing grade and thickness.	Y	-	X	SI1	PE/SE or EI
b. Verify nominal size of framing members at adjoining panel edges.	Y	-	X	SI1	PE/SE or EI
c. Verify nail or staple diameter and length.	Y	-	X	SI1	PE/SE or EI
d. Verify number of fastener lines.	Y	-	X	SI1	PE/SE or EI
e. Verify spacing between fasteners in each line and at panel edges.	Y	-	X	SI1	PE/SE or EI
3. Shearwalls:					
a. Verify sheathing grade and thickness.	N	-	X	SI1	PE/SE or EI
b. Verify nominal size of framing members at adjoining panel edges.	N	-	X	SI1	PE/SE or EI
c. Verify nail or staple diameter and length.	N	-	X	SI1	PE/SE or EI
d. Verify number of fastener lines.	N	-	X	SI1	PE/SE or EI
e. Verify spacing between fasteners in each line and at panel edges.	N	-	X	SI1	PE/SE or EI
f. Location and size of holdowns.	N	-	X	SI1	PE/SE or EI
4. Verify nailing, bolting, anchoring, and fastening of:					
a. Drag struts and collectors.	N	-	X	SI1	PE/SE Or EI
b. Braces.	N	-	X	SI1	PE/SE Or EI
c. Hold-downs.	N	-	X	SI1	PE/SE Or EI
5. Metal-plate-connected wood trusses spanning 60 feet or greater:			X	SI1	PE/SE Or EI
a. Verify temporary installation restraint/bracing installed in accordance with the approved shop drawings.	N	-	X	SI1	PE/SE Or EI
b. Verify permanent individual truss member restraint/bracing installed in accordance with the approved shop drawings.	N	-	X	SI1	PE/SE Or EI

Schedule of Special Inspections and Tests

FABRICATION AND IMPLEMENTATION PROCEDURES – STRUCTURAL STEEL

VERIFICATION AND INSPECTION IBC Section 1704.2.5	Y/N	Submittal	Agent	Agent Qualification
1. Fabrications Procedures: Review of fabricator's written procedural and quality control manuals and periodic auditing of fabrication practices by an approved special inspection agency. At the completion of fabrication, the approved fabricator shall submit a certificate of compliance to the building code official stating that the work was performed in accordance with the approved construction documents. -OR-	N	X	SI1	PE/SE or EI
2. AISC Certification	N	X	SI1	PE/SE or EI
3. At completion of fabrication, the approved fabricator shall submit a certificate of compliance to the building code official stating that the work was performed in accordance with the approved construction documents.	N	X	SI1	PE/SE or EI

Schedule of Special Inspections and Tests

FABRICATION AND IMPLEMENTATION PROCEDURES – WOOD TRUSSES

VERIFICATION AND INSPECTION IBC Section 1704.2.5	Y/N	Submittal	Agent	Agent Qualification
1. Fabrications Procedures: Review of fabricator's written procedural and quality control manuals and periodic auditing of fabrication practices by an approved special inspection agency. At the completion of fabrication, the approved fabricator shall submit a certificate of compliance to the building code official stating that the work was performed in accordance with the approved construction documents. -OR-	Y	X	SI1	PE/SE or EI
2. TPI Inspection Program: Fabricator shall participate in the TPI Quality Assurance Inspection Program and maintain a copy of the Quality Assurance Procedures Manual, QAP-90. Submit copy of certificate. All trusses shall bear the TPI Registered Mark.	Y	X	SI1	PE/SE or EI
3. At completion of fabrication, the approved fabricator shall submit a certificate of compliance to the building code official stating that the work was performed in accordance with the approved construction documents	Y	X	SI1	PE/SE or EI

Schedule of Special Inspections and Tests

WIND RESISTANCE - STRUCTURAL

Special inspections for wind resistance. Special inspection as specified in this section is required for the following:

Project: Contract 2026.07 - Crosby Maintenance Office Building
Date Prepared: October 3, 2025

- Wind Exposure Category B, where V_{asd} exceeds 120 mph.
- Wind Exposure Category C, where V_{asd} exceeds 110 mph.

VERIFICATION AND INSPECTION	Y/N	Continuous	Periodic	Agent	Agent Qualification
Structural Wood (ref: IBC-15 Section 1705.11.1) Note: The inspections below are not required if the sheathing fastener spacing is greater than 4" on center.					
1. Inspection of field gluing of elements of the main wind force-resisting system.	N	X	-	SI1	PE/SE or EI
2. Inspection of nailing, bolting, anchoring, and other fastening of elements of the main wind force-resisting system.	N	-	X	SI1	PE/SE or EI
Cold-Formed Steel Light Frame Construction (ref: IBC-15 Section 1705.11.2) Note: The inspections below are not required if the sheathing is gypsum board or fiberboard, or if the sheathing is wood structural panel or sheets on only one side of the shear wall, shear panel or diaphragm assembly and the fastener spacing is greater than 4" on center.					
1. Inspection of welding operations of elements of the main wind force-resisting system.	N	-	X	SI1	PE/SE or EI
2. Inspection of screw attachment, bolting, anchoring, and other fastening of elements of the main wind force-resisting system, including shear wall, braces, diaphragms, collectors, and hold-downs.	N	-	X	SI1	PE/SE or EI
Wind-Resisting components (ref: IBC-15 Section 1705.11.3)					
1. Inspection of roof covering, roof deck, and roof framing connections.	N	-	X	SI1	PE/SE or EI
2. Inspection of exterior wall covering and wall connections to roof and floor diaphragms and framing.	N		X	SI1	PE/SE or EI

Schedule of Special Inspections and Tests

SEISMIC RESISTANCE - STRUCTURAL

Special inspections for seismic resistance. The special inspections specified in this section are not required for structures designed in accordance with one of the following:

- The structure consists of light-frame construction, S_{DS} does not exceed 0.5, and the building does not exceed 35 feet.
- The seismic force-resisting system of the structure consists of reinforced masonry or reinforced concrete, S_{DS} does not exceed 0.5, and the building height does not exceed 25 feet.
- The structure is a detached one- or two-family dwelling not exceeding two stories above grade and does not have any of the following horizontal or vertical irregularities:
 - a. Torsional or extreme torsional irregularity
 - b. Nonparallel systems irregularity
 - c. Stiffness-soft story or stiffness-extreme soft story irregularity
 - d. Discontinuity in lateral strength-weak story irregularity.

VERIFICATION AND INSPECTION	Y/N	Continuous	Periodic	Agent	Agent Qualification
Structural Steel Seismic Force-Resisting Systems (ref: IBC-15 Section 1705.12.1) Note: The inspections below are not required for structures assigned to SDC B or C that are not specifically detailed for seismic resistance, with a response modification coefficient, R , of 3 or less, excluding cantilever column systems	-				
1. Inspection of structural steel in the seismic force-resisting systems of buildings and structures assigned to SDC B, C, D, E, or F shall be performed in accordance with the quality assurance requirements of ASIC 341.	N	-	X	TA1	AWS AISC-SSI
2. Inspection of structural steel elements in the seismic force-resisting systems of buildings and structures assigned to SDC B, C, D, E, or F including struts, collectors, chords, and foundation elements, shall be performed in accordance with the quality assurance requirements of ASIC 341.	N	-	X	TA1	AWS AISC-SSI
Structural wood (ref: IBC-15 Section 1705.12.2) Note: The inspections below are not required if the sheathing fastener spacing is greater than 4" on center.	-				
1. Continuous special inspection during field gluing operations of elements of the seismic-force-resisting system.	N	X	-	SI1	PE/SE or EI
2. Periodic special inspections for nailing, bolting, anchoring and other fastening of components within the seismic-force-resisting system, including drag struts, braces, and hold-downs.	N	-	X	SI1	PE/SE or EI
Cold-Formed Steel Light Frame Construction (ref: IBC-15 Section 1705.12.3) Note: The inspections below are not required if the sheathing is gypsum board or fiberboard, or if the sheathing is wood structural panel or sheets on only one side of the shear wall, shear panel or diaphragm assembly and the fastener spacing is greater than 4" on center.	-				
1. Inspection of welding operations of elements of the main seismic force-resisting system.	N	-	X	SI1	PE/SE or EI
2. Inspection of screw attachment, bolting, anchoring, and other fastening of elements of the main seismic force-resisting system, including shear wall, braces, diaphragms, collectors, and hold-downs.	N	-	X	SI1	PE/SE or EI
Designated seismic systems (ref: IBC-15 Section 1705.12.4)	-				
1. For structures assigned to SDC C, D, E, or F, the designated seismic systems requiring seismic qualification in accordance with ASCE7 and verify that the label, anchorage, and mounting conform to the certificate of compliance.	N	-	X	SI1	PE/SE or EI

Schedule of Special Inspections and Tests

SEISMIC RESISTANCE – STRUCTURAL (CONTINUED)

VERIFICATION AND INSPECTION	Y/N	Continuous	Periodic	Agent	Agent Qualification
Architectural Components (ref: IBC-15 Section 1705.12.5) Note: The inspections below are not required for the following situations: - Exterior cladding, interior and exterior nonbearing walls, and interior and exterior veneer 30 feet or less in height above grade or walking surface. - Exterior cladding and interior and exterior veneer weighing 5 psf or less. - Interior nonbearing walls weighing 15 psf or less.				-	
1. Inspection of the erection and fastening of exterior cladding, interior and exterior nonbearing walls, and interior and exterior veneer in structures assigned to SDC D, E, or F.	N	-	X	SI1	PE/SE or EI
2. Inspection of the anchorage of access floors in structures assigned to SDC D, E, or F.	N	-	X	SI1	PE/SE or EI
Plumbing, Mechanical, and Electrical Components (ref: IBC-15 Section 1705.12.6)				-	
1. Anchorage of electrical equipment for emergency and standby power systems in structures assigned to SDC C, D, E, or F.	N	-	X	SI1	PE/SE or EI
2. Anchorage of other electrical equipment in structures assigned to SDC E or F.	N	-	X	SI1	PE/SE or EI
3. Installation and anchorage of piping systems designed to carry hazardous materials and their associated mechanical units in structures assigned to SDC C, D, E, or F.	N	-	X	SI1	PE/SE or EI
4. Installation and anchorage of HVAC designed to carry hazardous materials in structures assigned to SDC C, D, E, or F.	N	-	X	SI1	PE/SE or EI
5. Installation and anchorage of vibration isolation systems in structures assigned to SDC C, D, E, or F where the approved construction documents require a nominal clearance of ¼ inch or less between the equipment support frame and restraint.	N	-	X	SI1	PE/SE or EI
6. Inspection of clearances of installed mechanical and electrical equipment where automatic fire sprinkler systems are installed in SDC C, D, E, or F structures.	N	-	X	SI1	PE/SE or EI
Storage racks (ref: IBC-15 Section 1705.12.7)					
1. Inspection of storage racks that are 8 feet or greater in height in structures assigned to SDC D, E, or F.	N	-	X	SI1	PE/SE or EI
Seismic Isolation System (ref: IBC-15 Section 1705.12.8)					
1. Inspection of seismic isolation systems during the fabrication and installation of isolator units and energy dissipation devices in structures assigned to SDC B, C, D, E, F	N	-	X	SI1	PE/SE or EI
Cold-formed steel special bolted moment frames (ref: IBC-15 Section 1705.12.9)				-	
1. Inspection of the installation of cold-formed steel special bolted moment frames in the seismic force-resisting systems in structures assigned to SDC D, E, or F.	N	-	X	SI1	PE/SE or EI

Schedule of Special Inspections and Tests

SEISMIC RESISTANCE – STRUCTURAL (CONTINUED)

VERIFICATION AND INSPECTION	Y/N	Continuous	Periodic	Agent	Agent Qualification
Testing for Seismic Resistance (ref: IBC-15 Section 1705.13)	-				
1. Structural steel: Nondestructive testing for seismic resistance is required in accordance with the schedule of steel special inspections and tests as applicable and AISC 341.	N	-	X	TA1	AWS AISC-SSI
2. Seismic force resisting systems: Nondestructive testing of structural steel in the seismic force-resisting systems (including struts, collectors, chords, and foundation elements) of buildings and structures assigned to SDC B, C, D, E, or F. Note: Nondestructive testing is not required in the seismic force resisting systems of structures assigned to SDC B or C that are not specifically detailed for seismic resistance, with a response modification coefficient, R, of 3 or less, excluding cantilever column systems.	N	-	X	TA1	AWS AISC-SSI
3. Nonstructural components: Review certificate of compliance for designated seismic system components.	N	-	X	TA1	AWS AISC-SSI
4. Designated seismic systems: Review certificate of compliance for designated seismic system components.	N	-	X	TA1	AWS AISC-SSI
5. Seismic isolation systems: Test seismic isolation system in accordance with ASCE 7 section 17.8	N	-	X	TA1	AWS AISC-SSI

Schedule of Special Inspections and Tests

ARCHITECTURAL

Test or Special Inspection	Y/ N	Submittal	Continuous	Periodic	Agent	Agent Qualification
Sprayed Fire-Resistant Materials (ref: IBC-15 Section 1705.14)						
1. Perform inspections and tests of sprayed fire-resistant materials in accordance with IBC-15 Section 1705.14 and the project specifications as follows:						
a. Material Specifications	N	X	-	-	TA1	PE/SE or EI
b. Verify preparation of structural member surface to receive sprayed fire-resistant materials.	N	-	-	X	TA1	ICC-SFSI
c. Verify ambient air temperature and ventilation is suitable for application and curing of sprayed fire-resistant materials.	N	-	-	X	TA1	ICC-SFSI
d. Inspect application of sprayed fire-resistant materials to properly prepared surfaces.	N	-	-	X	TA1	ICC-SFSI
e. Test thickness of fireproofing (ASTM E605). Perform a set of four thickness measurements for every 1000SF of floor and roof assemblies at each story or portion thereof. Thickness testing shall be performed on not less than 25% of the structural members at each level.	N	-	-	X	TA1	ICC-SFSI
f. Test the density of the sprayed fire-resistant material (ASTM E605). Test 1 sample for each type of framing where material is applied (beams, columns, deck) for every 2,500 SF or portion thereof at each level.	N	-	-	X	TA1	ICC-SFSI
g. Test the cohesive/adhesive bond strength of the sprayed fire-resistant material (ASTM E736). Test 1 sample for each type of structural framing for every 2,500 SF or portion thereof at each level.	N	-	-	X	TA1	ICC-SFSI
Mastic and Intumescent Fire-Resistant Coatings (ref: IBC-15 Section 1705.15)						
1. Special inspections and tests for mastic and intumescent fire-resistant coatings applied to structural elements and decks shall be performed in accordance with AWC 12-B and shall be based on the fire-resistance design as shown in the approved construction documents.	N	-	-	X	TA1	ICC-SFSI
Exterior Insulation and Finish Systems (EIFS) (ref: IBC-15 Section 1705.16)						
1. Verify materials, details and installations are per the approved construction documents.	N	-	-	X	TA1	PE/SE or ETT
2. Inspection of water-resistive barrier over sheathing substrate.	N	-	-	X	TA1	PE/SE or ETT
3. Special inspection shall be required for all EIFS applications except for the following situations: a. EIFS applications installed over a water-resistive barrier with a means of draining moisture to the exterior. b. EIFS applications installed over masonry or concrete walls.	N	-	-	X	TA1	PE/SE or ETT
Fire-resistant Penetrations and Joints (ref: IBC-15 Section 1705.17)						
1. Perform inspections and tests in accordance with project specifications and IBC-15 Section 1705.17 as follows:						
a. Inspect penetration firestop systems (ASTM E2174) that have been tested and listed in accordance with Section 714.3.2.	N	-	-	X	TA1	ICC-SFSI
b. Inspect fire-resistant joint systems (ASTM E2393) that have been tested and listed in accordance with Section 715.3.	N	-	-	X	TA1	ICC-SFSI
Testing for Smoke Control (ref: IBC-15 Section 1705.18)						
1. Smoke control systems shall be tested by a special inspector. The test scope shall be as follows: a. During erection of ductwork and prior to concealment for the purposes of leakage testing and recording device location. b. Prior to occupancy and after sufficient completion for the purposes of pressure difference testing, flow measurements, and detection and control verification.	N	-	-	X	TA1	Approved agencies shall have expertise in fire protection engineering, mechanical engineering, and certification as air balancers.

Schedule of Special Inspections and Tests

SPECIAL CASES

Test or Special Inspection	Y/ N	Submittal	Continuous	Periodic	Agent	Agent Qualification
Special Cases (ref: IBC-15 Section 1705.1)	-					
1. Special cases: Inspect work unusual in nature, including but not limited to alternative materials and systems, unusual design applications, materials, and systems with special manufacturer's requirement.	N	X	-	X	TA1	PE/SE or EI

SECTION 033000 - CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section specifies cast-in place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes, for the following:
 - 1. Footings.
 - 2. Foundation walls.
 - 3. Slabs-on-grade.
 - 4. Exterior concrete slabs and walks.
- B. Related Sections include the following:
 - 1. Division 01 Section "Temporary Facilities and Controls" for heating and dehumidification requirements for drying new concrete slabs to receive floor finishes.
 - 2. Division 07 Section "Under-Slab Vapor Retarders" for vapor retarders under slabs-on-grade.
 - 3. Division 09 Section "Resinous Flooring" for epoxy body and urethane top-coat flooring finish.
 - 4. Divisions 31, 32 and 33 Sections for drainage fill under slabs-on-grade.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Design Mixtures: For each concrete mixture. Submit alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.
 - 1. Indicate amounts of mixing water to be withheld for later addition at Project site.
 - 2. Prepare design mixtures for each type and strength of concrete, proportioned on the basis of laboratory trial mixture or field test data, or both, according to ACI 301.
 - 2. Use a qualified independent testing agency for preparing and reporting proposed mixture designs based on laboratory trial mixtures.
- C. Steel Reinforcement Shop Drawings: Placing drawings that detail fabrication, bending, and placement. Include bar sizes, lengths, material, grade, bar schedules, stirrup spacing, bent bar diagrams, bar arrangement, splices and laps, mechanical connections, tie spacing, hoop spacing, and supports for concrete reinforcement. Include special reinforcing required for openings through concrete structures.

- D. Submit locations for construction and control joint layout for walls, slabs and exterior flatwork and walks.
- E. Qualification Data: For ACI certified flatwork finisher certificate.
- F. Submit for record, a written plan of the field procedures to be implemented for hot and cold weather protection.
- G. Submit chart for application requirements of evaporation control should field conditions require use.
- H. Minutes of pre-concrete conference and pre-concrete slab conference.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications - Slabs: A qualified installer who employs on Project personnel qualified as ACI-certified Flatwork Technician and Finisher and an on site supervisor who is an ACI-certified Concrete Flatwork Technician.
- B. Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.
- C. Testing Agency Qualifications: An independent agency, acceptable to authorities having jurisdiction, qualified according to ASTM C 1077 and ASTM E 329 for testing indicated, as documented according to ASTM E 548.
 - 1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-01.
 - 2. Personnel performing laboratory tests shall be ACI-certified Concrete Strength Testing Technician and Concrete Laboratory Testing Technician - Grade I. Testing Agency laboratory supervisor shall be an ACI-certified Concrete Laboratory Testing Technician - Grade II.
- D. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from one source, and obtain admixtures through one source from a single manufacturer.
- E. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:
 - 1. ACI 301, "Specification for Structural Concrete."
 - 2. ACI 117, "Specifications for Tolerances for Concrete Construction and Materials."
- F. Pre-Concrete Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."
 - 1. Before submitting design mixtures, review concrete design mixture and examine procedures for ensuring quality of concrete materials. Review requirements of submittals, status of coordinating work, and availability of materials. Establish preliminary work progress schedule and procedures for materials inspection, testing, and certifications. Require representatives of each entity directly concerned with cast-in-place concrete to attend, including the following:
 - a. Contractor's superintendent.

- b. Agency responsible for concrete design mixtures.
 - c. Agency responsible for field quality control.
 - d. Concrete flatwork subcontractor, including ACI Certified Concrete Flatwork Finisher and ACI Certified field foreman.
 - e. Ready-mix concrete manufacturer.
 - f. Concrete subcontractor.
 - g. Architect.
 - 2. Review special inspection and testing and inspecting agency procedures for field quality control, concrete finishes and finishing, cold- and hot-weather concreting procedures, curing procedures, construction contraction and isolation joints, and joint-filler strips, steel reinforcement installation, and concrete protection.
- G. Pre-Concrete Slab Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."
- 1. Before submitting design mixtures, review concrete design mixture and examine procedures for ensuring quality of concrete materials. Review mix design requirements for concrete containing. Review requirements of submittals, status of coordinating work, and availability of materials. Establish preliminary work progress schedule and procedures for materials inspection, testing, and certifications. Require representatives of each entity directly concerned with cast-in-place concrete to attend, including the following:
 - a. Contractor's superintendent.
 - b. Agency responsible for concrete design mixtures.
 - c. Agency responsible for field quality control.
 - d. Ready-mix concrete manufacturer.
 - e. ACI Certified Concrete Flatwork Finisher, including ACI Certified field foreman.
 - f. Architect.
 - g. Concrete flatwork subcontractor.
 - h. Resilient athletic-flooring subcontractor.
 - i. Party responsible for under slab vapor barrier installation.
 - 2. Review special inspection and testing and inspecting agency procedures for field quality control, concrete finishes and finishing, cold- and hot-weather concreting procedures, curing procedures, construction contraction and isolation joints, and joint-filler strips, vapor-retarder installation coordination, steel reinforcement installation, floor and slab flatness and levelness measurement, and concrete protection.
 - 3. Review floor trowel finish requirements specified in Article 3.8, test area location, and coordination for review by all parties.
 - 4. Review slab drying requirements for the placement of floor finishes per Section 015000.
- H. Allow concrete slabs receiving finish flooring, including gymnasium athletic flooring, resilient flooring, carpet and thin-set ceramic and quarry tile to cure for 120 days minimum before the installation of floor systems.

1.5 PROJECT CONDITIONS

- A. To prevent exterior concrete entrance slabs, pavement and walks from repeated freeze thaw cycles and deicers before adequate curing to protect concrete has occurred, placement shall occur before October 1 or in the Spring after frost in the ground is gone and temperatures remain above freezing so surface is not exposed to freezing temperature. No deicers shall be applied to the concrete surface during the project.

1.6 FOUNDATION LAYOUT

- A. Verification: Before proceeding to lay out the Work, verify layout information shown on Drawings, in relation to the property survey and existing benchmarks. If discrepancies are discovered, notify Architect promptly in writing.
- B. General: Engage an engineering surveyor to lay out the Work using accepted surveying practices.
 - 1. Work from establish benchmarks and control points to set lines and levels.
 - 2. Inform installers of lines and levels to which they must comply.
 - 3. Check the location, level and plumb, of every major element as the Work progresses.
 - 4. Notify Contractor and Architect when deviations from required lines and levels exceed allowable tolerances.
 - 5. Coordinate and locate anchor bolt layouts.
 - 6. Coordinate elevation and locations of openings, bondouts, sleeves and inserts required to be placed in the work.

1.7 DELIVERY, STORAGE, AND HANDLING

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

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Products: Subject to compliance with requirements, provide one of the products specified.
 - 2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 FORM-FACING MATERIALS

- A. Smooth-Formed Finished Concrete: Form-facing panels that will provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.
 - 1. Plywood, metal, or other approved panel materials.
 - 2. Exterior-grade plywood panels, suitable for concrete forms, complying with DOC PS 1, and as follows:
 - a. B-B (Concrete Form), Class 1 or better; mill oiled and edge sealed.
- B. Rough-Formed Finished Concrete: Plywood, lumber, metal, or another approved material. Provide lumber dressed on at least two edges and one side for tight fit.
- C. Void Forms: Biodegradable paper surface, treated for moisture resistance, structurally sufficient to support weight of plastic concrete and other superimposed loads.
- D. Chamfer Strips: Wood, metal, PVC, or rubber strips, 1/2 by 1/2 inch, minimum.

- E. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.
 - 1. Comply with State of Maine DEP regulations for VOC content of not more than 450 g/L. Formulate form-release agent with rust inhibitor for steel form-facing materials.
- F. Form Ties: Factory-fabricated, removable or snap-off metal or glass-fiber-reinforced plastic form ties designed to resist lateral pressure of fresh concrete on forms and to prevent spalling of concrete on removal.
 - 1. Furnish units that will leave no corrodible metal closer than 1 inch to the plane of exposed concrete surface.
 - 2. Furnish ties that, when removed, will leave holes no larger than 1 inch in diameter in concrete surface.

2.3 STEEL REINFORCEMENT

- A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed.
- B. Steel Bar Mats: ASTM A 184/A 184M, fabricated from ASTM A 615/A 615M, Grade 60, deformed bars, assembled with clips.
- C. Plain-Steel Wire: ASTM A 82, as drawn.
- D. Deformed-Steel Wire: ASTM A 496.
- E. Plain-Steel Welded Wire Reinforcement: ASTM A 185, plain, fabricated from as-drawn steel wire into flat sheets.

2.4 REINFORCEMENT ACCESSORIES

- A. Joint Dowel Bars: ASTM A 615/A 615M, Grade 60, plain-steel bars, cut bars true to length with ends square and free of burrs.
- B. Slab Construction Joint Dowels:
 - 1. PNA Diamond Dowel System, PNA Construction Technologies; pna-inc.com.
 - a. Load Plates: Saw cut from hot rolled plate per ASTM A36, 1/4-inch thick by 4-1/2-inch square.
 - b. Pocket Former: High-density plastic pocket former with nailing fins for attachment to edge forms.
- C. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice," of greater compressive strength than concrete and as follows:
 - 1. For concrete surfaces exposed to view where legs of wire bar supports contact forms, use CRSI Class 1 plastic-protected steel wire or CRSI Class 2 stainless-steel bar supports.

2.5 CONCRETE MATERIALS

- A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source, throughout Project:
 - 1. Portland Cement: ASTM C 150, Type I or II, gray.
 - a. Supplementary Cementitious Materials (Permitted for Footings and Walls Only):
 - 1) Ground Granulated Blast-Furnace Slag, ASTM C 989, Grade 100 or 120. Limit the amount of ground granulated blast-furnace slag ash as a percentage of cementitious materials to 40% maximum.
 - 2) Fly Ash: ASTM C 618, Class F. Limit the amount of fly ash as a percentage of cementitious materials to 30% maximum.
- B. Normal-Weight Aggregates: ASTM C 33, Class 3S coarse aggregate or better, graded. Provide aggregates from a single source.
 - 1. Maximum Coarse-Aggregate Size: #57 gradation (nominal size 1-inch to No. 4).
 - 2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.
- C. Water: ASTM C 94/C 94M and potable.

2.6 ADMIXTURES

- A. Air-Entraining Admixture: ASTM C 260.
- B. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and that will not contribute water-soluble chloride ions exceeding those permitted in hardened concrete. Do not use calcium chloride or admixtures containing calcium chloride.
 - 1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A or Type F.
 - 2. Retarding Admixture: ASTM C 494/C 494M, Type B.
 - 3. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.
 - 4. High-Range, Water-Reducing Admixture: ASTM C 494/C 494M, Type F.
 - 5. High-Range, Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type G.
 - 6. Plasticizing and Retarding Admixture: ASTM C 1017/C 1017M, Type II.
 - 7. Set-Accelerating Admixture: ASTM C 494/C Type C.

2.7 FIBER REINFORCEMENT

- A. Synthetic Fiber: Monofilament polypropylene fibers engineered and designed for use in concrete pavement, complying with ASTM C 1116, Type III, 3/4 inches long.
 - 1. Products:
 - a. Monofilament Fibers:
 - 1) Grace Construction Products, W. R. Grace & Co.; Grace MicroFiber.

2.8 CURING AND SEALING MATERIALS

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

- a. Conspec Marketing & Manufacturing Co., Inc., a Dayton Superior Company; Aquafilm.
 - b. Dayton Superior Corporation; Sure Film.
 - c. Euclid Chemical Company (The); Eucobar.
 - d. L&M Construction Chemicals, Inc.; E-Con.
 - e. MBT Protection and Repair, Div. of ChemRex; Confilm.
 - f. Meadows, W. R., Inc.; Sealtight Evapre.
 - g. Nox-Crete Products Group, Kinsman Corporation; Monofilm.
 - h. Sika Corporation, Inc.; SikaFilm.
 - i. Symons Corporation, a Dayton Superior Company; Finishing Aid.
 - j. Vexcon Chemicals, Inc.; Certi-Vex EnvioAssist.
- B. Moisture-Retaining Cover:
 - 1. Interior Slabs: ASTM C 171, white polyethylene film or white polyethylene sheet with rayon and polyester fiber.
 - 2. Exterior Slabs: White polyethylene sheet with rayon and polyester fiber fabric coated contact surface.
 - a. PNA HydraCure S16 or equivalent.
- C. Exterior Concrete Flatwork Sealer: Water-based silane/siloxane water repellent and chloride screen.
 - 1. Prosoco Consolideck Saltguard WB.
- D. Water: Potable.

2.9 RELATED MATERIALS

- A. Expansion- and Isolation-Joint-Filler Strips: ASTM D3575, 1.7 pound minimum density closed cell polyethylene with 1/2-inch deep top strip-off edge to allow installation of joint sealant; 1/2-inch thickness by full depth of slab..
 - 1. A.H. Harris; Harristrip-Off; Harris Polyethylene Joint Filler.
 - 2. Foam Peel HT; Foamtastic, division of Hohmann & Barnard.
 - 3. W.R. Meadows; Deck-O-Foam.
- B. Joint-Filler Strips Left Exposed: ASTM D 1751, asphalt-saturated cellulosic fiber.
- C. Bonding Agent: ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.

2.10 REPAIR MATERIALS

- A. Repair Underlayment (To Receive Resilient Floor Covering): Cement-based, polymer-modified, self-leveling product that can be applied in thicknesses from 1/8 inch and that can be feathered at edges to match adjacent floor elevations.
 - 1. Cement Binder: ASTM C 150, portland cement or hydraulic or blended hydraulic cement as defined in ASTM C 219.
 - 2. Primer: Product of underlayment manufacturer recommended for substrate, conditions, and application.
 - 3. Aggregate: Well-graded, washed gravel, 1/8 to 1/4 inch or coarse sand as recommended by underlayment manufacturer.

4. Compressive Strength: Not less than 4100 psi at 28 days when tested according to ASTM C 109/C 109M.

2.11 CONCRETE MIXTURES, GENERAL

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

2.12 CONCRETE MIXTURES FOR BUILDING ELEMENTS

- A. Foundation Walls and Footings: Proportion normal-weight (145 pcf) concrete mixture as follows:
 1. Minimum Compressive Strength: 3500 psi at 28 days.
 2. Maximum Water-Cementitious Materials Ratio: 0.55.
 3. Slump Limit: 4 inches max.
 - a. 6 inches for concrete with addition of mid-range water-reducing admixture or plasticizing admixture.
 - b. 8 inches for concrete with addition of high-range water-reducing admixture or plasticizing admixture.
 4. Air Content: 6 percent, plus or minus 1.5 percent at point of discharge.
- B. Interior Slabs: Proportion normal-weight concrete mixture as follows:
 1. Minimum Compressive Strength: 3000 psi at 28 days.
 2. Maximum Water-Cementitious Materials Ratio: 0.54.
 3. Slump Limit: 4 inches max.
 - a. 6 inches for concrete with addition of mid-range water-reducing admixture or plasticizing admixture.
 - b. 8 inches for concrete with addition of high-range water-reducing admixture or plasticizing admixture.
 4. Air Content: Do not allow air content of troweled finished floors to exceed 3 percent. Entrapped air only, do not add air-entraining admixture.
 5. Synthetic Fiber: Uniformly disperse in concrete mixture at manufacturer's recommended rate, but not less than 1.0 lb/cu. yd.
 - a. Fiber is not required for slabs reinforced with reinforcing bars.
 6. Fly ash and slag cementitious materials are not permitted for slabs.
- C. Exterior Slabs and Walks: Proportion normal-weight (145 pcf) concrete mixture as follows:
 1. Minimum Compressive Strength: 5000 psi at 28 days.
 2. Maximum Water-Cementitious Materials Ratio: 0.40.
 3. Slump Limit: 4 inches max.
 - a. 6 inches for concrete with addition of mid-range water-reducing admixture or plasticizing admixture.
 - b. 8 inches for concrete with addition of high-range water-reducing admixture or plasticizing admixture.
 4. Air Content: 6 percent, plus or minus 1.5 percent at point of discharge.

2.13 FABRICATING REINFORCEMENT

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

2.14 CONCRETE MIXING

- A. Ready-Mixed Concrete: Measure, batch, mix, and deliver concrete according to ASTM C 94/C 94M and ASTM C 1116, and furnish batch ticket information. Include on batch ticket the amount of water introduced into the mix at the plant, and amount of water that can be added later, and stay within the specified water-cementitious materials ratio.
 - 1. When air temperature is between 85 and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.1 FORMWORK

- A. Design, erect, shore, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads.
- B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.
- C. Limit concrete surface irregularities, designated by ACI 347R as abrupt or gradual, as follows:
 - 1. Class A, 1/8 inch for smooth-formed finished surfaces (exposed concrete surface).
 - 2. Class C, 1/2 inch for rough-formed finished surfaces.
- D. Construct forms tight enough to prevent loss of concrete mortar.
- E. Fabricate forms for easy removal without hammering or prying against concrete surfaces. Provide crush or wrecking plates where stripping may damage cast concrete surfaces. Provide top forms for inclined surfaces steeper than 1.5 horizontal to 1 vertical.
 - 1. Do not use rust-stained steel form-facing material for exposed surfaces.
- F. Set edge forms, bulkheads, and intermediate screed strips for slabs to achieve required elevations and slopes in finished concrete surfaces. Provide and secure units to support screed strips; use strike-off templates or compacting-type screeds.
- G. Provide temporary openings for cleanouts and inspection ports where interior area of formwork is inaccessible. Close openings with panels tightly fitted to forms and securely braced to prevent loss of concrete mortar. Locate temporary openings in forms at inconspicuous locations.
- H. Chamfer exterior corners and edges of permanently exposed concrete.
- I. Form openings, chases, offsets, sinkages, keyways, reglets, blocking, screeds, and bulkheads required in the Work. Determine sizes and locations from trades providing such items.

- J. Clean forms and adjacent surfaces to receive concrete. Remove chips, wood, sawdust, dirt, and other debris just before placing concrete.
- K. Retighten forms and bracing before placing concrete, as required, to prevent mortar leaks and maintain proper alignment.
- L. Coat contact surfaces of forms with form-release agent, according to manufacturer's written instructions, before placing reinforcement.

3.2 EMBEDDED ITEMS

- A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 1. Install anchor rods, accurately located, to elevations required and complying with tolerances in Section 7.5 of AISC's "Code of Standard Practice for Steel Buildings and Bridges."

3.3 REMOVING AND REUSING FORMS

- A. General: Formwork for sides of beams, walls, columns, and similar parts of the Work that does not support weight of concrete may be removed after cumulatively curing at not less than 50 deg F for 24 hours after placing concrete, if concrete is hard enough to not be damaged by form-removal operations and curing and protection operations are maintained.
 - 1. Leave formwork for beam soffits, joists, slabs, and other structural elements that supports weight of concrete in place until concrete has achieved at least 70 percent of its 28-day design compressive strength.
 - 2. Remove forms only if shores have been arranged to permit removal of forms without loosening or disturbing shores.
- B. Clean and repair surfaces of forms to be reused in the Work. Split, frayed, delaminated, or otherwise damaged form-facing material will not be acceptable for exposed surfaces. Apply new form-release agent.
- C. When forms are reused, clean surfaces, remove fins and laitance, and tighten to close joints. Align and secure joints to avoid offsets. Do not use patched forms for exposed concrete surfaces unless approved by Architect.

3.4 STEEL REINFORCEMENT

- A. General: Comply with CRSI's "Manual of Standard Practice" for placing reinforcement.
 - 1. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.
- B. Clean reinforcement of loose rust and mill scale, earth, ice, and other foreign materials that would reduce bond to concrete.
- C. Accurately position, support, and secure reinforcement against displacement. Locate and support reinforcement with bar supports to maintain minimum concrete cover. Do not weld reinforcing bars.

- D. Set wire ties with ends directed into concrete, not toward exposed concrete surfaces.
- E. Install welded wire reinforcement in longest practicable lengths on bar supports spaced to minimize sagging. Lap edges and ends of adjoining sheets at least one mesh spacing. Offset laps of adjoining sheet widths to prevent continuous laps in either direction. Lace overlaps with wire.

3.5 JOINTS

- A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.
- B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Architect.
 - 1. Place joints perpendicular to main reinforcement. Continue reinforcement across construction joints, unless otherwise indicated. Do not continue reinforcement through sides of strip placements of floors and slabs.
 - 2. Form keyed joints as indicated. Embed keys at least 1-1/2 inches into concrete.
 - 3. Locate joints for beams, slabs, joists, and girders in the middle third of spans. Offset joints in girders a minimum distance of twice the beam width from a beam-girder intersection.
 - 4. Locate horizontal joints in walls and columns at underside of floors, slabs, beams, and girders and at the top of footings or floor slabs.
 - 5. Space vertical joints in walls as indicated. Locate joints beside piers integral with walls, near corners, and in concealed locations where possible.
 - 6. Use a bonding agent at locations where fresh concrete is placed against hardened or partially hardened concrete surfaces.
- C. Contraction (Control) Joints in Slabs-on-Grade: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of concrete thickness, with a one inch minimum, as follows:
 - 1. Sawed Joints: Form contraction joints with Soff-Cut early-entry dry-cut control joint saw cutting. Install cuts at each control joint location as soon as concrete will support weight of saw and operator without disturbing final finish. Provide adequate equipment to complete cutting operations within 2 hours after final pass of trowel. Use Soff-Cut blades and skid plates, using a new skid plate with each new blade. Remove debris in path of cut and under skid plate before cutting. Install Soff-Cut joint protector at saw-cut intersection prior to cross-cut. Remove dry powder saw cut concrete spoils immediately without disturbing finish.
 - 2. Joint Width: 1/8-inch for slabs to receive floor coverings. 1/4-inch for joints to be left exposed and filled with joint sealant.
 - 3. Contraction joints shall be placed in accordance with approved Shop Drawings. The panel shall be as nearly square as possible. If panel cannot be square, do not exceed panel length to panel width ratio of 1 to 1-1/2. Conform to bay spacing wherever possible (at column centerlines, half bays, third bays, one quarter bays, or equal division to meet the specified spacing requirements).
 - 4. Make initial saw cut at mid-length of slab and proceed by saw-cutting at mid-length of each subsequent panel until all joints have been cut.
 - 5. Joints are not permitted in slabs of coolers or freezers.
 - 6. Avoid traffic across saw cut until sufficient strength is gained to protect joint edges.
 - 7. Saw cut slabs on grade in accordance with spacing indicated. Where not indicated, saw cut in accordance with the following maximum spacing:

- a. 4 inches thick slab: 8 feet.
 - b. 5 to 6 inches thick: 10 feet.
 - c. 6 1/4 to 7 inches thick: 12 feet.
 - d. 7 1/4 to 8 inches thick: 14 feet.
- D. Isolation Joints in Slabs-on-Grade: After removing formwork, install joint-filler strips at slab junctions with vertical surfaces, such as column pedestals, foundation walls, grade beams, and other locations, as indicated.
 - 1. Extend joint-filler strips full width and depth of joint, terminating flush with finished concrete surface, unless otherwise indicated.
 - 2. Install joint-filler strips in lengths as long as practicable. Where more than one length is required, lace or clip sections together.
- E. Doweled Slab Joints: Install plate system and support assemblies at construction joints and joints where indicated.
- F. Joints in Sidewalks and Exterior Flatwork: Radius edges of walks and outside edges of slabs with 1/4-inch radius edge tool.
 - 1. Saw cut joints, complying with contraction joint cutting requirements, unless indicated otherwise. Submit shop drawing of saw cut layout for approval.

3.6 CONCRETE PLACEMENT

- A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections have been performed.
- B. Do not add water to concrete during delivery, at Project site, or during placement unless approved by Architect. Record water added at the Project site on batch ticket. Added water shall not exceed allowable amount to maintain concrete water cement ratio.
- C. Before test sampling and placing concrete, water may be added at Project site, subject to limitations of ACI 301.
 - 1. Do not add water to concrete after adding high-range water-reducing admixtures to mixture.
- D. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete will be placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as indicated. Deposit concrete to avoid segregation.
 - 1. Deposit concrete in horizontal layers of depth to not exceed formwork design pressures and in a manner to avoid inclined construction joints.
 - 2. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301.
 - 3. Do not use vibrators to transport concrete inside forms. Insert and withdraw vibrators vertically at uniformly spaced locations to rapidly penetrate placed layer and at least 6 inches into preceding layer. Do not insert vibrators into lower layers of concrete that have begun to lose plasticity. At each insertion, limit duration of vibration to time necessary to consolidate concrete and complete embedment of reinforcement and other embedded items without causing mixture constituents to segregate.
- E. Deposit and consolidate concrete for floors and slabs in a continuous operation, within limits of construction joints, until placement of a panel or section is complete.

1. Consolidate concrete during placement operations so concrete is thoroughly worked around reinforcement and other embedded items and into corners.
 2. Maintain reinforcement in position on chairs during concrete placement.
 3. Screed slab surfaces with a straightedge and strike off to correct elevations.
 4. Slope surfaces uniformly to drains where required.
 5. Begin initial floating using bull floats to form a uniform and open-textured surface plane, before excess bleedwater appears on the surface. Do not further disturb slab surfaces before starting finishing operations.
- F. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.
1. When average high and low temperature is expected to fall below 40 deg F for three successive days, maintain delivered concrete mixture temperature within the temperature range required by ACI 301.
 2. Do not use frozen materials or materials containing ice or snow. Do not place concrete on frozen subgrade or on subgrade containing frozen materials.
 3. Do not use calcium chloride, salt, or other materials containing antifreeze agents.
- G. Hot-Weather Placement: Comply with ACI 301 and as follows:
1. Maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
 2. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade uniformly moist without standing water, soft spots, or dry areas.

3.7 FINISHING FORMED SURFACES

- A. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
1. Apply to concrete surfaces not exposed to view.
- B. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defects. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
1. Apply to concrete surfaces exposed to public view.
- C. Related Unformed Surfaces: At tops of walls, horizontal offsets, and similar unformed surfaces adjacent to formed surfaces, strike off smooth and finish with a texture matching adjacent formed surfaces. Continue final surface treatment of formed surfaces uniformly across adjacent unformed surfaces, unless otherwise indicated.

3.8 FINISHING FLOORS AND SLABS

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

- B. Float Finish: Consolidate surface with power-driven floats or by hand floating if area is small or inaccessible to power driven floats. If pan floats are used, the first floating shall be done by power trowel with conventional float blades to open surface to allow release of bleed water and prevent blistering. Restraighten, cut down high spots, and fill low spots as required to meet the floor flatness and levelness tolerances. Repeat float passes and restraightening until surface is left with a uniform, smooth, granular texture.
1. Apply float finish to surfaces to receive trowel finish.
- C. Trowel Finish: After applying float finish, apply first troweling and consolidate concrete by hand or power-driven trowel. Continue troweling passes and restraighten until surface is free of trowel marks and uniform in texture and appearance. Grind smooth any surface defects that would telegraph through applied coatings or floor coverings.
1. Apply a smooth trowel finish to surfaces exposed to view or to be covered with resilient flooring, carpet, paint, or another thin-film-finish coating system.
 - a. Trowel finish shall provide a smooth, uniform surface, with no ridges or swirl marks that would telegraph through floor coverings. Do not trowel to a shiny burnish surface. The intent is to provide a smooth even floor while leaving the surface texture open enough to permit drying of the slab to achieve required moisture content for floor covering installation.
 - 1) Provide a trowel finish test area and review surface finish with Architect and floor covering subcontractor.
 2. Finish surfaces to the following tolerances, according to ASTM E 1155, for a randomly trafficked floor surface:
 - a. Specified overall values of flatness, F(F) 35; and of levelness, F(L) 25; with minimum local values of flatness, F(F) 24; and of levelness, F(L) 17; for slabs-on-grade.
 - b. Specified overall values of flatness, F(F) 30; and of levelness, F(L) 20; with minimum local values of flatness, F(F) 24; and of levelness, F(L) 15; for suspended slabs.
 3. Where floor drains occur, water test the slab in the presence of the Architect to confirm proper slope to drains without high and low areas that cause ponding and bird baths. Grind high spots to permit drainage.
 - a. Include testing of slabs to receive thin set ceramic tile.
- D. Exterior Concrete Walks and Flatwork: Place concrete, screed and wood float surfaces to a smooth and uniform finish, free of open texturing and exposed aggregate. Avoid working bleed water into surface mortar.
1. Bull float directly behind screed before bleedwater appears. IF bleed water appears, do not work bleed water into surface, allow it to evaporate.
 2. Immediately behind bullfloat, drag broom across surface for a light broom finish if surface paste provides adequate stiffness to maintain acceptable surface texture. If bleedwater appears before application of broom finish, allow surface water to evaporate before brooming.
 3. Coordinate required final broom finish with Architect before application.
 4. Walks and slabs shall be flat at no greater than plus or minus 1/4 inch in 10 feet. Walks and slabs shall pitch to permit drainage, free of ponding water.

3.9 MISCELLANEOUS CONCRETE ITEMS

- A. Filling In: Fill in holes and openings left in concrete structures, unless otherwise indicated, after work of other trades is in place. Mix, place, and cure concrete, as specified, to blend with in-place construction. Provide other miscellaneous concrete filling indicated or required to complete the Work.
- B. Curbs: Provide monolithic finish to interior curbs by steel-troweling surfaces to a hard, dense finish with corners, intersections, and terminations sloped to detail.
- C. Equipment Bases and Foundations: Provide machine and equipment bases and foundations as shown on Drawings. Set anchor bolts for machines and equipment at correct elevations, complying with diagrams or templates from manufacturer furnishing machines and equipment.

3.10 CONCRETE PROTECTING AND CURING AND SEALING

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures. Comply with ACI 306.1 for cold-weather protection and ACI 301 for hot-weather protection during curing.
- B. Evaporation Retarder: Apply evaporation retarder to unformed concrete slab surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.
- C. Formed Surfaces: Cure formed concrete surfaces, including supported slabs, and other similar surfaces. If forms remain during curing period, moist cure after loosening forms. If removing forms before end of curing period, continue curing for the remainder of the curing period.
- D. Unformed Surfaces: Begin curing immediately after finishing concrete. Cure unformed surfaces, including floors and slabs, concrete floor toppings, and other surfaces.
- E. Cure concrete according to ACI 308.1, by the following method:
 - 1. Moisture-Retaining-Cover Curing (Slabs receiving floor coverings, sealer, exterior walks and exterior slabs): Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Cure for not less than seven days. Immediately repair any holes or tears during curing period using cover material and waterproof tape.
 - a. Do not add water to surface of interior concrete slabs before covering.
 - b. Concrete shall remain above 40°F for a minimum of 28 days to permit proper curing.

3.11 EXTERIOR CONCRETE FLATWORK SEALER

- A. Exterior Concrete Flatwork Sealer: Apply sealer to all exterior horizontal surfaces including, walks, entrance slabs, plazas, landings, concrete steps and ramps.
 - 1. Allow concrete to dry for a minimum of 7 days after moisture retaining curing methods are removed.

2. Concrete surface and air temperatures during application and for at least 8 hours following shall be above 40°F.
3. Clean dirt and dust from surface before application of sealer and allow concrete to dry.
4. Apply sealer to clean dry surface in accordance with manufacturer's application instructions. Keep surface wet with sealer to permit penetration. Broom out puddles thoroughly until all sealer has penetrated the surface.

3.12 CONCRETE SURFACE REPAIRS

- A. Defective Concrete: Repair and patch defective areas in new work when approved by Architect. Remove and replace concrete that cannot be repaired and patched to Architect's approval.
- B. Formed Surfaces Patching Mortar: Mix dry-pack patching mortar, consisting of one part portland cement to two and one-half parts fine aggregate passing a No. 16 sieve, using only enough water for handling and placing.
- C. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.
 1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch in any dimension in solid concrete, but not less than 1 inch in depth. Make edges of cuts perpendicular to concrete surface. Clean, dampen with water, and brush-coat holes and voids with bonding agent. Fill and compact with patching mortar before bonding agent has dried. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.
 2. Repair defects on surfaces exposed to view by blending white portland cement and standard portland cement so that, when dry, patching mortar will match surrounding color. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike off slightly higher than surrounding surface.
 3. Repair defects on concealed formed surfaces that affect concrete's durability and structural performance as determined by Architect.
- D. Repairing Unformed Surfaces: Test unformed surfaces, such as floors and slabs, for finish and verify surface tolerances specified for each surface. Correct low and high areas. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.
 1. Repair finished surfaces containing defects. Surface defects include spalls, popouts, honeycombs, rock pockets, crazing and cracks in excess of 0.01 inch wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.
 2. After concrete has cured at least 14 days, correct high areas by grinding.
 3. Correct localized low areas during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish repaired areas to blend into adjacent concrete.
 4. Correct other low areas scheduled to receive floor coverings with a repair underlayment. Prepare, mix, and apply repair underlayment and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface. Feather edges to match adjacent floor elevations.
 5. Repair defective areas, except random cracks and single holes 1 inch or less in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean,

square cuts and expose steel reinforcement with at least a 3/4-inch clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials and mixture as original concrete except without coarse aggregate. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.

6. Repair random cracks and single holes 1 inch or less in diameter with patching mortar. Groove top of cracks and cut out holes to sound concrete and clean off dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding agent. Place patching mortar before bonding agent has dried. Compact patching mortar and finish to match adjacent concrete. Keep patched area continuously moist for at least 72 hours.
- E. Perform structural repairs of concrete, subject to Architect's approval, using epoxy adhesive and patching mortar.
- F. Repair materials and installation not specified above may be used, subject to Architect's approval.

3.13 FIELD QUALITY CONTROL

- A. Testing and Inspecting: Owner will engage a special inspector and qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.
- B. Inspections:
1. Steel reinforcement placement.
 2. Headed bolts and studs.
 3. Verification of use of required design mixture.
 4. Concrete placement, including conveying and depositing.
 5. Curing procedures and maintenance of curing temperature.
- C. Concrete Tests: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:
1. Testing Frequency: Obtain at least one composite sample for each 100 cu. yd. or fraction thereof of each concrete mixture placed each day.
 - a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.
 - b. When total quantity of a given class of concrete is less than 50 cu. yd., Architect may waive strength testing if adequate evidence of satisfactory strength is provided.
 2. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mixture. Perform additional tests when concrete consistency appears to change.
 3. Air Content: ASTM C 231, pressure method, for normal-weight concrete; one test for each composite sample, but not less than one test for each day's pour of each concrete mixture.
 4. Concrete Temperature: ASTM C 1064/C 1064M; one test hourly when air temperature is 40 deg F and below and when 80 deg F and above, and one test for each composite sample.
 1. Compression Test Specimens: ASTM C 31/C 31M.
 - a. Cast and laboratory cure two sets of two standard cylinder specimens for each composite sample (assumes 6" diameter by 12" cylinders per ASTM).

- b. Properly store cylinders while awaiting transport to laboratory, maintaining temperature between 60 deg F and 80 deg F. Deliver to laboratory for curing within 24 hours of casting test specimen.
 - c. Field-Cured Cylinders: For severe cold weather concrete operations, where and when directed by the Architect, prepare an additional set of four standard cylinders to be cured at the site, maintaining cylinders in the conditions and at the temperature of the in-place concrete. Provide cure box with temperature recorder. Protect field cylinders from being hit, damaged, and from vibration during initial set
- 2. Compressive-Strength Tests: ASTM C 39/C 39M;
 - a. Test one set of two laboratory-cured specimens at 7 days and one set of two specimens at 28 days (assumes 6" diameter by 12" cylinders per ASTM). If 4" diameter by 8" cylinders are used test one cylinder at 7 days and one set of three cylinders at 28 days. Additional cylinders may be taken as directed by contractor for tests outside of days specified.
 - b. A compressive-strength test shall be the average compressive strength from a set of specimens obtained from same composite sample and tested at age indicated.
- 3. When strength of field-cured cylinders is less than 85 percent of companion laboratory-cured cylinders, Contractor shall evaluate operations and provide corrective procedures for protecting and curing in-place concrete.
- 4. Strength of each concrete mixture will be satisfactory if every average of any three consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.
- 5. Test results shall be reported in writing to Architect, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.
- 6. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.
- 7. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect. Testing and inspecting agency may conduct tests to determine adequacy of concrete by cored cylinders complying with ASTM C 42/C 42M or by other methods as directed by Architect.
- 8. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
- 9. Correct deficiencies in the Work that test reports and inspections indicate does not comply with the Contract Documents.

END OF SECTION 033000

SECTION 042000 - UNIT MASONRY ASSEMBLIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes unit masonry assemblies consisting of the following:
 - 1. Face brick.
 - 2. Mortar and grout.
 - 3. Masonry joint reinforcement.
 - 4. Ties and anchors.
 - 5. Embedded flashing.
 - 6. Miscellaneous masonry accessories.
 - 7. Veneer-wall insulation.
 - 8. Masonry waste disposal.
- B. Related Sections include the following:
 - 1. Division 05 Section "Metal Fabrications" for steel relieving.
 - 2. Division 07 Section "Fluid-Applied Air/Vapor Barrier System" for air/vapor barrier system.
 - 3. Division 07 Section "Sheet Metal Flashing and Trim" for exposed sheet metal flashing.
 - 4. Division 07 Section "Joint Sealants" for sealing control and expansion joints in unit masonry.
- C. Products installed, but not furnished, under this Section include the following:
 - 1. Steel lintels for unit masonry, furnished under Division 05 Section "Metal Fabrications."
 - 2. Counterflashing in masonry joints for metal flashing, furnished under Division 07 Section "Sheet Metal Flashing and Trim."

1.3 DEFINITIONS

- A. Reinforced Masonry: Masonry containing reinforcing steel in grouted cells.

1.4 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional structural engineer, as defined in Division 01 Section "Quality Requirements," to design layout and spacing of masonry veneer anchors.
- B. Design Wind Pressures for Wall Components:
 - 1. Corner Pressures: +19 lbf/sq. ft. and -23 lbf/sq. ft.
 - 2. Field-of-Building Pressures: +19 lbf/sq. ft. and -21 lbf/sq. ft.

1.5 SUBMITTALS

- A. General: Submit in accordance with Division 01 Section "Submittal Procedures."
- B. Product Data: For each type of product indicated.
- C. Shop Drawings: For the following:
 - 1. Masonry Units: Show sizes, profiles, coursing, and locations of special shapes.
 - 2. Fabricated Flashing: Detail corner units, end-dam units, and other special applications.
- D. Delegated-Design Data for Masonry Veneer Anchors: For masonry veneer anchors indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- E. Samples for Initial Selection: For the following:
 - 1. Weep holes/vents showing colors available.
- F. Samples for Verification: For each type and color of the following:
 - 1. For each color and texture of face brick, in the form of straps of five or more bricks.
- G. Qualification Data: For firms and persons specified in "Quality Assurance" Article.
- H. Material Certificates: Include statements of material properties indicating compliance with requirements including compliance with standards and type designations within standards. Provide for each type and size of the following:
 - 1. Masonry Units.
 - a. Include material test reports substantiating compliance with requirements.
 - b. For masonry units used in structural masonry, include data and calculations establishing average net-area compressive strength of units.
 - c. For masonry units used in fire-rated assemblies, provide certificate establishing fire-resistance rating of units.
 - 2. Cementitious materials. Include brand, type, and name of manufacturer.
 - 3. Preblended, dry mortar mixes. Include description of type and proportions of ingredients.
 - 4. Grout mixes. Include description of type and proportions of ingredients.
 - 5. Reinforcing bars.
 - 6. Joint reinforcement.
 - 7. Anchors, ties, and metal accessories.
- I. Submit samples of sand to an approved laboratory for tests. Submit test report for approval.
- J. Cold- and Hot-Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with cold-weather requirements.
- K. Installation Inspection Report: Submit report of completed work inspection, for each area that is completed and ready to turn over for application of the air/vapor barrier system.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: Company specializing in performing the work of this Section with minimum 5 years experience.

- B. Source Limitations for Masonry Units: Obtain exposed masonry units of a uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, through one source from a single manufacturer for each product required.
- C. Source Limitations for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color for exposed masonry, from a single manufacturer for each cementitious component and from one source or producer for each aggregate.
- D. Fire-Resistance Ratings: Where indicated, provide materials and construction identical to those of assemblies with fire-resistance ratings determined per ASTM E 119 by a testing and inspecting agency, by equivalent concrete masonry thickness, or by other means, as acceptable to authorities having jurisdiction.
- E. Mockups: Build mockup panels to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution with each trade providing components of their work.
 - 1. Prepare mockups for review at Preinstallation Conference.
 - 2. Exterior Framed Wall Mockup: Provide masonry veneer mockup on one leg of exterior framed wall mockup constructed in Division 05 Section "Cold-Formed Metal Framing" as follows:
 - a. Include cavity insulation and veneer anchors and ties at same spacing as specified.
 - b. Install Brick Veneer above precast architectural concrete band provided in Division 03 Section "Plant-Precast Architectural Concrete."
 - c. Include a sealant-filled joint at least 16 inches long in masonry mockup.
 - d. Include through-wall flashing installed for a 24-inch length in corner of exterior wall mockup approximately 16 inches down from top of mockup, with a 12-inch length of flashing left exposed to view (omit masonry above half of flashing). Include counterflashing necessary at top edge of air/vapor barrier.
 - 3. Clean one-half of exposed faces of mockups with masonry cleaner as indicated.
 - 4. Protect accepted mockups from the elements with weather-resistant membrane. Maintain approved mockups during construction in an undisturbed condition as a standard for judging the completed Work.
 - 5. Approval of mockups is for color, texture, and blending of masonry units; relationship of mortar and sealant colors to masonry unit colors; tooling of joints; and aesthetic qualities of workmanship.
 - a. Approval of mockups is also for other material and construction qualities specifically approved by Architect in writing.
 - b. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless such deviations are specifically approved by Architect in writing.
 - 6. Demolish and remove mockups when directed by Architect.
- F. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."
 - 1. Parties that shall be present shall include the Owner, Architect, masonry subcontractor, masonry subcontractor's field superintendent and field workers performing the actual application, air/vapor barrier applicator, and installers whose work interfaces with or affects unit masonry assemblies, including but not limited to installers of storefront, curtain wall, and doors.
 - 2. Review mockup.
 - 3. Review tooling requirements for masonry receiving air/vapor barrier membrane.

4. Review procedures and installation requirements of flexible and metal flashings.
 5. Document proceedings, including corrective measures and actions required, and furnish copy of record to each participant.
 6. Provide 5 business days minimum advance notice to participants prior to convening preinstallation conference.
- G. Installation Inspection: Contractor and Installer shall inspect completed masonry backup installation for compliance with installation specifications and details and submit a report for each area that is completed and ready to turn over for application of the air/vapor barrier system. Report shall include the following:
1. Verify masonry joints are completely filled and free of voids and lumps.
 2. Verify masonry joints are tooled slightly concave.
 3. Verify that masonry reinforcing with pintels is at the specified spacing.
 4. Verify that masonry pintels are free of mortar droppings.
 5. Verify foundation ledge is clean and free of mortar droppings.
 6. Verify through wall flashings are at installed at specified locations.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store masonry units on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied. If units become wet, do not install until they are dry.
- B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.
- C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.
- D. Deliver preblended, dry mortar mix in moisture-resistant containers designed for lifting and emptying into dispensing silo. Store preblended, dry mortar mix in delivery containers on elevated platforms, under cover, and in a dry location or in a metal dispensing silo with weatherproof cover.
- E. Store masonry accessories, including metal items, to prevent corrosion and accumulation of dirt and oil.
- F. Protect plastic insulation as follows:
 1. Do not expose to sunlight, except to extent necessary for period of installation and concealment.
 2. Store insulation on pallets of blocking not less than 4 inches above grade. Insulation stored directly on ground may void insulation warranty.
 3. Protect insulation with a waterproof covering, and ventilate to avoid condensation. Wrapping materials used for shipping are not adequate for weather protection at job site.
 4. Protect against ignition at all times. Do not deliver plastic insulating materials to Project site before installation time.
 5. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.
 6. Maintain in dry condition. Do not install wet insulation within exterior wall assemblies.
 7. Do not install damaged insulation.

1.8 PROJECT CONDITIONS

- A. Protection of Masonry: During construction, cover tops of walls, projections, and sills with waterproof sheeting at end of each day's work. Cover partially completed masonry when construction is not in progress.
 - 1. Extend cover a minimum of 24 inches down both sides and hold cover securely in place.
- B. Do not apply uniform floor or roof loads for at least 12 hours and concentrated loads for at least 3 days after building masonry walls or columns.
- C. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Immediately remove grout, mortar, and soil that come in contact with such masonry.
 - 1. Protect base of walls from rain-splashed mud and from mortar splatter by spreading coverings on ground and over wall surface.
 - 2. Protect sills, ledges, and projections from mortar droppings.
 - 3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.
 - 4. Turn scaffold boards near the wall on edge at the end of each day to prevent rain from splashing mortar and dirt onto completed masonry.
- D. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602 and the following:
 - 1. Cold-Weather Construction: When the ambient temperature is within the limits indicated, use the following procedures:
 - a. 40 to 32 deg F: Heat mixing water or sand to produce mortar temperatures between 40 and 120 deg F.
 - b. 32 to 25 deg F: Heat mixing water and sand to produce mortar temperatures between 40 and 120 deg F. Heat grout materials to produce grout temperatures between 40 and 120 deg F. Maintain mortar and grout above freezing until used in masonry.
 - c. 25 to 20 deg F: Heat mixing water and sand to produce mortar temperatures between 40 and 120 deg F. Heat grout materials to produce grout temperatures between 40 and 120 deg F. Maintain mortar and grout above freezing until used in masonry. Heat masonry units to 40 deg F if grouting. Use heat on both sides of walls under construction.
 - d. 20 deg F and Below: Heat mixing water and sand to produce mortar temperatures between 40 and 120 deg F. Heat grout materials to produce grout temperatures between 40 and 120 deg F. Maintain mortar and grout above freezing until used in masonry. Heat masonry units to 40 deg F. Provide enclosures and use heat on both sides of walls under construction to maintain temperatures above 32 deg F within the enclosures.
 - 2. Cold-Weather Protection: When the mean daily temperature is within the limits indicated, provide the following protection, this is in addition to construction procedures specified above:
 - a. 40 to 25 deg F: Cover masonry insulating blankets for 48 hours after construction.
 - b. 25 deg F and Below: Provide enclosure and heat to maintain temperatures above 32 deg F within the enclosure for 72 hours after construction.

3. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F and above and will remain so until masonry has dried, but not less than 7 days after completing cleaning.
- E. Hot-Weather Requirements: Protect unit masonry work when temperature and humidity conditions produce excessive evaporation of water from mortar and grout. Provide artificial shade and wind breaks and use cooled materials as required.
1. When ambient temperature exceeds 100 deg F, or 90 deg F with a wind velocity greater than 8 mph, do not spread mortar beds more than 48 inches ahead of masonry. Set masonry units within one minute of spreading mortar.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
1. Products: Subject to compliance with requirements, provide one of the products specified.
 2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 MASONRY UNITS, GENERAL

- A. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to exceed tolerances and to contain chips, cracks, or other defects exceeding limits stated in the standard. Do not use units where such defects, including dimensions that vary from specified dimensions by more than stated tolerances, will be exposed in the completed Work or will impair the quality of completed masonry.

2.3 BRICK

- A. General: Provide shapes indicated and as follows for each form of brick required:
1. For ends of sills and caps and for similar applications that would otherwise expose unfinished brick surfaces, provide units without cores or frogs and with exposed surfaces finished.
 2. Provide special shapes for applications where stretcher units cannot accommodate special conditions, including those at corners, movement joints, bond beams, sashes, and lintels.
 3. Provide special shapes as indicated and for applications requiring brick of size, form, color, and texture on exposed surfaces that cannot be produced by sawing.
 4. Provide special shapes for applications where shapes produced by sawing would result in sawed surfaces being exposed to view.
- B. Face Brick: ASTM C 216, Grade SW, Type FBS.
1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of not less than 8000 psi.
 2. Initial Rate of Absorption: Less than 18 g/30 sq. in. per minute when tested per ASTM C 67.

3. Efflorescence: Provide brick that has been tested according to ASTM C 67 and is rated "not effloresced."
 4. Size (Actual Dimensions):
 - a. Brick Veneer: 3-5/8 inches wide by 2-1/4 inches high by 7-5/8 inches long.
 - b. Special shapes shall have dimensions indicated.
 5. Application: Use where brick is exposed, unless otherwise indicated.
 6. Color and Texture: As indicated.
- C. Building (Common) Brick: ASTM C 62, Grade SW.
1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of not less than 8000 psi.
 2. Size: Match size of face brick.
 3. Application: Use where brick is indicated for concealed locations.

2.4 MORTAR AND GROUT MATERIALS

- A. Portland Cement: ASTM C 150, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.
- B. Hydrated Lime: ASTM C 207, Type S.
- C. Portland Cement-Lime Mix: Packaged blend of portland cement complying with ASTM C 150, Type I or Type III, and hydrated lime complying with ASTM C 207, Type S. Standard masonry cement is not acceptable. Provide one of the following portland cement-lime mix products:
1. Eaglebond; Lafarge North America Inc.
 2. Portland and lime; Cement Quebec, Inc.
 3. Portland and lime Quikrete; The Quikrete Companies.
- D. Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes. Use only pigments with a record of satisfactory performance in masonry mortar. Pigmented mortar used
1. Products: Solomon Grind-Chem Services, Inc.; SGS Mortar Colors.
 - a. Colors for pigmented mortar as selected by Architect from manufacturer's full range of options.
 - b. Pigmented mortar used with Brick Veneer.
- E. Aggregate for Mortar: ASTM C 144.
1. For mortar that is exposed to view, use washed aggregate consisting of natural sand.
- F. Aggregate for Grout: ASTM C 404.
- G. Water: Potable.

2.5 REINFORCEMENT

- A. Uncoated Steel Reinforcing Bars: ASTM A 615/A 615M or ASTM A 996/A 996M, Grade 60.

2.6 MASONRY JOINT REINFORCEMENT

- A. Masonry Joint Reinforcement, General: ASTM A 951.
 - 1. Interior Walls: Hot-dip galvanized, carbon steel.
 - 2. Exterior Walls: Hot-dip galvanized, carbon steel.
 - 3. Wire Size for Side Rods - Exterior Walls: W2.8 or 0.188-inch diameter.
 - 4. Wire Size for Side Rods - Interior Walls: W1.7 or 0.148-inch diameter.
 - 5. Wire Size for Cross Rods: W1.7 or 0.148-inch diameter.
 - 6. Wire Size for Veneer Ties: W1.7 or 0.148-inch diameter.
 - 7. Spacing of Cross Rods, Tabs, and Cross Ties: Not more than 16 inches o.c.
 - 8. Provide in lengths of not less than 10 feet, with prefabricated corner and tee units.

2.7 TIES AND ANCHORS

- A. Materials: Provide ties and anchors specified in subsequent paragraphs that are made from materials that comply with eight subparagraphs below, unless otherwise indicated.
 - 1. Stainless-Steel Wire: ASTM A 580/A 580M, Type 304 or 316.
 - 2. Stainless-Steel Sheet: ASTM A 666, Type 304.
 - 3. Stainless Steel Bars: ASTM A 276 or ASTM A 666, Type 304.
- B. Wire Ties, General: Unless otherwise indicated, size wire ties to extend at least halfway through veneer but with at least 5/8-inch cover on outside face. Outer ends of wires are bent 90 degrees and extend 2 inches parallel to face of veneer.
- C. Adjustable Masonry-Veneer Anchors:
 - 1. General: Provide anchors that allow vertical adjustment but resist tension and compression forces perpendicular to plane of wall, for attachment over sheathing to metal studs and as follows:
 - a. Structural Performance Characteristics: Capable of withstanding a 100-lbf load in both tension and compression without deforming or developing play in excess of 0.05 inch.
 - 2. Screw-Attached, Masonry-Veneer Anchors with Weather-Resistant Gypsum Sheathing and Insulation: Units consisting of a wire tie and an adjustable metal anchor section.
 - a. Anchor Section: Dual-diameter stainless steel barrel section with thermal-plastic wing nut and metal backed neoprene washer, and corrosion-resistant, self-drilling screw. Barrel length to suit sheathing thickness and insulation thickness.
 - b. Wire Ties: Triangular-shaped wire ties fabricated from 0.188-inch- diameter, adjustable, stainless steel wire.
 - c. Product: Hohmann & Barnard, Inc.; Thermal 2-Seal Wing Nut Tie with 2X-Hook Tie.
 - d. Product: Heckmann Building Products #75KB Pos-I-Tie® KeyBolt Veneer Anchoring System at precast veneer.

2.8 EMBEDDED FLASHING MATERIALS

- A. Metal Flashing: Provide metal flashing, where flashing is exposed or partly exposed and where indicated, complying with SMACNA's "Architectural Sheet Metal Manual, Division 07 Section "Sheet Metal Flashing and Trim," and as follows:
 - 1. Tin-Zinc Alloy Coated Copper: Temper H00 or H01, cold-rolled copper sheet, 16-oz./sq. ft. weight or 0.0216 inch thick, coated with tin-zinc alloy and a protective washcoat.

- a. Product: FreedomGray; Revere Copper Products, Inc.
- 2. Fabrication: Form metal flashing to required shape using sheet metal break.
 - a. Fabricate metal flashing with drip edge. Fabricate by extending flashing 3/8 inch out from wall, with outer edge bent down 45 degrees.
 - 1) Lintel head flashings shall be fabricated with ends turned up and inside corners soldered. Metal flashing shall extend horizontally across lintel angle, up the vertical leg, and across the cavity to support the flexible flashing tie-in to the air/vapor barrier.
- B. Flexible Flashing: For flashing not exposed to the exterior, use the following, unless otherwise indicated:
 - 1. Rubberized-Asphalt Flashing: Composite flashing product consisting of a pliable, adhesive rubberized-asphalt compound, bonded to a high-density, cross-laminated polyethylene film to produce an overall thickness of not less than 0.040 inch.
 - a. Coordinate flashing and mastic with manufacturer of air/vapor barrier system. If proposed flashing system is not from the air/vapor barrier manufacturer being used on the project, it is the responsibility of the mason contractor to obtain and submit a statement of compatibility from the air/vapor barrier system being used on the project.
 - b. Products:
 - 1) Carlisle Coatings & Waterproofing; CCW-705-TWF Thru-Wall Flashing.
 - a) Termination Mastic: CCW-704 rubberized bitumen mastic. Coordinate mastic and flashing with manufacturer of air/vapor barrier system.
 - 2) Grace Construction Products, a unit of W. R. Grace & Co. - Conn.; Perm-A-Barrier Wall Flashing.
 - a) Termination Mastic: Bituthene Mastic. Coordinate mastic and flashing with manufacturer of air/vapor barrier system.
 - 3) Henry Company; Blueskin TWF Thru-Wall Flashing.
 - a) Termination Mastic: Polybitume 579-05. Coordinate mastic and flashing with manufacturer of air/vapor barrier system.
- C. Adhesives, Primers, and Seam Tapes for Flashings: Flashing manufacturer's standard products or products recommended by flashing manufacturer for bonding flashing sheets to each other and to substrates.

2.9 MISCELLANEOUS MASONRY ACCESSORIES

- A. Compressible Filler: Premolded filler strips complying with ASTM D 1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from neoprene, urethane, or PVC.
- B. Preformed Control-Joint Gaskets: Made from styrene-butadiene-rubber compound, complying with ASTM D 2000, Designation M2AA-805 or PVC, complying with ASTM D 2287, Type PVC-65406 and designed to fit standard sash block and to maintain lateral stability in masonry wall; size and configuration as indicated.
- C. Bond-Breaker Strips: Asphalt-saturated, organic roofing felt complying with ASTM D 226, Type I (No. 15 asphalt felt).
- D. Weep/Vent Products: Use the following, unless otherwise indicated:

1. Cellular Plastic Weep/Vent: One-piece, flexible extrusion made from UV-resistant polypropylene copolymer, full height and width of head joint and depth 1/8 inch less than depth of outer wythe, in color selected from manufacturer's standard.
 - a. Products:
 - 1) Hohmann & Barnard, Inc.; Quadro-Vent.
 - 2) Wire-Bond; Cell Vent.
- E. Cavity Drainage Material: Free-draining mesh, made from nonabsorbent, polymer strands that will not degrade within the wall cavity.
 1. Configuration: Strips, full-depth of cavity and 10 inches wide, with dovetail shaped notches 7 inches deep that prevent mesh from being clogged with mortar droppings.
 2. Thickness: 2-inches.
 3. Product: Mortar Net; Mortar Net USA, Ltd.

2.10 CAVITY-WALL INSULATION

- A. Rigid Insulation: ASTM C1289 Type 1, Class 2, closed-cell polyisocyanurate foam insulation faced with 10.5 mil thick glass fiber reinforced foil facer on each side, exposed side shall have a 1.5 mil thick reflective aluminum facer and meeting the following physical properties:
 1. Density: ASTM D 1622, nominal 2.0 pcf.
 2. Compressive Strength: ASTM D1621, 20 psi, minimum.
 3. Water Absorption: ASTM C209, less than 0.1 percent by volume.
 4. Air Permeance: ASTM E 2178, less than 0.02l/ssm.
 5. Board Size and Configuration:
 - a. Panel Size: 4 feet by 12 feet long.
 - b. Thickness: 3 inches.
 - c. Edge Condition: Square.
 6. Thermal Resistance: R-20.3.
 7. Fire Performance: Shall be compliant with NFPA 285 and UL 1715.
 8. Fire-Test-Response Characteristics: ASTM E 84, maximum flame-spread and smoke-developed indexes of 25 and 450, respectively.
 9. Product: Rmax Operating, LLC; TSX-8500.
- B. Insulation Tape: Provide board insulation manufacturer's compatible joint tape for sealing joints and brick tie penetrations through the insulation layer.
 1. Facer: Aluminum foil.
 2. Adhesive: Acrylic adhesive.
 3. Width: 4 inch.
 4. Thickness: 3.3 mils.
 5. Product: Rmax Operating, LLC; R-SEAL 3000.
- C. Insulation Flashing Tape: Provide insulation manufacturer's recommended flashing tape for sealing corners, ceiling and floor transitions, exterior envelop opening penetrations and through wall penetrations.
 1. Adhesive: Butyl rubber (non-asphalt).
 2. Width: 9-inch and 12-inch widths as required.
 3. Thickness: 35 mils.
 4. Product: Rmax Operating, LLC; R-SEAL 6000.
- D. Insulation Caulk: Provide insulation manufacturer's recommended caulk for sealing small penetrations.

1. Product: Henry Company; Henry HE925-BES or equivalent.
- E. Adhesive: Type recommended by insulation board manufacturer for application indicated.

2.11 MASONRY CLEANERS

- A. Job-Mixed Detergent Solution: Solution of 1/2-cup dry measure tetrasodium polyphosphate (Spic and Span) and 1/2-cup dry measure laundry detergent dissolved in 1 gal. of water.
- B. Proprietary Buffered Detergent-Based Cleaner: Manufacturer's standard-strength cleaner designed for removing mortar/grout stains, efflorescence, and other new construction stains from new masonry without discoloring or damaging masonry and precast concrete surfaces. Use product expressly approved for intended use by cleaner manufacturer and manufacturer of masonry units being cleaned. Muriatic acid is not permitted.
 1. Cleaners for Brick: EaCoChem; NMD 80.

2.12 MORTAR AND GROUT MIXES

- A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures, unless otherwise indicated.
 1. Do not use calcium chloride in mortar or grout.
 2. Limit cementitious materials in mortar for exterior and reinforced masonry to portland cement and lime.
- B. Preblended, Dry Mortar Mix: Furnish dry mortar ingredients in form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.
- C. Mortar for Unit Masonry: Comply with BIA Technical Notes 8A, Proportion Specification. Provide the following types of mortar for applications stated unless another type is indicated or needed to provide required compressive strength of masonry.
 1. For masonry below grade or in contact with earth, use Type M.
 2. For reinforced masonry, use Type S.
 3. For exterior veneer masonry, use Type N.
- D. Pigmented Mortar: Select and proportion pigments with other ingredients to produce color required. Do not add pigments to colored cement products.
 1. Pigments shall not exceed 10 percent of portland cement by weight.
- E. Grout for Unit Masonry: Comply with ASTM C 476.
 1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with Table 1.15.1 in ACI 530.1/ASCE 6/TMS 602 for dimensions of grout spaces and pour height.
 2. Provide grout with a slump of 8 to 11 inches as measured according to ASTM C 143/C 143M.
- F. Concrete for Unit Masonry: 3000 psi, 28-day compressive strength. Comply with requirements of Division 03 Section "Cast-In-Place Concrete."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of work.
 - 1. If unsatisfactory conditions are encountered, prepare written report, endorsed by Installer, listing conditions detrimental to performance of work.
 - 2. Verify that foundations are within tolerances specified.
 - 3. Verify that reinforcing dowels are properly placed.
 - 4. Examine wall framing, sheathing, and air/vapor barrier to verify that stud locations are suitable for spacing of veneer anchors and that installation will result in a weatherproof covering.
- B. Before installation, examine rough-in and built-in construction for piping and electrical systems to verify actual locations of piping and electrical connections.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

- A. Thickness: Build cavity walls and other masonry construction to full thickness shown. Build single-wythe walls to actual widths of masonry units, using units of widths indicated.
- B. Build chases and recesses to accommodate items specified in this and other Sections.
- C. Leave openings for equipment to be installed before completing masonry. After installing equipment, complete masonry to match the construction immediately adjacent to opening.
- D. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying, unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.
- E. Select and arrange units for exposed unit masonry to produce a uniform blend of colors and textures.
 - 1. Mix units from several pallets or cubes as they are placed.
- F. Comply with construction tolerances in ACI 530.1/ASCE 6/TMS 602 and with the following:
 - 1. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2 inch maximum.
 - 2. For vertical alignment of exposed head joints, do not vary from plumb by more than 1/4 inch in 10 feet, or 1/2 inch maximum.
 - 3. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than 1/8 inch in 10 feet, 1/4 inch in 20 feet, or 1/2 inch maximum.
 - 4. For exposed bed joints, do not vary from thickness indicated by more than plus or minus 1/8 inch, with a maximum thickness limited to 1/2 inch. Do not vary from bed-joint thickness of adjacent courses by more than 1/8 inch.

5. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8 inch. Do not vary from adjacent bed-joint and head-joint thicknesses by more than 1/8 inch.
6. For faces of adjacent exposed masonry units, do not vary from flush alignment by more than 1/16 inch except due to warpage of masonry units within tolerances specified for warpage of units.
7. For exposed bed joints and head joints of stacked bond, do not vary from a straight line by more than 1/16 inch from one masonry unit to the next.

3.3 INSULATION INSTALLATION

- A. General: Install insulation in accordance with manufacture's written instructions.
 1. Do not install insulation on walls when water, frost or ice is present.
 2. Do not install wet insulation. Wet insulation shall be fully air dried before installing, sealing or covering.
 3. All taping and flashing of started sections of insulation installations shall be completed each day. Exposed foam edges shall be sealed with insulation tape at end of each work day.
- B. Fit courses of cavity insulation firmly against air/vapor barrier membrane or back-up wythe, with edges butted tightly both ways. Hold firmly in place until veneer anchor are installed. Install insulation with the long dimension horizontal and the foil facer facing the exterior. Each row of insulation shall be staggered a minimum of 16 inches from the row below. At corners, boards shall be overlapped tightly.
- C. Seal end and edge joints of insulation with continuous insulation joint tape, 4 inches wide, using sufficient hand pressure to ensure seal and in accordance with rigid insulation manufacturer's joint sealing recommendations.
 1. All surfaces to which the insulation joint tape is applied shall be free of moisture, oils, dust, dirt and other debris that could inhibit adhesion. Clean surfaces with a dry cloth as necessary.
 2. Center tape along insulation joints. When connection ends of tape segments, provide a minimum of 2 inch overlap.
 3. At insulation board terminations, including but not limited to, building foundations, slabs, shelf protrusions, roofing membranes, blocking for exterior envelop openings, seal insulation to adjacent surface with flashing tape.
 4. Corners shall be sealed using insulation flashing tape.
 5. At through-wall penetrations, seal penetration to insulation with 12 inch tape.
- D. Damages to foam core and foil facing shall be replaced by fully cutting out the damaged area. At steel framed walls, the removed piece shall be large enough to span entire stud spacing to ensure new joints are backed by framing. Replace removed piece with new insulation.
- E. Insulation shall be permanently held in place by masonry veneer anchors installed in paragraph 3.6 below.

3.4 MORTAR BEDDING AND JOINTING

- A. Lay solid masonry units, including brick veneer, with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.
 - 1. Full head joints in masonry veneer are required to make wall as water impermeable as possible. If field observations find head joints are not fully filled, the contractor will be required to remove brick at random locations as directed by the Architect. If additional locations are found with partially filled head joints, the masonry veneer shall be removed and new masonry veneer properly laid.
- B. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness, unless otherwise indicated.

3.5 CAVITY WALLS

- A. Keep cavities clean of mortar droppings and other materials during construction. Strike joints facing cavities flush.
 - 1. Use wood strips temporarily placed in cavity to collect mortar droppings. As work progresses, remove strips, clean off mortar droppings, and replace in cavity.
 - 2. Place cavity drainage mat at the base flashing of all new masonry, providing a continuous drainage system at base of wall, at heads of windows, doors, and other horizontal interruptions in cavity. (Note: It is still intended to have mortar dropping minimized through proper placement, drag boards and other methods required to keep the cavity clear.)
- B. At base of cavity wall where brick runs below grade, fill cavity solid with mortar, without voids up to an elevation above grade. Smooth top of mortar in cavity to provide a level uniform surface to receive flexible flashing.

3.6 ANCHORING MASONRY VENEERS

- A. Anchor masonry veneers to wall framing and with masonry-veneer anchors to comply with the following requirements:
 - 1. At steel framed walls, screw masonry anchors through insulation, air/vapor barrier membrane, and gypsum sheathing into steel studs. Press insulation tight to substrate and tighten wing nut to be flush with foil facer on insulation without damaging facer, holding insulation in place without gaps between back side of insulation and air/vapor barrier. If anchor misses stud, remove anchor and insulation, patch holes in air/vapor barrier membrane, and replace insulation with new insulation.
 - 2. Insert tie sections into anchor wing nuts.
 - 3. Embed tie sections in masonry joints. Provide not less than 2 inches of air space between back of masonry veneer and face of insulation.
 - 4. Coordinate spacing with anchor manufacturer's requirements, but not more than 16 inches o.c. vertically and 32 inches o.c. horizontally. Install additional anchors within 12 inches of openings and at intervals, not exceeding 8 inches, around perimeter.

3.7 CONTROL AND EXPANSION JOINTS

- A. General: Install control and expansion joint materials in unit masonry as masonry progresses. Do not allow materials to span control and expansion joints without provision to allow for in-plane wall or partition movement.
 - 1. Where control joints are not shown, provide control joints at a maximum spacing of 30 feet; review proposed locations with Architect prior to installation.
- B. Form expansion joints in brick as follows:
 - 1. Build in compressible joint fillers where indicated.
 - 2. Form open joint full depth of brick wythe and of width indicated, but not less than 3/8 inch for installation of sealant and backer rod specified in Division 07 Section "Joint Sealants."
- C. Provide horizontal, pressure-relieving joints by either leaving an air space or inserting a compressible filler of width required for installing sealant and backer rod specified in Division 07 Section "Joint Sealants," but not less than 3/8 inch.
 - 1. Locate horizontal, pressure-relieving joints beneath relieving angles supporting masonry.

3.8 LINTELS

- A. Install steel lintels where indicated.
- B. Provide masonry lintels where shown and at all exposed block locations.
- C. Provide minimum bearing of 8 inches at each jamb, unless otherwise indicated.

3.9 FLASHING, WEEP HOLES, CAVITY DRAINAGE, AND VENTS

- A. General: Install embedded flashing and weep holes in masonry at shelf angles, lintels, ledges, other obstructions to downward flow of water in wall, and where indicated. Install vents at shelf angles, ledges, and other obstructions to upward flow of air in cavities, and where indicated.
- B. Install flashing as follows, unless otherwise indicated:
 - 1. Prepare masonry surfaces so they are smooth and free from projections that could puncture flashing. Before covering with mortar, seal penetrations in flashing with adhesive, sealant, or tape as specified.
 - 2. Flexible flashing shall not span across a gap greater than 1/4-inch.
 - 3. Extend sheet metal flashing 3/8 inch beyond face of masonry at exterior and turn flashing down at 45 degrees to form a drip. Lap joints of metal flashing 3 inches, sealing between with full bed of asphalt mastic. Over the top of each joint, apply a 4-inch wide strip of flexible sheet flashing to both horizontal and vertical legs.
 - 4. Flexible Flashing Tie-In to Air/Vapor Barrier: Prepare surface of air/vapor barrier in accordance with air/vapor barrier manufacturer to receive flexible flashing. Run flexible flashing up face of air/vapor barrier 8 inches minimum. Flexible flashing shall be smooth, free of gaps and wrinkles. Roll surface of flexible flashing with hand roller to ensure full adhesion over the entire surface. Apply continuous bead of termination mastic along flexible flashing top edge, vertical edges, seams, cuts, and penetrations.

5. Base of Wall Flashing: Provide 3-1/2-inch wide metal drip flashing and flexible flashing. Lap flexible flashing onto sheet metal drip flashing 3 inches, stopping flexible flashing minimum 1/2-inch back from face of brick, providing continuous watertight seal between. Extend flexible flashing fully supported across mortar filled cavity and turning up wall 8 inches minimum, tying into air/vapor barrier system as specified above.
 6. At lintels, provide metal flashing extending a minimum of 8 inches into masonry at each end, turning up not less than 2 inches to form end dams with inside corners soldered. Metal flashing shall extend horizontally across lintel angle, up the vertical leg, and across the cavity to support the flexible flashing tie-in to the air/vapor barrier.
 - a. Metal flashing shall be one piece, full width of opening. Where opening width exceeds available sheet metal length, lap joints of metal flashing 3 inches, sealing between with full bed of asphalt mastic. Over the top of each joint, apply a 4-inch wide strip of flexible sheet flashing to both the horizontal and vertical legs.
 - b. Install flexible flashing tie-in to air/vapor barrier, extending a minimum of 8 inches up face of wall. Run flexible flashing full width of metal flashing, lapping beyond metal flashing ends. Run flexible flashing across insulation and metal flashing spanning cavity, and turn down face of lintel 3 inches minimum.
 7. At two-piece receiver and counterflashing furnished in Division 07 Section "Sheet Metal Flashing and Trim," install receiver, providing proper weeping and drainage to exterior. Tie in metal flashing to air/water barrier with 12 inch wide cap strip of flexible flashing, adhering 8 inches to air/vapor barrier free of gaps and wrinkles, lapping 4 inches on to metal flashing. Apply continuous bead of termination mastic along cap strip top edge.
 8. At base of wall locations where brick shelves is below finish floor elevation, the air/vapor barrier system will be applied to brick shelf as part of air/vapor barrier system specified in Division 07 Section "Fluid Applied Air/Vapor Barrier System." Where brick shelf is flush with or above finish floor elevation, provide metal drip and flexible flashing, tying into air/vapor barrier system as specified above.
- C. Install weep holes in head joints in exterior wythes of first course of masonry immediately above embedded flashing and as follows:
1. Use specified weep/vent products to form weep holes.
 2. Space weep holes 24 inches o.c., unless otherwise indicated.
 3. Provide weep holes not more than 8 inches from end of lintels.
- D. Place cavity drainage material in cavities to comply with configuration requirements for cavity drainage material in Part 2 "Miscellaneous Masonry Accessories" Article.
- E. Install vents in head joints in exterior wythes at tops of walls at spacing indicated; if spacing not indicated, space vents 64 inches o.c. Use specified weep/vent products to form vents.

3.10 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections indicated below and prepare test reports:
1. Payment for these services will be made by Owner.
 2. Retesting of materials failing to comply with specified requirements shall be done at Contractor's expense.
- B. Testing Frequency: One set of tests for each 5000 sq. ft. of wall area or portion thereof.
- C. Mortar Test (Property Specification): For each mix provided, per ASTM C 780.

3.11 REPAIRING, POINTING, AND CLEANING

- A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Install new units to match adjoining units; install in fresh mortar, pointed to eliminate evidence of replacement.
- B. Pointing: During the tooling of joints, enlarge voids and holes, except weep holes, and completely fill with mortar. Point up joints, including corners, openings, and adjacent construction, to provide a neat, uniform appearance. Prepare joints for sealant application, where indicated.
- C. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.
- D. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:
 - 1. Allow mortar to cure above 45 degrees F or greater for minimum 14 days before cleaning. If cure temperature is below 45 degrees F, allow additional time above 45 degrees F to achieve the 14 day cure period to allow the mortar to cure thoroughly.
 - 2. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
 - 3. Mix cleaner with water at manufacturer's recommended rate. Test cleaning methods on wall at an inconspicuous location.
 - 4. Protect adjacent non-masonry surfaces from contact with cleaner by covering them with liquid strippable masking agent or polyethylene film and waterproof masking tape.
 - 5. Lightly pre-wet wall surfaces with water before applying cleaner.
 - 6. Clean brick in accordance with manufacturer's printed instructions:
 - a. Apply cleaner with low-pressure sprayer and allow to foam and dwell until foam collapses. Reapply cleaner without rinsing until cleaner no longer foams. Do not let cleaner dry on surface.
 - b. Pressure wash surface using 25 to 40 degree wide tip nozzle. Use the minimum pressure possible, as determined by the sample test area. Rinse in overlapping pattern, maintaining tip location and pressure in a manner to prevent surface damage to masonry units and mortar joints.
- E. Protection: Provide final protection and maintain conditions that ensure unit masonry is without damage and deterioration at time of Substantial Completion.

3.12 MASONRY WASTE DISPOSAL

- A. Salvageable Materials: Unless otherwise indicated, excess masonry materials are Contractor's property. At completion of unit masonry work, remove from Project site.
- B. Excess Masonry Waste: Remove excess clean masonry waste and other masonry waste, and legally dispose of off Owner's property.

END OF SECTION 042000

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SECTION 055000 - METAL FABRICATIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes, but is not limited to, the following:
 - 1. Ladders.
 - 2. Loose steel lintels.
 - 3. Steel framing and supports for the following:
 - a. Steel framing and supports for applications where framing and supports are not specified in other Sections.
 - 4. Steel weld plates and angles for casting into concrete not specified in other Sections.
 - 5. Miscellaneous fabrications:
 - a. Bench supports.
 - b. Insulation supports.
 - c. Closure angle.
 - d. Sheet metal fabrications to contain mineral wool firesafing.
 - 6. Metal bollards.
 - 7. Rough hardware.
- B. Products furnished, but not installed, under this Section include the following:
 - 1. Loose steel lintels.
 - 2. Insulation supports.
 - 3. Anchor bolts, steel pipe sleeves, and wedge-type inserts indicated to be cast into concrete or built into unit masonry.
- C. Related Sections include the following:
 - 1. Division 03 Section "Cast-in-Place Concrete" for installing anchor bolts, steel pipe sleeves, wedge-type inserts and other items indicated to be cast into.
 - 2. Division 04 Section "Unit Masonry Assemblies" for installing loose lintels, anchor bolts, and other items indicated to be built into unit masonry.
 - 3. Division 06 Section "Rough Carpentry" for concealed wood blocking

1.3 PERFORMANCE REQUIREMENTS

- A. Structural Performance of Ladders: Provide ladders capable of withstanding the effects of loads and stresses within limits and under conditions specified in ANSI A14.3, except as indicated otherwise.
- B. Thermal Movements: Provide exterior metal fabrications that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
 - 1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

1.4 SUBMITTALS

- A. General: Submit in accordance with Division 01 Section "Submittal Procedures."
- B. Product Data: For the following:
 - 1. Paint products.
 - 2. Grout.
- C. Shop Drawings: Show fabrication and installation details for metal fabrications.
 - 1. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items.
 - 2. Provide templates for anchors and bolts specified for installation under other Sections.
 - 3. For installed products indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional structural engineer responsible for their preparation.
- D. Welding Certificates: Signed by Contractor specified under the "Quality Assurance" Article.
- E. Qualification Data: For professional structural engineer.

1.5 QUALITY ASSURANCE

- A. Fabricator Qualifications: Firm experienced in producing metal fabrications similar to those indicated for this Project with a record of successful in-service performance, and with sufficient production capacity to produce required units without delaying the Work.
- B. Professional Engineer Qualifications: Professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of kind indicated. Engineering services are defined as those performed for design of concrete filled steel pan stairs that are similar to those indicated for this Project in material, design, and extent.
- C. Welding: Qualify procedures and personnel according to the following:
 - 1. AWS D1.1, "Structural Welding Code--Steel."
 - 2. AWS D1.3, "Structural Welding Code--Sheet Steel."
 - 3. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone re-certification.

1.6 PROJECT CONDITIONS

- A. Field Measurements: Verify actual locations of walls and other construction contiguous with metal fabrications by field measurements before fabrication and indicate measurements on Shop Drawings.
 - 1. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating metal fabrications without field measurements. Coordinate wall and other contiguous construction to ensure that actual dimensions correspond to established dimensions.
 - 2. Provide allowance for trimming and fitting at site.

1.7 COORDINATION

- A. Coordinate installation of anchorages for metal fabrications. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.
- B. Coordinate installation of steel weld plates and angles for casting into concrete or built into unit masonry that are specified in this Section but required for work of another Section. Deliver such items to Project site in time for installation.
- C. Apply bituminous paint to concealed bottoms, sides, and edges of cast-metal units set into concrete.

PART 2 - PRODUCTS

2.1 METALS, GENERAL

- A. Metal Surfaces, General: Provide materials with smooth, flat surfaces, unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.

2.2 FERROUS METALS

- A. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
 - 1. Galvanized finish for exterior installations and where indicated.
- B. Stainless-Steel Sheet, Strip, Plate, and Flat Bars: ASTM A 666, Type 304.
- C. Stainless-Steel Bars and Shapes: ASTM A 276, Type 304.
- D. Steel Tubing: Product type (manufacturing method) and as follows:
 - 1. Cold-Formed Steel Tubing: ASTM A 500.
 - 2. Hot-Formed Steel Tubing: ASTM A 501.
 - a. For exterior installations and where indicated, provide tubing with hot-dip galvanized coating per ASTM A 53.
- E. Steel Pipe: ASTM A 53/A 53M, standard weight (Schedule 40), unless another weight is indicated or required by structural loads.
 - 1. Black finish, unless otherwise indicated.
 - 2. Galvanized finish for exterior installations and where indicated.
- F. Uncoated, Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, structural steel, Grade 30, unless another grade is required by design loads.
- G. Galvanized-Steel Sheet: ASTM A 653/A 653M, G90 coating, structural steel, Grade 33, unless another grade is required by design loads.
- H. Malleable-Iron Castings: ASTM A 47, Grade 32510 (ASTM A 47M, Grade 22010).
- I. Steel Bars for Grating Treads: ASTM A 36/A 36M.
- J. Wire Rod for Grating Crossbars: ASTM A 510.

2.3 FASTENERS

- A. General: Unless otherwise indicated, provide Type 304 stainless-steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B 633, Class Fe/Zn 5, at exterior walls. Select fasteners for type, grade, and class required.
- B. Steel Bolts and Nuts: Regular hexagon-head bolts, ASTM A 307, Grade A; with hex nuts, ASTM A 563; and, where indicated, flat washers.
- C. Stainless-Steel Bolts and Nuts: Regular hexagon-head annealed stainless steel bolts, nuts and, where indicated, flat washers; ASTM F 593 for bolts and ASTM F 594 for nuts, Alloy Group 1.
- D. Anchor Bolts: ASTM F 1554, Grade 36.
 - 1. Provide hot-dip or mechanically deposited, zinc-coated anchor bolts where item being fastened is indicated to be galvanized.
- E. Eyebolts: ASTM A 489.
- F. Machine Screws: ASME B18.6.3.
- G. Lag Bolts: ASME B18.2.1.
- H. Wood Screws: Flat head, ASME B18.6.1.
- I. Plain Washers: Round, ASME B18.22.1.
- J. Lock Washers: Helical, spring type, ASME B18.21.1.
- K. Cast-in-Place Anchors in Concrete: Anchors capable of sustaining, without failure, a load equal to four times the load imposed, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.
 - 1. Threaded or wedge type; galvanized ferrous castings, either ASTM A 47/A 47M malleable iron or ASTM A 27/A 27M cast steel. Provide bolts, washers, and shims as needed, hot-dip galvanized per ASTM A 153/A 153M.
- L. Expansion Anchors: Anchor bolt and sleeve assembly with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.
 - 1. Material for Anchors in Interior Locations: Carbon-steel components zinc-plated to comply with ASTM B 633, Class Fe/Zn 5.
 - 2. Material for Anchors in Exterior Locations: Alloy Group 1 stainless-steel bolts complying with ASTM F 593 and nuts complying with ASTM F 594.
- M. Toggle Bolts: FS FF-B-588, tumble-wing type, class and style as required.
- N. Chemical Anchors: Two-part epoxy systems with impacted bolt, rod or anchor as follows:
 - 1. Concrete Anchor: Epoxy capsule system similar to Hilti HVA Adhesive Anchor System, Ramset Chemset anchor system, or approved equal.
 - 2. Masonry Anchor: Epoxy injection system similar to Hilti HIT C-100 System.

2.4 MISCELLANEOUS MATERIALS

- A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.
- B. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with performance requirements of FS TT-P-664, selected for good resistance to normal atmospheric corrosion, compatibility with finish paint system indicated, and capability to provide a sound foundation for field-applied topcoats despite prolonged exposure.
- C. Galvanizing Repair Paint: High-zinc-dust-content paint for regalvanizing welds in steel, complying with SSPC-Paint 20.
- D. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187.
- E. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.
 - 1. Products:
 - a. Sure-grip High Performance Grout; Dayton Superior Corp.
 - b. Euco N-S Grout; Euclid Chemical Co.
 - c. Five Star Grout; Five Star Products.
 - d. Crystex; L & M Construction Chemicals, Inc.
 - e. Masterflow 928 and 713; Master Builders Technologies, Inc.
 - f. Sealtight 588 Grout; W. R. Meadows, Inc.
 - g. SonogROUT 14; Sonneborn Building Products - ChemRex, Inc.
- F. Concrete Materials and Properties: Comply with requirements in Division 03 Section "Cast-in-Place Concrete" for normal-weight, air-entrained, ready-mix concrete with a minimum 28-day compressive strength of 3000 psi, unless otherwise indicated.

2.5 FABRICATION, GENERAL

- A. Shop Assembly: Preassemble items in 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. Form metal fabrications from materials of size, thickness, and shapes indicated but not less than needed to comply with performance requirements indicated. Work to dimensions indicated or accepted on Shop Drawings, using proven details of fabrication and support. Use type of materials indicated or specified for various components of each metal fabrication.
- C. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch, unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
- D. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
- E. Form exposed work true to line and level with accurate angles and surfaces and straight edges.
- F. 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.
- G. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) screws or bolts, unless otherwise indicated. Locate joints where least conspicuous.
- H. Fabricate seams and other connections that will be exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.
- I. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.
- J. 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. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.
1. 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.

2.6 METAL LADDERS

- A. General:
1. Comply with ANSI A14.3, unless otherwise indicated.
 2. Space siderails 24 inches apart for other ladders, unless otherwise indicated.
 3. Support each ladder at top and bottom and not more than 60 inches o.c. with welded or bolted brackets, made from same metal as ladder.
 - a. Size brackets to support design dead and live loads indicated and to hold centerline of ladder rungs clear of the wall surface by not less than 7 inches, except as otherwise indicated.
 - b. Extend siderails 48 inches above top rung and return rails to wall or structure unless other secure handholds are provided. If the adjacent structure does not extend above the top rung, gooseneck the extended rails back to the structure to provide secure ladder access.
- B. Steel Ladders:
1. Siderails: As indicated.
 2. Rungs: Steel bars in size indicated, spaced 12 inches o.c.
 3. Fit rungs in centerline of siderails; plug-weld and grind smooth on outer rail faces.
 4. Provide nonslip surfaces on top of each rung, either by coating rung with aluminum-oxide granules set in epoxy-resin adhesive or by using a type of manufactured rung filled with aluminum-oxide grout.
 5. Bar Grate Platform at Exterior Ladders: Welded steel grating with 1-1/4-by-3/16-inch bearing bars at 15/16 inch o.c. and crossbars at 4 inches o.c., NAAMM designation: W-15-4 (1-1/4 x 3/16) STEEL; serrated surface; and galvanized finish.
 6. Galvanize exterior ladders, including brackets and fasteners.

- C. Provide metal ships' ladders where indicated. Fabricate of open-type construction with channel or plate stringers, pipe and tube railings, and bar grating treads, unless otherwise indicated. Provide brackets and fittings for installation.
 - 1. Fabricate ships' ladders, including treads and railings from steel.
 - 2. Comply with applicable requirements in Steel Pipe Railings and Handrails Article.

2.7 LOOSE STEEL LINTELS

- A. Fabricate loose structural steel lintels from steel angles and shapes of size indicated for openings and recesses in masonry walls and partitions at locations indicated.
- B. Weld adjoining members together to form a single unit where indicated.
- C. Size loose lintels for equal bearing of 1-inch per foot of clear span but not less than 8-inches bearing at each side of openings, unless otherwise indicated.
- D. Galvanize loose steel lintels located in exterior walls.

2.8 MISCELLANEOUS FRAMING AND SUPPORTS

- A. General: Provide steel framing and supports for applications indicated that are not specified in other Sections as needed to complete the Work.
- B. Fabricate units from steel shapes, plates, and bars of welded construction, unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction retained by framing and supports. Cut, drill, and tap units to receive hardware, hangers, and similar items.
 - 1. Equip units with integrally welded anchors for casting into concrete or building into masonry. Furnish inserts if units must be installed after concrete is placed.
 - a. Except as otherwise indicated, space anchors 24 inches o.c. and provide minimum anchor units in the form of steel straps 1-1/4 inches wide by 1/4 inch thick by 8 inches long.
 - 2. Furnish inserts if units are installed after concrete is placed.
- C. Galvanize miscellaneous framing and supports at exterior locations and where indicated.

2.9 STEEL WELD PLATES AND ANGLES

- A. Provide steel weld plates and angles not specified in other Sections, for items supported from concrete construction as needed to complete the Work. Provide each unit with not less than two integrally welded steel strap anchors for embedding in concrete.

2.10 MISCELLANEOUS STEEL TRIM

- A. Unless otherwise indicated, fabricate units from steel shapes, plates, and bars of profiles shown with continuously welded joints and smooth exposed edges. Miter corners and use concealed field splices where possible.
- B. Provide cutouts, fittings, and anchorages as needed to coordinate assembly and installation with other work.
 - 1. Provide with integrally welded steel strap anchors for embedding in concrete or masonry construction.

- C. Galvanize exterior miscellaneous steel trim.

2.11 ROUGH HARDWARE

- A. Furnish bent, or otherwise custom-fabricated, bolts, plates, anchors, hangers, dowels, and other miscellaneous steel and iron shapes as required for framing and supporting woodwork, and for anchoring or securing woodwork to concrete or other structures. Straight bolts and other stock rough hardware items are specified in Division 06 Sections.
- B. Fabricate items to sizes, shapes, and dimensions required. Furnish malleable-iron washers for heads and nuts that bear on wood structural connections, and furnish steel washers elsewhere.

2.12 FINISHES, GENERAL

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Finish metal fabrications after assembly.

2.13 STEEL AND IRON FINISHES

- A. Galvanizing: Provide coating for iron and steel fabrications applied by the hot-dip process, 0.05 - 0.09% nickel content, Duragalv by Duncan Galvanizing, or approved equal. Provide thickness of galvanizing specified in referenced standards. Hot-dip galvanize items as indicated to comply with applicable standard listed below:
 - 1. ASTM A 123/A 123M, for galvanizing both fabricated and unfabricated steel and iron products made of uncoated rolled, pressed, and forged shapes, plates, bars, and strip 0.0299 inch thick or thicker.
 - 2. ASTM A 153/A 153M, for galvanizing steel and iron hardware.
 - 3. Galvanizing shall exhibit a rugosity (smoothness) not greater than 4 rug (16-20 microns of variation) when measured by a profilometer over a 1-inch straight line on the surface of architectural and structural elements that are less than 24 pounds per running foot. Profilometer shall be capable of operating in 1 micron increments.
- B. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with minimum requirements indicated below for SSPC surface preparation specifications and environmental exposure conditions of installed metal fabrications:
 - 1. Exteriors (SSPC Zone 1B): SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
 - 2. Interiors (SSPC Zone 1A): SSPC-SP 3, "Power Tool Cleaning."
- C. Shop Priming: Apply shop primer to uncoated surfaces of metal fabrications, except those with galvanized finishes and those to be embedded in concrete, sprayed-on fireproofing, or masonry, unless otherwise indicated. Comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.
 - 1. Stripe paint corners, crevices, bolts, welds, and sharp edges.

2.14 STAINLESS-STEEL FINISHES

- A. Remove tool and die marks and stretch lines or blend into finish.

- B. Grind and polish surfaces to produce uniform, directionally textured, polished finish indicated, free of cross scratches. Run grain with long dimension of each piece.
- C. Dull Satin Finish: No. 6, unless indicated otherwise.
- D. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Coordinate and furnish anchorages, setting drawings, diagrams, templates, instructions, and directions for installing anchorages, including concrete inserts, sleeves, anchor bolts, and miscellaneous items having integral anchors that are to be embedded in concrete or masonry construction. Coordinate delivery of such items to Project site.
- B. Set sleeves in concrete with tops flush with finish surface elevations. Protect sleeves from water and concrete entry.

3.2 INSTALLATION, GENERAL

- A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.
- B. 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 intended for bolted or screwed field connections.
- C. Field Welding: Comply with the following requirements:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
- D. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction. Provide threaded fasteners for use with concrete and masonry inserts, toggle bolts, through bolts, lag bolts, wood screws, and other connectors.
- E. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

- F. Corrosion Protection: Coat concealed surfaces of aluminum that will come into contact with grout, concrete, masonry, wood, or dissimilar metals with a heavy coat of bituminous paint.

3.3 INSTALLING MISCELLANEOUS FRAMING AND SUPPORTS

- A. General: Install framing and supports to comply with requirements of items being supported, including manufacturers' written instructions and requirements indicated on Shop Drawings.

3.4 INSTALLING PIPE BOLLARDS

- A. Anchor bollards in place with concrete footings. Center and align bollards in holes 3 inches above bottom of excavation. Place concrete and vibrate or tamp for consolidation. Support and brace bollards in position until concrete has cured.

3.5 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 Division 09 Section "Painting."
- C. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780.

END OF SECTION 055000

SECTION 061000 - ROUGH CARPENTRY

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Wood products including but not limited to studs, plates, truss bracing, wood nailers, blocking, and wood furring
 - 2. Wood-preserved-treated lumber.
 - 3. Dimension lumber framing.
 - 4. Exterior plywood sheathing
 - 5. Miscellaneous lumber.
 - 6. Plywood backing panels.
 - 7. Fasteners and accessories
- B. Related Requirements:
 - 1. Section 061200 "Structural Insulated Panels"
 - 2. Section 061753 "Shop-Fabricated Wood Trusses" for wood trusses made from dimension lumber.

1.2 DEFINITIONS

- A. Rough Carpentry: Carpentry work not specified in other Sections and not exposed, unless otherwise indicated.
- B. Exposed Framing: Framing not concealed by other constructions
- C. Boards or Strips: Lumber of less than 2 inches nominal (38 mm actual) size in least dimension.
- D. Dimension Lumber: Lumber of 2 inches nominal (38 mm actual) size or greater but less than 5 inches nominal (114 mm actual) size in least dimension.
- E. Lumber grading agencies, and abbreviations used to reference them, include the following:
 - 1. NeLMA: Northeastern Lumber Manufacturers' Association.
 - 2. NLGA: National Lumber Grades Authority.
 - a. All structural framing shall be NLGA certified.
 - 3. SPIB: The Southern Pine Inspection Bureau.
 - 4. Sheathing Grading Agency: Certified by APA or ICBO approved certification agency.

1.3 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. Hangers, Hardware and Accessories

1.4 INFORMATIONAL SUBMITTALS

A. Material Certificates:

1. For dimension lumber specified to comply with minimum allowable unit stresses. Indicate species and grade selected for each use and design values approved by the ALSC Board of Review.
2. For preservative-treated wood products. Indicate type of preservative used and net amount of preservative retained.

1.5 DELIVERY, STORAGE, AND HANDLING

- ##### A.
- Stack wood products flat with spacers beneath and between each bundle to provide air circulation. Protect wood products 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

- ##### A.
- Lumber: Comply with DOC PS 20 and applicable rules of grading agencies indicated. If no grading agency is indicated, comply with the applicable rules of any rules-writing agency certified by the ALSC Board of Review. Grade lumber by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.
1. Factory mark each piece of lumber with grade stamp of grading agency.
 2. For exposed lumber indicated to receive a stained or natural finish, mark grade stamp on end or back of each piece or omit grade stamp and provide certificates of grade compliance issued by grading agency.
 3. Where nominal sizes are indicated, provide actual sizes required by DOC PS 20 for moisture content specified. Where actual sizes are indicated, they are minimum dressed sizes for dry wood products.
 4. Dress lumber, S4S, unless otherwise indicated.
- ##### B.
- For structural framing (4" and wider and from 2" to 4" thick), provide the following grade and species:
- ##### C.
- Spruce-Pine-Fir (SPF) #1/2 or better, NLGA Graded, unless noted otherwise on Structural Drawings, Minimum Design Stresses:
1. Fb: 875 psi
 2. Ft: 450 psi
 3. Fv: 135 psi
 4. Fc_⊥: 425 psi
 5. Fc: 1,150 psi

6. E: 1,400,000 psi
- D. Spruce-Pine-Fir South (SPF(S)) #2 or better, NELMA Graded, unless noted otherwise on Structural Drawings, Minimum Design Stresses:
1. Fb: 775 psi
 2. Ft: 350 psi
 3. Fv: 135 psi
 4. Fc $\perp$: 335 psi
 5. Fc: 1,000 psi
 6. E: 1,100,000 psi
- E. Douglas Fir Larch (North) #1/2 or better, NLGA Graded, where indicated on drawings. Minimum Design Stresses:
1. Fb: 850 psi
 2. Ft: 500 psi
 3. Fv: 180 psi
 4. Fc $\perp$: 625 psi
 5. Fc: 1,400 psi
 6. E: 1,600,000 psi
- F. Pressure treated lumber: Southern Yellow Pine #2 or better. Minimum Design Stresses:
1. Fb: 1,300 psi
 2. Ft: 775 psi
 3. Fv: 175 psi
 4. Fc $\perp$: 565 psi
 5. Fc: 1,650 psi
 6. E: 1,400,000 psi
- G. See structural drawings for grades and bending stress at specific locations.
- H. Maximum Moisture Content:
1. Boards: 19 percent.
 2. Dimension Lumber: 19 percent
- I. Miscellaneous Lumber: Provide wood for support or attachment of other work including cant strips, bucks, nails, blocking, furring, grounds, stripping and similar members. Provide lumber of sizes indicated, worked into shapes shown, and as follows:
1. Moisture content: 19% maximum for lumber items not specified to receive wood preservative treatment.
 2. Grade: Construction Grade light framing size lumber of any species or board size lumber as required. Provide construction grade boards (NELMA, NLGA or WCLB) or No.2 boards (SPIB, NLGA, NELMA, or WWPA).

2.2 WOOD-PRESERVATIVE-TREATED LUMBER

- A. Preservative Treatment by Pressure Process: AWPA U1, Use Category UC2 for interior construction not in contact with the ground. Use Category UC3b for exterior construction not in contact with the ground, and use Category UC4a for items in contact with the ground.
1. Preservative Chemicals: Micronized Copper Azole, MCA.
 2. Product: MicroPro/Life Wood; Osmose, Inc.

- B. Kiln-dry material after treatment to a maximum moisture content of 19 percent for lumber. Do not use material that is warped or does not comply with the requirements for untreated lumber.
- C. Mark each treated item with the treatment quality mark of an inspection agency approved by the American Lumber Standards Committee Board of Review
- D. Application: Treat items indicated on Drawings, and the following:
 - 1. Wood sills, blocking, and similar concealed members in contact with concrete
 - 2. Wood floor plates that are installed over concrete slabs
 - 3. Pressure-treat members in contact with the ground or fresh water with water-borne preservatives to a minimum retention of 0.40 pcf.

2.3 ENGINEERED WOOD PRODUCTS

- A. Laminated-Veneer Lumber: Structural composite lumber made from wood veneers with grain primarily parallel to member lengths, evaluated and monitored according to ASTM D 5456 and manufactured with an exterior-type adhesive complying with ASTM D 2559
 - 1. Veneer characteristics: Douglas fir or southern pine veneers of varying thickness by widths and lengths standard with manufacturer, end jointed with a lap-joint, but joint, or scarf joint. Architectural grade exposed face.
 - 2. Extreme Fiber Stress in Bending, Edgewise: 2600 psi
 - 3. Modulus of Elasticity, Edgewise: 2,000,000 psi
 - 4. Size: 1-3/4 inch thick by depth and length indicated
 - 5. Products:
 - a. Boise Cascade Corporation; Versa-Lam LVL
 - b. Weyerhaeuser Company; iLevel Micro-Lam LVL
- B. Parallel-Strand Lumber (PSL): Lumber manufactured by laying up wood strands using an exterior-type adhesive complying with ASTM D 2559, and cured under pressure to produce members with grain of strands parallel to their lengths and complying with the following requirements:

I-Level: $F_{cII} = 2,900 \text{ psi}$, $F_b = 2900 \text{ psi}$, $E = 2.0 \times 10^6$

2.4 MISCELLANEOUS LUMBER

- A. Provide miscellaneous lumber indicated and lumber for support or attachment of other construction, including the following:
 - 1. Blocking.
 - 2. Nailers.
 - 3. Rooftop equipment bases and support curbs.
 - 4. Cants.
 - 5. Furring.
 - 6. Grounds.
 - 7. Utility shelving.

2.5 PLYWOOD BACKING PANELS

- A. Equipment Backing Panels: Plywood, DOC PS 1, Exposure 1, C-D Plugged, fire-retardant treated, in thickness indicated or, if not indicated, not less than 1/2-inch nominal thickness.

2.6 WALL SHEATHING

- A. Plywood Wall Sheathing: APA graded, Exposure 1, Structural I sheathing
 1. Span rating: Not less than 32/16.
 2. Nominal Thickness: Not less than 1/2 inch
 3. Species: Fir

2.7 FASTENERS

- A. General: Fasteners are to be of size and type indicated and comply with requirements specified in this article for material and manufacture. Provide nails or screws, in sufficient length, to penetrate not less than 1-1/2 inches (38 mm) into wood substrate.
 1. Where rough carpentry is exposed to weather, in ground contact, pressure-preservative treated, or in area of high relative humidity, provide fasteners with hot-dip zinc coating complying with ASTM A153/A153M or ASTM F2329.
 2. For roof and wall sheathing, provide fasteners with hot-dip zinc coating complying with ASTM A 153/A 153M.
 3. Where preservative-treated lumber or plywood is used, provide stainless steel fasteners.
- B. Nails, Brads, and Staples: ASTM F1667.
- C. Power-Driven Fasteners: Fastener systems with an evaluation report acceptable to authorities having jurisdiction, based on ICC-ES AC70.
- D. Fasteners (for wood framing): Nail fasteners shall meet requirements of ASTM F1667. Unless noted otherwise, nails referenced on drawings are to be Common Nails with dimensions as follows:
 1. 8d: 2 1/2" long by 0.131" diameter shank with 0.281" diameter head
 2. 10d: 3" long by 0.148" diameter shank with 0.312" diameter head
 3. 12d: 3 1/4" long by 0.148" diameter shank with 0.312" diameter head
 4. 16d: 3 1/2" long by 0.162" diameter shank with 0.344" diameter head
- E. Screw fasteners (where indicated on drawings or required to install connection hardware):
 1. SD & SDS Screws by Simpson Strong Tie
 2. RSS Screws by GRK Fasteners, (800) 263-0463
 3. Timberlok Screws by Fasten Master.
 4. Wood Screws: ANSI/ASME Standard B18.6.1
- F. Through Bolts: ANSI/ASME Standard B18.2.1:
 1. Holes for through bolts shall be a minimum of 1/32nd and a maximum of 1/16th larger than bolt diameter.
 2. A standard cut washer shall be provided between the wood and bolt head, and wood and nut, unless noted otherwise.

2.8 METAL FRAMING ANCHORS

- A. Manufacturer: Simpson Strong-Tie Co., Inc.
- B. Metal Framing Connectors: As indicated.
- C. Galvanized Steel Sheet: Hot-dip, zinc coated steel sheet complying with ASTM A653/A 653M, G60 coating designation
 - 1. Use for interior locations where stainless steel is not indicated
- D. Stainless-Steel Sheet: ASTM A666, Type 304
 - 1. Use for exterior locations and where indicated
- E. Unless noted, fill all nail holes to achieve manufacturer's maximum reaction rating.
- F. Use nail diameter and length as specified by connector manufacturer. Substitutions of pneumatic nails or "joist hanger" (non standard length) nails shall not be made without written authorization of the Engineer.

2.9 MISCELLANEOUS MATERIALS

- A. Sill-Sealer Gaskets:
 - 1. Closed-cell neoprene foam, 1/4 inch thick, selected from manufacturer's standard widths to suit width of sill members indicated.
- B. Flexible Flashing: Composite, self-adhesive, flashing product consisting of a pliable, butyl rubber compound, bonded to a high-density polyethylene film, aluminum foil, or spunbonded polyolefin to produce an overall thickness of not less than 0.025 inch
- C. Water-Repellent Preservative: NWWDA-tested and -accepted formulation containing 3-iodo-2-propynyl butyl carbamate, combined with an insecticide containing chlorpyrifos as its active ingredient.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Framing Standard: Comply with AF&PA's WCD 1, "Details for Conventional Wood Frame Construction," unless otherwise indicated.
- B. Set work to required levels and lines, with members plumb, true to line, cut, and fitted. Fit rough carpentry accurately to other construction. Locate nailers, blocking and similar supports to comply with requirements for attaching other construction.
- C. Install plywood backing panels by fastening to studs; coordinate locations with utilities requiring backing panels. Install fire-retardant-treated plywood backing panels with classification marking of testing agency exposed to view.

- D. Install metal framing anchors to comply with manufacturer's written instructions. Install fasteners through each fastener hole.
- E. Install sill sealer gasket/termite barrier in accordance with manufacturer's written instructions at the underside of wall bottom track or rim track and at the top of foundation wall or slab at stud or joist locations.
- F. Do not splice structural members between supports unless otherwise indicated.
- G. Provide blocking and framing as indicated and as required to support facing materials, fixtures, specialty items, and trim.
 - 1. Provide metal clips for fastening gypsum board or lath at corners and intersections where framing or blocking does not provide a surface for fastening edges of panels. Space clips not more than 16 inches o.c.
- H. Provide fire blocking in furred spaces, stud spaces, and other concealed cavities as indicated and as follows:
 - 1. Fire block furred spaces of walls, at each floor level, at ceiling, and at not more than 96 inches o.c. with solid wood blocking or noncombustible materials accurately fitted to close furred spaces.
 - 2. Fire block concealed spaces of wood-framed walls and partitions at each floor level, at ceiling line of top story, and at not more than 96 inches o.c. Where fire blocking is not inherent in framing system used, provide closely fitted solid wood blocks of same width as framing members and 2-inch nominal thickness.
 - 3. Fire block concealed spaces between floor sleepers with same material as sleepers to limit concealed spaces to not more than 100 sq. ft. and to solidly fill space below partitions.
 - 4. Fire block concealed spaces behind combustible cornices and exterior trim at not more than 20 feet o.c.
- I. 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.
- J. Comply with AWPAC 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.
- K. Where wood-preservative-treated lumber is installed adjacent to metal decking, install continuous flexible flashing separator between wood and metal decking.
- L. Securely attach rough carpentry work to substrate by anchoring and fastening as indicated, complying with the following:
 - 1. Table 2304.10.1, "Fastening Schedule," in ICC's International Building Code (IBC).
- M. Securely attach roofing nailers to substrates by anchoring and fastening to withstand bending, shear, or other stresses imparted by Project wind loads and fastener-resistance loads as designed in accordance with ASCE/SEI 7.

- N. 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 INSTALLATION OF WOOD BLOCKING AND NAILERS

- A. Install where indicated and where required for attaching other work as indicated in drawings. Install wood blocking and nailers where required to support fixtures, equipment services, grab bars, millwork, casework, window treatment, shelving, residential casework, building specialties, shower curtain rods, window sills, flashing, etc. Provide 1 1/2 inch thick blocking minimum for grab bars. Form to shapes indicated and cut as required for true line and level of attached work. Coordinate locations with other work involved.
 - 1. Install blocking for grab bars to withstand a downward load of at least 250 lbf, when tested according to method in ASTM F 446

3.3 INSTALLATION OF WOOD FURRING

- A. Install level and plumb with closure strips at edges and openings. Shim with wood as required for tolerance of finish work.
- B. Furring to Receive Plywood or Hardboard Paneling: Install 1-by-3-inch nominal size furring horizontally and vertically at 24 inches o.c.

3.4 INSTALLATION OF WALL AND PARTITION FRAMING

- A. General: Provide single bottom plate and double top plates using members of 2-inch nominal thickness whose widths equal that of studs, except single top plate may be used for non-load-bearing partitions and for load-bearing partitions where framing members bearing on partition are located directly over studs. Fasten plates to supporting construction unless otherwise indicated.
 - 1. For exterior walls, provide 2-by-4-inch nominal size wood studs spaced 16 inches o.c. unless otherwise indicated.
 - 2. For interior partitions and walls, provide 2-by-4-inch nominal size wood studs spaced 16 inches o.c. unless otherwise indicated.
 - 3. Provide continuous horizontal blocking at midheight of partitions more than 96 inches high, using members of 2-inch nominal thickness and of same width as wall or partitions.
- B. Construct corners and intersections with three or more studs, except that two studs may be used for interior non-load-bearing partitions.
- C. Frame openings with multiple studs and headers. Provide nailed header members of thickness equal to width of studs. Support headers on jamb studs.

3.5 INSTALLATION OF CEILING JOIST

- A. Ceiling Joists: Install with crown edge up and complying with requirements specified above for floor joists. Face nail to ends of parallel rafters.
- B. Provide special framing as indicated for eaves, overhangs, dormers, and similar conditions if any.

3.6 PROTECTION

- A. Protect wood that has been treated with inorganic boron (SBX) from weather. If, despite protection, inorganic boron-treated wood becomes wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.

END OF SECTION 061000

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SECTION 061200 - STRUCTURAL INSULATED PANELS (SIPS)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 DESCRIPTION OF WORK

- A. Work Included: Provide labor, materials and equipment necessary to complete the work of this Section, including but not limited to the following:
 - 1. Structural insulated panels for wall and roof construction.
- B. Related Work: The following items are not included in this Section and are specified under the designated Sections:
 - 1. Section 061000 - ROUGH CARPENTRY.

1.3 PERFORMANCE REQUIREMENTS

- A. Basis of Design –Foard Panels– Allowable Diaphragm Shear Strength 575plf. Based on screw/nailling indicated in the Load Design Charts provided by Foard Panels

1.4 SUBMITTALS

- A. Product Data: For each product specified.
- B. Shop Drawings: Show layout, spacings, sizes, thicknesses, cantilevers and types of structural insulated panels; fabrication; and fastening and anchorage details, including mechanical fasteners. Show reinforcing, framing, strapping, bracing, bridging, splices, accessories, connection details, and attachment to adjoining work.
- C. Product Test Reports: From a qualified testing agency, unless otherwise stated, indicating that each of the system components complies with requirements, based on evaluation of comprehensive tests for current products.

1.5 QUALITY ASSURANCE

- A. Source Limitations: Obtain each product through one source from a single manufacturer.
- B. Engineering Responsibility: Preparation of Shop Drawings, design calculations, and other structural data by a qualified professional engineer.
- C. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in the jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of products that are similar to those indicated for this Project in material, design, and extent.

- D. Product Tests: Mill certificates or data from a qualified independent testing agency, or in-house testing with calibrated test equipment indicating steel sheet complies with requirements, including base-metal thickness, yield strength, tensile strength, total elongation, chemical requirements, ductility, and metallic-coating thickness.
- E. Each SIP shall be labeled indicating Third Party Certification.
 - 1. Provide evidence of Third Party Certification and labeling of all insulation used in the manufacturing of SIPs.
 - 2. SIP manufacturer shall provide lamination, R-value (RSI-value) and warranty document for building owner acceptance and execution.
 - 3. Dimensional Tolerance – shall comply with values listed in the SIP manufacturer Quality Control Manual.
- F. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials in original packages, containers, or bundles, each bearing brand name and identification of manufacturer.
- B. Store materials protected against damage from weather, moisture, surface contamination, corrosion, construction traffic, or other causes. Neatly stack structural insulated panels flat on leveled supports off the ground, under cover, and fully protected from weather.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Foard Panels, West Chesterfield, NH 03466– Basis-of-Design
 - 2. Foam Laminates of Vermont, a Division of Energy Smart Building, Inc.
 - 3. R-Control SIPs Insulspan Incorporated, Division of Plasti-Fab Ltd., Delta, BC Canada.
 - 4. The Murus Company, Inc., Mansfield, PA 16933.

2.2 STRUCTURAL INSULATED PANELS

- A. Panels: A stress skin panel manufactured by a pressure lamination process consisting of the following:
 - 1. Sizes: As indicated.
 - 2. Skin Panels: APA Rated, Exposure 1, DOC PS 2 span rating 24/16 or greater, oriented strand board (OSB).
 - 3. Insulation Core: Manufacturer's standard expanded polystyrene core, 0.95 pcf min.
 - 4. Panel Thickness and R-Value, Roof Panel: 8 1/4 inches nominal and R-29.3 at 75 degrees F.

2.3 ACCESSORIES

- A. Splines: As indicated on Structural Drawings. OSB, dimensional lumber, engineered wood or I-beam for use in joining SIPs shall be supplied by the SIP manufacturer as specified on approved SIP shop drawings.
- B. Fasteners:
 - 1. Nails as per SIP manufacturer design requirements shall be used for spline and plate attachments following fastening requirements specified on approved SIP shop drawings. Nails for field installation of spline and plates to be supplied by the SIP installer.
 - 2. Panel Screws as per SIP manufacturer design requirements shall be used following fastening requirements specified on approved SIP shop drawings. Panel screws are to be supplied by the SIP manufacturer or approved equal supplied by the SIP installer.
- C. Sealant: Sealants shall be specifically designed for use with SIPs. Sealant must be compatible with all components of the SIP. Sealant is to be supplied by the SIP manufacturer or approved equal supplied by the SIP installer.
- D. Seal Tape: Tape with an adhesive suitable for indoor use, minimum 6" (152 mm) wide for use on flat SIP joints and minimum 12" (304 mm) wide for use on opposing angled surfaces including ridge and roof-to-wall connections. SIP tape shall be supplied by the manufacturer.

2.4 FABRICATION

- A. Panel sizes shall be fabricated in accordance with approved shop drawings. Maximum panel size shall be 2440 mm x 7320 mm (8' X 24'). Fabrication tolerances shall comply with values in manufacturer product specification.
- B. Manufacturing Standards: SIPs shall be manufactured under a third party certification program monitored by an accredited agency and manufacturer shall maintain a quality management system in accordance with ISO 9001: 2000.
- C. SIP Thermal Resistance at a Mean Temperature of 75° F (24° C) for SIP only consisting of 7/16" (11 mm) OSB structurally laminated to both faces of EPS insulation core.
 - 1. 4-1/2" (114 mm) thick SIP with R-14.5.
 - 2. 6-1/2" (165 mm) thick SIP with R-22.1.
 - 3. 8-1/4" (210 mm) thick SIP with R-28.6.
 - 4. 10-1/4" (260 mm) thick SIP with R-36.1.
 - 5. 12-1/4" (311 mm) thick SIP with R-43.6.
- D. Fire Performance Rating: Intertek Testing Services or equal assembly listing for testing per ASTM E119/CAN/CSA-S101 to required fire resistance rating

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine supporting substrates and abutting structural insulated panels for compliance with requirements for installation tolerances and other conditions affecting performance.
 - 1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install materials and systems in accordance with manufacturer's instructions and approved submittals. Install materials and systems in proper relation with adjacent construction and with uniform appearance. Coordinate with work of other sections.
- B. Install structural insulated panels and accessories plumb, square, and true to line, and with connections securely fastened and taped.
 - 1. Precut panels and members at factory.
- C. Do not bridge building expansion and control joints with structural insulated panels.
- D. Erection Tolerances: Install structural insulated panels level, plumb, and true to line to a maximum allowable tolerance variation of 1/8 inch in 10 feet.

3.3 PROTECTION

- A. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that structural insulated panels are without damage or deterioration at time of Substantial Completion.
 - 1. Roof panels must be fully protected from weather by roofing materials or other means to provide temporary protection at the end of the day, or when rain or snow is imminent.
 - 2. Remove and replace insulated wall or roof panels which have become excessively wet or damaged before proceeding with installation of additional panels or other work.

END OF SECTION 061200

SECTION 061753 - SHOP-FABRICATED WOOD TRUSSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Wood roof trusses.
 - 2. Wood girder trusses.

1.3 ALLOWANCES

- A. Provide wood truss bracing under the Metal-Plate-Connected Truss Bracing Allowance as specified in Section 012100 "Allowances."

1.4 DEFINITIONS

- A. Metal-Plate-Connected Wood Trusses: Planar structural units consisting of metal-plate-connected members fabricated from dimension lumber and cut and assembled before delivery to Project site.

1.5 ACTION SUBMITTALS

- A. Product Data: For metal-plate connectors, metal truss accessories, and fasteners.
- B. Shop Drawings: Show fabrication and installation details for trusses.
 - 1. Show location, pitch, span, camber, configuration, and spacing for each type of truss required.
 - 2. Indicate sizes, stress grades, and species of lumber.
 - 3. Indicate locations of permanent bracing required to prevent buckling of individual truss members due to design loads.
 - 4. Indicate locations, sizes, and materials for permanent bracing required to prevent buckling of individual truss members due to design loads.
 - 5. Indicate type, size, material, finish, design values, orientation, and location of metal connector plates.
 - 6. Show splice details and bearing details.
- C. Delegated-Design Submittal: For metal-plate-connected wood trusses indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.6 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For metal-plate-connected wood trusses, signed by officer of truss-fabricating firm.
- B. Evaluation Reports: For the following, from ICC-ES:
 - 1. Metal-plate connectors.
 - 2. Metal truss accessories.

1.7 QUALITY ASSURANCE

- A. Metal Connector-Plate Manufacturer Qualifications: A manufacturer that is a member of TPI and that complies with quality-control procedures in TPI 1 for manufacture of connector plates.
 - 1. Manufacturer's responsibilities include providing professional engineering services needed to assume engineering responsibility.
 - 2. Engineering Responsibility: Preparation of Shop Drawings and comprehensive engineering analysis by a qualified professional engineer.
- B. Fabricator Qualifications: Shop that participates in a recognized quality-assurance program, complies with quality-control procedures in TPI 1, and involves third-party inspection by an independent testing and inspecting agency acceptable to Architect and authorities having jurisdiction.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Handle and store trusses to comply with recommendations in SBCA BCSI, "Building Component Safety Information: Guide to Good Practice for Handling, Installing, Restraining, & Bracing Metal Plate Connected Wood Trusses."
 - 1. Store trusses flat, off of ground, and adequately supported to prevent lateral bending.
 - 2. Protect trusses from weather by covering with waterproof sheeting, securely anchored.
 - 3. Provide for air circulation around stacks and under coverings.
- B. Inspect trusses showing discoloration, corrosion, or other evidence of deterioration. Discard and replace trusses that are damaged or defective.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design metal-plate-connected wood trusses
- B. Structural Performance: Metal-plate-connected wood trusses shall be capable of withstanding design loads within limits and under conditions indicated. Comply with requirements in TPI 1 unless more stringent requirements are specified below.
 - 1. Design Loads: As indicated.
 - 2. Maximum Deflection under Design Loads:
 - a. Roof Trusses: Vertical deflection of 1/360 of span (1 ½" MAX).
 - b. Gable End Trusses: Horizontal deflection of 1/360 of span

- C. Comply with applicable requirements and recommendations of TPI 1, TPI DSB, and SBCA BCSI.
- D. Wood Structural Design Standard: Comply with applicable requirements in AF&PA's "National Design Specifications for Wood Construction" and its "Supplement."

2.2 DIMENSION LUMBER

- A. Lumber: DOC PS 20 and applicable rules of any rules-writing agency certified by the American Lumber Standard Committee (ALSC) Board of Review. Provide lumber graded by an agency certified by the ALSC Board of Review to inspect and grade lumber under the rules indicated.
 - 1. Factory mark each piece of lumber with grade stamp of grading agency.
 - 2. For exposed lumber indicated to receive a stained or natural finish, omit grade stamp and provide certificates of grade compliance issued by grading agency.
 - 3. Provide dressed lumber, S4S.
 - 4. Provide dry lumber with 19 percent maximum moisture content at time of dressing.
- B. Minimum Chord Size for Roof Trusses: 2 by 6 inches nominal (38 by 140 mm actual) for both top and bottom chords unless noted otherwise
- C. Minimum Specific Gravity for Top Chords: 0.50.
- D. Permanent Bracing: Provide wood bracing that complies with requirements for miscellaneous lumber in Section 061000 "Rough Carpentry."

2.3 METAL CONNECTOR PLATES

- A. General: Fabricate connector plates to comply with TPI 1.
- B. Hot-Dip 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); G60 (Z180) coating designation; and not less than 0.036 inch (0.9 mm) thick.
 - 1. Use for interior locations unless otherwise indicated.
- C. Stainless-Steel Sheet: ASTM A 666, Type 304 Type 316, and not less than 0.035 inch (0.88 mm) thick.
 - 1. Use for exterior locations and where indicated.

2.4 FASTENERS

- A. General: Provide fasteners of size and type indicated that comply with requirements specified in this article for material and manufacture.
 - 1. Provide fasteners for use with metal framing anchors that comply with written recommendations of metal framing manufacturer.
 - 2. Where trusses are exposed to weather, in ground contact, made from pressure-preservative treated wood, 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.

2.5 METAL FRAMING ANCHORS AND ACCESSORIES

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. Simpson Strong-Tie Co., Inc.
- B. Allowable design loads, as published by manufacturer, shall comply with or exceed those of products of manufacturers listed. Manufacturer's published values shall be determined from empirical data or by rational engineering analysis and demonstrated by comprehensive testing performed by a qualified independent testing agency. Framing anchors shall be punched for fasteners adequate to withstand same loads as framing anchors.
- C. Galvanized-Steel Sheet: Hot-dip, zinc-coated steel sheet complying with ASTM A 653/A 653M, G60 (Z180) coating designation.
 - 1. Use for interior locations unless otherwise indicated.
- D. Hot-Dip Heavy-Galvanized-Steel Sheet: ASTM A 653/A 653M; Structural Steel (SS), high-strength low-alloy steel Type A (HSLAS Type A), or high-strength low-alloy steel Type B (HSLAS Type B); G185 (Z550) coating designation; and not less than 0.036 inch (0.9 mm) thick.
 - 1. Use for wood-preservative-treated lumber and where indicated.
- E. Stainless-Steel Sheet: ASTM A 666, Type 304 Type 316.
 - 1. Use for exterior locations and where indicated.
- F. Truss Tie-Downs: Bent strap tie for fastening roof trusses to wall studs below, 1-1/2 inches (38 mm) wide by 0.050 inch (1.3 mm) thick. Tie fastens to one side of truss, top plates, and side of stud below.
- G. Truss Clips: Angle clips for bracing bottom chord of roof trusses and floor trusses at non-load-bearing walls, 1-1/4 inches wide by 0.050 inch thick. Clip is fastened to truss through slotted holes to allow for truss deflection.
- H. Roof Truss Bracing/Spacers: U-shaped channels, 1-1/2 inches (38 mm) wide by 1 inch (25 mm) deep by 0.040 inch (1.0 mm) thick, made to fit between two adjacent trusses and accurately space them apart, and with tabs having metal teeth for fastening to trusses.
- I. Drag Strut Connectors: Angle clip with one leg extended for fastening to the side of girder truss.
 - 1. Angle clip is 3 by 3 by 0.179 by 8 inches (76 by 76 by 4.55 by 203 mm) with extended leg 8 inches (203 mm) long. Connector has galvanized finish.
 - 2. Angle clip is 3 by 3 by 0.239 by 10-1/2 inches (76 by 76 by 6.07 by 267 mm) with extended leg 10-1/2 inches (267 mm) long. Connector has painted finish.

2.6 MISCELLANEOUS MATERIALS

- A. Galvanizing Repair Paint: SSPC-Paint 20, with dry film containing a minimum of 92 percent zinc dust by weight.

2.7 FABRICATION

- A. Cut truss members to accurate lengths, angles, and sizes to produce close-fitting joints.

- B. Fabricate metal connector plates to sizes, configurations, thicknesses, and anchorage details required to withstand design loads for types of joint designs indicated.
- C. Assemble truss members in design configuration indicated; use jigs or other means to ensure uniformity and accuracy of assembly, with joints closely fitted to comply with tolerances in TPI 1. Position members to produce design camber indicated.
 - 1. Fabricate wood trusses within manufacturing tolerances in TPI 1.
- D. Connect truss members by metal connector plates located and securely embedded simultaneously in both sides of wood members by air or hydraulic press.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install wood trusses only after supporting construction is in place and is braced and secured.
- B. If trusses are delivered to Project site in more than one piece, assemble trusses before installing.
- C. Hoist trusses in place by lifting equipment suited to sizes and types of trusses required, exercising care not to damage truss members or joints by out-of-plane bending or other causes.
- D. Install and brace trusses according to TPI recommendations and as indicated.
- E. Install trusses plumb, square, and true to line and securely fasten to supporting construction.
- F. Space trusses as indicated; adjust and align trusses in location before permanently fastening.
- G. Anchor trusses securely at bearing points; use metal truss tie-downs or floor truss hangers as applicable. Install fasteners through each fastener hole in metal framing anchors according to manufacturer's fastening schedules and written instructions.
- H. Securely connect each truss ply required for forming built-up girder trusses.
 - 1. Anchor trusses to girder trusses as indicated.
- I. Install and fasten permanent bracing during truss erection and before construction loads are applied. Anchor ends of permanent bracing where terminating at walls or beams.
 - 1. Install bracing to comply with Section 061000 "Rough Carpentry."
- J. Install wood trusses within installation tolerances in TPI 1.
- K. Do not alter trusses in field. Do not cut, drill, notch, or remove truss members.
- L. Replace wood trusses that are damaged or do not comply with requirements.
 - 1. Damaged trusses may be repaired according to truss repair details signed and sealed by the qualified professional engineer responsible for truss design, when approved by Architect.

3.2 REPAIRS AND 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 wood trusses from weather. If, despite protection, wood trusses become wet, apply EPA-registered borate treatment. Apply borate solution by spraying to comply with EPA-registered label.
- C. Repair damaged galvanized coatings on exposed surfaces according to ASTM A 780/A 780M and manufacturer's written instructions.

END OF SECTION 061753

SECTION 062000 - FINISH CARPENTRY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Reinforced fiberglass wall protection systems.
- B. Related Sections include the following:
 - 1. Division 06 Section "Rough Carpentry" for furring, blocking, and other carpentry work not exposed .
 - 2. Division 09 Section "Painting" for priming and backpriming of finish carpentry .

1.3 SUBMITTALS

- A. General: Submit in accordance with Division 01 Section "Submittal Procedures."
- B. Product Data: For each type of process and factory-fabricated product. Include construction details, material descriptions, dimensions of individual components and profiles, textures, and colors.
- C. Qualification Data: For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.
- D. Maintenance Data: For fiberglass reinforced wall protection systems to include in the operation and maintenance manual specified in Division 01.
 - 1. Include cleaning methods, cleaning solutions recommended, and stain removal methods recommended.
 - 2. Also include precautions for cleaning materials and methods that could be detrimental to finishes and performance.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Engage an experienced Installer who has completed finish carpentry similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.
- B. Fire-Test-Response Characteristics: Where fire-retardant materials are indicated, provide materials with specified fire-test-response characteristics as determined by a testing and inspecting agency acceptable to authorities having jurisdiction. Identify materials with appropriate markings of applicable testing and inspecting agency on surfaces of materials that

will be concealed from view after installation. Materials shall meet the following requirements when tested in accordance with ASTM E 84:

1. Flame Spread: 25 or less.
2. Smoke Developed: 450 or less.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver interior finish carpentry only when environmental conditions meet requirements specified for installation areas. If finish carpentry must be stored in other than installation areas, store only where environmental conditions meet requirements specified for installation areas.
- B. Store fiberglass reinforced, wall protection materials in original undamaged packages and containers inside a well-ventilated area protected from weather, moisture, soiling, extreme temperatures, and out of direct sunlight.

1.6 PROJECT CONDITIONS

- A. Weather Limitations for Exterior Carpentry: Proceed with installation only when existing and forecasted weather conditions permit work to be performed according to manufacturer's written instructions and warranty requirements and at least one coat of specified finish to be applied without exposure to rain, snow, or dampness.
- B. Environmental Limitations for Interior Carpentry: Do not deliver or install interior finish carpentry until building is enclosed and weatherproof, wet work in space is completed and nominally dry, and provisions are made to maintain temperature and relative humidity at occupancy levels during the remainder of the construction period.
 1. Fiberglass Reinforced, Wall Protection Systems: Do not install until ambient temperature within the building is maintained at not less than 70 deg F for not less than 72 hours before, during and after installation.
- C. 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.

1.7 WARRANTY

- A. Manufacturer's Warranty for Cellular PVC Trim: Manufacturer agrees to repair or replace trim that fails due to defects in manufacturing within specified warranty period. Failures include, but are not limited to, deterioration, delamination, and excessive swelling from moisture.
 1. Warranty Period: Manufacturer's standard, but not less than 25 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

- A. Lumber: DOC PS 20 and applicable grading rules of inspection agencies certified by the American Lumber Standards' Committee Board of Review.
 - 1. Factory mark each piece of lumber with grade stamp of inspection agency indicating grade, species, moisture content at time of surfacing, and mill.
 - 2. For exposed lumber, mark grade stamp on end or back of each piece.

2.2 WOOD-PRESERVATIVE-TREATED MATERIALS

- A. Preservative Treatment by Pressure Process: AWPAC U1; Use Category UC2 for interior construction not in contact with the ground, Use Category UC3b for exterior construction not in contact with the ground, and Use Category UC4a for items in contact with the ground.
 - 1. Preservative Chemicals: Micronized Copper Azole, MCA.
 - 2. Product: MicroPro/Life Wood; Osmose, Inc.

2.3 WALL PROTECTION SYSTEM

- A. Fiberglass Reinforced Wall Panel (FRP): Crane Composites, Inc.; Glasbord with surfaseal, pebble finish, 0.090 inch thick. PVC inside and outside corners, and 1-inch wide, minimum, H-molding. Use adhesive and caulking as specified by manufacturer. Color for panel and molding shall match.
 - 1. Sheet Size: 4 feet wide x full height panels.
 - 2. Color: As selected by Architect from manufacturer's full range of colors.
- B. Adhesive: Comply with paneling manufacturer's recommendations for adhesives.

2.4 MISCELLANEOUS MATERIALS

- A. Fasteners for Exterior Finish Carpentry: Provide nails or screws of the following materials, in sufficient length to penetrate minimum of 1-1/2 inches into substrate, unless otherwise recommended by manufacturer:
 - 1. Stainless steel.
- B. 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.
 - 1. Where finish carpentry materials are exposed in areas of high humidity, provide fasteners and anchorages with hot-dip galvanized coating complying with ASTM A 153/A 153M.
- C. Glue: Aliphatic-resin, polyurethane, or resorcinol wood glue recommended by manufacturer for general carpentry use.
 - 1. Wood glue used inside the weatherproofing system shall have a VOC content of 30 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- D. 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.
- 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, unless longer conditioning is recommended by manufacturer.

3.3 INSTALLATION, GENERAL

- A. Do not use materials that are unsound, warped, improperly treated or finished, inadequately seasoned, or too small to fabricate with proper jointing arrangements.
 - 1. Do not use manufactured units with defective surfaces, sizes, or patterns.
- B. Install finish carpentry level, plumb, true, and aligned with adjacent materials. Use concealed shims where necessary for alignment.
 - 1. Scribe and cut finish carpentry to fit adjoining work. Refinish and seal cuts as recommended by manufacturer.
 - 2. Countersink fasteners, fill surface flush, and sand where face fastening is unavoidable.
 - 3. Install to tolerance of 1/8 inch in 96 inches for level and plumb. Install adjoining finish carpentry with 1/32-inch maximum offset for flush installation and 1/16-inch maximum offset for reveal installation.
 - 4. Coordinate finish carpentry with materials and systems in or adjacent to it. Provide cutouts for mechanical and electrical items that penetrate exposed surfaces of finish carpentry.
 - 5. Finish according to specified requirements.

3.4 FRP INSTALLATION

- A. Install according to manufacturer's recommendations for a moisture-resistant installation. Set fiberglass reinforced panel edges in silicone sealant. Install FRP panels plumb, level, square, flat and in proper alignment. Set fiberglass reinforced panel edges, moldings, fasteners, and fixtures in silicone sealant for a moisture-resistant installation. Perimeter and H-moldings shall be fastened through the wallboard to studs or blocking back-up. Provide continuous cove base molding at the bottom of fiberglass panels, set in sealant. Apply wall panels with adhesive, allowing proper clearance for expansion and contraction as recommended by manufacturers of FRP panels and adhesive. Remove excess sealant and smears as FRP panels are installed. Brace wall panels to assure even contact to wall without bubbles until adhesive has cured.

3.5 ADJUSTING

- A. Replace finish carpentry that is damaged or does not comply with requirements. 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.

3.6 CLEANING

- A. Clean finish carpentry on exposed and semiexposed surfaces. Touch up factory-applied finishes to restore damaged or soiled areas.

3.7 PROTECTION

- A. Provide final protection and maintain conditions that ensure finish carpentry is without damage or deterioration at time of Substantial Completion.

END OF SECTION 062000

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SECTION 072100 - BUILDING INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Foam-plastic board insulation.
 - 2. Glass-fiber blanket (batt) insulation.
 - 3. Mineral-wool blanket (batt) insulation.
 - 4. Loose-fill insulation.Foam-in-place insulation sealant.
 - 5. Insulation in frames of steel doors and louvers.
 - 6. Vapor retarders.
- B. Related Sections:
 - 1. Division 04 Section "Unit Masonry Assemblies" for cavity insulation installed in masonry cavity walls.
 - 2. Division 07 Section "Commissioning of Thermal and Moisture Protection (Building Enclosure)" for Contractor's responsibilities for commissioning of building enclosure and coordination with Owner's commissioning agent for thermal imaging of installed thermal insulation.
 - 3. Division 07 Section "Foamed-In-Place Insulation."
 - 4. Division 07 Section "Fluid-Applied Air/Vapor Barrier System."
 - 5. Division 07 Section "Under-Slab Vapor Retarders" for vapor retarder applied over under slab insulation.
 - 6. Division 07 Section "Ethylene-Propylene-Diene-Monomer (EPDM) Roofing" for insulation specified as part of low-slope roofing construction.
 - 7. Division 09 Section "Gypsum Board Assemblies" for providing acoustical insulation in wood-framed assemblies.
 - 8. Divisions 22 and 23 Sections for insulation on ducts, piping, and equipment.

1.3 DEFINITIONS

- A. Thermal Resistivity: Where the thermal resistivity of insulation products are designated by "r-values," they represent the reciprocal of thermal conductivity (k-values). Thermal conductivity is the rate of heat flow through a homogenous material exactly 1 inch thick. Thermal resistivities are expressed by the temperature difference in degrees F between the two exposed faces required to cause one BTU to flow through one square foot per hour at mean temperatures indicated.
- B. Mineral-Fiber Insulation: Insulation composed of rock-wool fibers, slag-wool fibers, or glass fibers; produced in boards and blanket with latter formed into batts (flat-cut lengths) or rolls.

1.4 SUBMITTALS

- A. General: Submit in accordance with Division 01 Section "Submittal Procedures."

- B. Product Data: For each type of product indicated.
- C. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for each product.
- D. Research/Evaluation Reports: For foam-plastic insulation, from ICC-ES.

1.5 QUALITY ASSURANCE

- A. Source Limitations: Obtain each type of building insulation through one source from a single manufacturer.
- B. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency and bearing UL label. Identify products with appropriate markings of applicable testing agency.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Protect insulation materials from physical damage and from deterioration due to moisture, soiling, and other sources. Store inside and in a dry location. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.
- B. Protect foam-plastic board insulation as follows:
 - 1. Do not expose to sunlight except to necessary extent for period of installation and concealment.
 - 2. Protect against ignition at all times. Do not deliver foam-plastic board materials to Project site before installation time.
 - 3. Quickly complete installation and concealment of foam-plastic board insulation in each area of construction.
- C. Storage Requirements for Spray Urethane Foam Insulation: Store and handle materials in compliance with manufacturer's recommendations to prevent their deterioration or damage due to moisture, high or low temperatures, contaminants, or other causes. Store materials covered, out of direct sunlight, and at temperatures between 60 deg F and 70 deg F.
 - 1. Dispose of empty containers by technicians in accordance with manufacturer's recommendations, current law, and industry standard practice.

1.7 COORDINATION

- A. Sequence and coordinate installation of firesafing components specified in this and other Sections to assure completed system complies with required fire-resistance ratings and that firesafing remains dry.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
2. Products: Subject to compliance with requirements, provide one of the products specified.

2.2 FOAM-PLASTIC BOARD INSULATION

- A. Under Slab and Foundation Perimeter Extruded-Polystyrene Board Insulation: ASTM C 578, Type IV, 25 psi, with maximum flame-spread and smoke-developed indexes of 75 and 450, respectively, per ASTM E 84.
 1. Edge Condition: As follows:
 - a. Under Slab Insulation: Square edge.
 - b. Perimeter Insulation: Tongue and groove or shiplap edges.
 2. Thickness: 2 inch, unless indicated otherwise.
 3. Products:
 - a. Styrofoam Tongue and Groove; Dow Chemical Company (The).
 - b. Foamular 250; Owens Corning.
 - c. GreenGuard Insulation Board; Pactiv Building Products.
- B. Adhesive for Bonding Insulation: Product with demonstrated capability to bond insulation securely to substrates without damaging insulation and substrates.

2.3 GLASS-FIBER BLANKET (BATT) INSULATION

- A. Manufacturers:
 1. CertainTeed Corporation.
 2. Guardian Building Products, Inc.
 3. Johns Manville.
 4. Knauf Insulation.
 5. Owens Corning.
- B. Unfaced, Glass-Fiber Blanket (Batt) Insulation: ASTM C 665, Type I; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively, per ASTM E 84; passing ASTM E 136 for combustion characteristics. Provide in thickness for full depth of cavity. Where cavity requires insulation that is thicker than standard size, install next larger size and compress into cavity.
 1. Provide insulation in standard density except as noted otherwise.

2.4 MINERAL-WOOL BLANKET (BATT) INSULATION

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Owens Corning.
 2. Roxul Inc.
 3. Thermafiber.
- B. Unfaced, Mineral-Wool Blanket (Batt) Insulation (Firesafing): ASTM C 665, Type I (blankets without membrane facing); consisting of fibers; with maximum flame-spread and smoke-developed indexes of 25 and 50, respectively, per ASTM E 84; passing ASTM E 136 for combustion characteristics.

2.5 FOAM-IN-PLACE INSULATION SEALANT

- A. Foam-In-Place Insulation Sealant, General Use: On-site foam-in-place insulation shall be Class 1 foam.
 - 1. Products:
 - a. Froth-Pac Foam Sealant; Dow Chemical Company (The).
 - b. Touch 'n Foam Gun Foam Sealant; Convenience Products.
- B. Polyurethane Foam Insulation Sealant (Minimal Expansive) for Perimeters of Openings in Exterior Walls: Single- or two-component, UL classified sealant, to insulate, seal, fill, and stop air infiltration; shall not expand to the point to cause pressure on jambs of openings in exterior walls.
 - 1. Density: ASTM D 1622, 1.0 - 1.8 lbs./cu. ft.
 - 2. R-Value: ASTM C 518, not less than 4.0 per inch of thickness.
 - 3. Fire-Test-Response Characteristics: ASTM E 84, as follows:
 - a. Flame Spread: Not greater than 25.
 - b. Smoke Developed: Not greater than 50.
 - 4. Products:
 - a. Great Stuff PRO Window & Door Insulating Foam Sealant; Dow Chemical Company (The).
 - b. Window & Door Polyurethane Foam Sealant; Convenience Products.
 - c. Handi-Foam Window and Door Low Pressure Polyurethane Foam Sealant; Fomo Products Inc..

2.6 VAPOR RETARDERS

- A. Polyethylene Vapor Retarders: ASTM D 4397, 6 mils thick, with maximum permeance rating of 0.13 perm.
- B. Vapor-Retarder Tape: Pressure-sensitive tape of type recommended by vapor-retarder manufacturer for sealing joints and penetrations in vapor retarder.
- C. Vapor retarders applied beneath slabs on ground specified in Division 07 Section "Under-Slab Vapor Retarders."

2.7 AUXILIARY INSULATING MATERIALS

- A. Insulation Support Anchor for Walls: 25 gage, galvanized continuous metal support strip with pre-punched tabs at 8 inches on center.
 - 1. Product: Insul-hold; Insul-Hold Co., Inc.; phone (207) 465-9066.
- B. Insulation Support Wire for Floor/Ceiling Assemblies: Steel wire, not less than 0.090 inch diameter, with chisel cut ends for use with wood trusses; coordinate length with truss spacing.
 - 1. Product: Simpson Strong-Tie Co., Inc.; Insulation Supports or approved equal.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean substrates of substances that are harmful to insulation or that interfere with insulation attachment.

3.2 INSTALLATION, GENERAL

- A. Comply with insulation manufacturer's written instructions applicable to products and applications indicated. Butt joints tight and fasten in place to prevent displacement during the installation of work that conceals insulation. Fill voids in thermal envelope not covered by the work of other sections.
 - 1. If printed instructions are not available or do not apply to project conditions, consult manufacturer's technical representative for specific recommendations before proceeding with installation of insulation.
- B. Install insulation that is undamaged, dry, and unsoiled and that has not been left exposed to ice, rain, or snow at any time.
- C. Extend insulation to envelop entire area to be insulated. Cut and fit tightly around obstructions and fill voids with insulation. Remove projections that interfere with placement.
- D. Provide sizes to fit applications indicated and selected from manufacturer's standard thicknesses, widths, and lengths. Apply single layer of insulation units to produce thickness indicated unless multiple layers are otherwise shown or required to make up total thickness.

3.3 INSTALLATION OF BELOW-GRADE INSULATION

- A. On vertical foundation wall surfaces, set insulation units using manufacturer's recommended adhesive according to manufacturer's written instructions.
 - 1. Extend insulation to top of footing, unless otherwise indicated.
 - 2. Adhere insulation to wall to prevent displacement during backfilling operations. Insulation shall remain tight to the walls.
 - 3. Interlock tongue and groove edges. Tightly abut boards without gaps.
- B. On horizontal surfaces under slabs, loosely lay insulation units according to manufacturer's written instructions. Stagger end joints and tightly abut insulation units. Insulate under slabs where indicated. Insulation shall be installed beneath vapor retarder. Coordinate with Section 072300 - Under-Slab Vapor Retarders.

3.4 INSTALLATION OF INSULATION OF BATT INSULATION

- A. Apply insulation units to substrates by method indicated, complying with manufacturer's written instructions. If no specific method is indicated, bond units to substrate with adhesive or use mechanical anchorage to provide permanent placement and support of units. Fill voids in thermal envelope not covered by the work of other sections.

- B. Glass-Fiber Blanket (Batt) Insulation: Install in cavities formed by framing members according to the following requirements:
 - 1. Install insulation support anchors at top of cavity and spaced 5 feet on center full length of each cavity.
 - 2. Use insulation widths and lengths that fill the cavities formed by framing members. If more than one length is required to fill the cavities, provide lengths that will produce a snug fit between ends.
 - 3. Place insulation in cavities formed by framing members to produce a friction fit between edges of insulation and adjoining framing members.
 - 4. Maintain 3-inch clearance of insulation around recessed lighting fixtures not rated for or protected from contact with insulation.
 - 5. Roof/Ceiling Assembly Insulation: Place insulation in a two-layer application consisting of a layer of 6-inch thick batt insulation covered with 5-inch thick glass fiber loose fill insulation. Place loose fill insulation to comply with ASTM C 1015. Level horizontal applications to uniform thickness, lightly settle to uniform density, but do not excessively compact.
 - 6. Floor Assembly Insulation: Shall be installed against subflooring and held in place with insulation support wires attached to the wood trusses at 12 inches o.c.
- C. Miscellaneous Voids: Install insulation in miscellaneous voids and cavity spaces where required to prevent gaps in insulation using the following materials:
 - 1. Unfaced, Glass-Fiber Batt: Apply according to manufacturer's written instructions.
 - 2. Spray Polyurethane Insulation: Apply according to manufacturer's written instructions.
- D. Install mineral-fiber insulation where indicated.

3.5 INSTALLATION OF FOAM-IN-PLACE INSULATION SEALANT

- A. Install foam-in-place insulation sealant to a minimum depth of 1 inch, sealing roof deck flutes and construction cracks and gaps where outside air and cold can infiltrate, providing an airtight building envelope.
- B. Seal around wires running through top and bottom plates in exterior walls, and through the top plates of top story walls with cold attic spaces above. Seal around all penetrations into cold attic spaces including conduits, pipes, vents and other items penetrating thermal barriers and vapor barriers.

3.6 INSULATING STEEL DOOR AND LOUVER FRAMES

- A. Exterior Frames: Steel door frames and louver frames in exterior steel-framed walls shall be filled with rigid insulation. Cut rigid insulation slab the full width of frame throat and insert continuous slab into door frame head and jambs and louver frame head, jamb and sills before frame is installed.
 - 1. After frame is installed, fill remaining gap between rigid insulation and air/vapor barrier or weather barrier with foam-in-place insulation.
 - 2. Foam remaining gaps with minimal expanding foam.

3.7 INSTALLATION OF VAPOR RETARDERS

- A. Installation of Vapor Retarders: Place vapor retarders on side of construction indicated on Drawings. Extend vapor retarders to extremities of areas to protect from vapor transmission. Secure vapor retarders in place with adhesives or other anchorage system as indicated. Extend vapor retarders to cover miscellaneous voids in insulated substrates, including those filled with loose-fiber insulation.
 - 1. Seal vapor barrier to electrical wall and ceiling boxes.
 - 2. Seal vapor barrier to flexible flashing membrane at top of exterior walls.
- B. Seal joints caused by pipes, conduits, electrical boxes, and similar items penetrating vapor retarders with vapor-retarder tape to create an airtight seal between penetrating objects and vapor retarders.
- C. Repair tears or punctures in vapor retarders immediately before concealment by other work. Cover with vapor-retarder tape or another layer of vapor retarders.
- D. Remove trash and debris from the project site and properly dispose of.

3.8 PROTECTION

- A. Protect installed insulation and vapor retarders from damage due to harmful weather exposures, physical abuse, and other causes. Provide temporary coverings or enclosures where insulation is subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

END OF SECTION 072100

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SECTION 072119 - FOAMED-IN-PLACE INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Closed-cell spray polyurethane foam.
- B. Related Requirements:
 - 1. Section 072100 "Thermal Insulation" for foam-plastic board insulation.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Preparation instructions and recommendations.
 - 2. Storage and handling requirements and recommendations.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Product Test Reports: For each product, for tests performed by a qualified testing agency.
- C. Evaluation Reports: For spray-applied polyurethane foam-plastic insulation, from ICC-ES.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.
- B. Environmental Limitations: Do not apply material when ambient or substrate temperature is 50 deg F or lower unless temporary protection and heat are provided to maintain temperature at or above this level for 24 hours before, during, and for 24 hours after product application. Do not apply material when moisture due to dew, frost or water is present on substrate materials.

PART 2 - PRODUCTS

2.1 CLOSED-CELL SPRAY POLYURETHANE FOAM

- A. Closed-Cell Spray Polyurethane Foam: ASTM C1029, Type II, minimum density of 2.0 lb/cu. ft. and minimum aged R-value at 1-inch thickness of 6.4 deg F x h x sq. ft./Btu at 75 deg F; with non-ozone depleting blowing agent. Coordinate catalysis with application temperature conditions.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Heatlok HFO Pro; Demilec (USA) LLC.
 - b. Styrofoam Brand CM Series; Dow Chemical Company.
 - c. ProSeal HFO; Icynene-Lapolla; Icynene.
 - d. JM Corbond III SPF; Johns Manville; a Berkshire Hathaway company.
2. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - a. Flame-Spread Index: 25 or less.
 - b. Smoke-Developed Index: 450 or less.
3. Density: ASTM D 1622; minimum density of 2.0 lb/cu. ft.
4. Closed Cell Content: ASTM D 2856, 90 percent minimum.
5. Vapor Permeance: ASTM E 96, 1-inch thickness, 1.2 perms maximum.
6. Fungi Resistance: ASTM C 1338, no growth.

PART 3 - EXECUTION

3.1 COORDINATION

- A. Coordinate locations where spray foam occurs with construction schedule and sequencing. Spray areas concealed within construction before area is fully enclosed by sheathing that would prevent access for spray foam application.
- B. Spray insulation applied to the interior side of exterior wall stud cavities shall be applied after completion of rainscreen horizontal girt attachment system, and after masonry tie installations to permit inspection of screw engagement to steel stud framing.

3.2 PREPARATION

- A. Mask and cover windows, doors, electrical boxes, and other items not indicated to receive insulation, protecting from fallout or overspray of materials during application.
- B. Verify that substrates are clean, dry, and free of substances that are harmful to insulation. Brush down framing, interior face of exterior sheathing, and adjacent substrates to loosen and remove cobwebs, dirt, dust and debris. Upon completion of brush-down, blow surfaces clean with compressed air to remove remaining surface dust and dirt.
- C. Maintain a minimum ambient and substrate temperature of 50 deg F for 72 hours prior to application of spray polyurethane foam insulation.
- D. Substrate Conditions: Using a thermal scan, verify that the temperature of the framing and sheathing substrates is 50 deg F or above. Record locations and temperatures of thermal readings. Do not apply insulation until substrates are at specified temperatures.

3.3 INSTALLATION

- A. Comply with insulation manufacturer's written instructions applicable to products and applications.
 1. To prevent foam shrinkage and separation from exterior framing members, verify that proper catalyst is being used for temperature conditions. Maintain two-part foam components at proper temperature in canisters and hose to nozzle tip.

- B. Spray insulation to envelop entire area to be insulated and fill voids.
- C. Apply in multiple passes to not exceed maximum thicknesses recommended by manufacturer. Do not spray into rising foam.
- D. Framed Construction: Install into cavities formed by framing members to achieve thickness indicated on Drawings, but not less than 2 inches.
- E. Miscellaneous Voids: Apply according to manufacturer's written instructions.

3.4 PROTECTION

- A. Protect installed insulation from damage due to harmful weather exposures, physical abuse, and other causes.

3.5 CLEANING

- A. Cleaning: Remove material overspray, and protection materials from surfaces of other construction and clean exposed surfaces. Remove trash and debris from the project site and properly dispose of.

END OF SECTION 072119

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SECTION 072300 - UNDER-SLAB VAPOR RETARDERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Vapor retarder under slabs-on-grade.
- B. Related Sections include the following:
 - 1. Division 07 Section 070800 "Building Envelope Commissioning" for Contractor's responsibilities in commissioning of building enclosure and coordination with Owner's commissioning agent.
 - 2. Division 07 Section "Building Insulation" for installation of underslab insulation below the vapor retarder.

1.3 SUBMITTALS

- A. General: Submit in accordance with Division 01 Section "Submittal Procedures."
- B. Product Data: For each type of product indicated.
- C. Samples for Verification: 12-inch square units for each type of vapor retarder indicated.

1.4 QUALITY ASSURANCE

- A. Mockup: Construct a mock-up at an approved location of the vapor barrier installation, including taping of seams, perimeter seal and attachment, and sealing of penetrations.
 - 1. Coordinate location with Architect and Commissioning Agent.
- B. Coordinate inspection of vapor barrier installations before slab placements. Notify Architect and Commissioning Agent not less than 10 days before vapor barrier inspection is required.
- C. Building Envelope Commissioning: Participate in building envelope commissioning pre-construction meeting and progress meetings as required by the Contractor and the Commissioning Agent.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Protect materials from physical damage and from deterioration by moisture, soiling, and other sources. Store inside and in a dry location. Comply with manufacturer's written instructions for handling, storing, and protecting during installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Products: Subject to compliance with requirements, provide one of the products specified.

2.2 VAPOR RETARDERS FOR UNDER SLABS

- A. Vapor Retarder: ASTM E-1745, meeting or exceeding Class B:
 - 1. Minimum Permeance: ASTM F 1249, not greater than 0.01 perms.
 - 2. Tensile Strength: ASTM E154 or D638, Class A - over 45 lbf/in.
 - 3. Puncture Resistance: ASTM E-154, Class B - over 1700 grams.
 - 4. Thickness of Barrier (Plastic): ACI 302.1R-96, not less than 15 mils.
 - 5. Products:
 - a. Stego Wrap; Stego Industries LLC, (877) 464-7834.
 - b. Vaporguard; Reef Industries.
 - c. Perminator Underslab Vapor-Mat; W.R. Meadows, Inc.
 - d. VaporBlock VB15; Raven Industries.
- B. Tape: Manufacturer's high-density polyethylene tape with rubber-based pressure sensitive adhesive. Minimum 4-inch width. Provide cold weather tape for low temperature applications.
- C. Perimeter Tape: StegoTack Tape, 2 inch wide double sided adhesive strip or equivalent product from other manufacturers.
- D. Mastic: Medium viscosity, polymer-modified anionic bituminous/asphalt emulsion. Mastic shall be by vapor retarder manufacturer or recommended by vapor retarder manufacturer for compatibility with vapor barrier product.
- E. Pipe Boot: Construct boots from vapor retarder material and high-density polyethylene tape per manufacturer's instruction.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for Sections in which substrates and related work are specified and other conditions affecting performance.
 - 1. Confirm granular base is level, properly rolled or tamped, and ready to receive vapor retarder.
 - 2. Confirm underslab insulation is in place with joints tight.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Clean substrates of substances harmful to vapor retarders, including removing projections capable of puncturing vapor retarders, or of interfering with attachment.

3.3 INSTALLATION, GENERAL

- A. Comply with manufacturer's written instructions applicable to products and application indicated.
- B. Extend retarders in thickness indicated to envelop entire area to be covered. Cut and fit tightly around obstructions. Remove projections that interfere with placement.

3.4 INSTALLATION OF UNDER-SLAB VAPOR RETARDERS

- A. Install vapor retarder under all interior floor slabs in strict accordance with the manufacturer's printed instructions and as follows:
 - 1. Place vapor retarder with the longest dimension parallel with the direction of the pour.
 - 2. Snap chalk line along inside perimeter of foundation walls at top of slab elevation.
 - 3. Without wetting, clean a 3-inch wide band on the surface of the concrete below the chalk line at approximately mid-slab height. Remove dirt, residual form release, or other bond inhibiting surface contaminants. Grind smooth any surface projections within the band.
 - 4. Lap vapor retarder on to perimeter foundation walls and vertical surfaces, sealing with continuous 1-1/2 inch wide bed of mastic.
 - 5. Lap joints 6 inches and seal with polyethylene tape.
 - 6. Seal pipe penetrations with pipe boot made from vapor barrier and tape, or mastic per manufacturer's detail requirements.
 - 7. Install vapor retarder directly beneath all slabs on ground, including radiant heated slabs with under slab insulation.
 - a. For areas receiving under slab insulation, place vapor retarder on top of insulation.
 - 8. Repair damaged areas by cutting patches of vapor retarder, overlapping damaged area 6 inches and taping all four sides with polyethylene tape.

3.5 PROTECTION

- A. Protect installed vapor retarders from damage due to harmful weather exposures, physical abuse, and other causes. Provide temporary coverings or enclosures where vapor retarders are subject to abuse and cannot be concealed and protected by permanent construction immediately after installation.

END OF SECTION 072300

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SECTION 072500 - WEATHER BARRIERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Weather barrier membrane (building wrap).
 - 2. Flashings and seam tapes.
 - 3. Flexible flashing membrane.
 - 4. Fasteners.
 - 5. Installation of flashing membrane over window flange and tying into weather barrier system.
- B. Related Sections:
 - 1. Section 070800 "Building Envelope Commissioning" for Contractor's responsibilities in commissioning of building enclosure and coordination with Owner's commissioning agent.
 - 2. Division 07 Section "Fluid-Applied Air/Vapor Barrier System" for air vapor barrier applied to sheathing beneath continuous wall insulation.
 - 3. Division 08 Sections for coordination and installation of window tie into weather barrier system.

1.3 SUBMITTALS

- A. Complete Shop Drawings and Product Data shall be submitted to the Architect at least 21 days before the Preinstallation Conference. No Preinstallation Conference will be held and no material shall be applied until submittals are complete and released for construction.
- B. Product Data: Submit manufacturer's current technical literature for each component. Include manufacturer's installation instructions and details showing the recommended procedures and sequence of installation of weather barrier.
- C. Shop Drawings: Submit custom details for each condition specific to the project. Submit manufacturer installation details for terminations, perimeter edges, attachment and sealing to adjacent construction for the entire construction envelope, including the following:
 - 1. Termination and sealing at weather barrier perimeter edges.
 - 2. Flanged windows.
 - 3. Door frames.
 - 4. Wall penetrations by pipes, ducts and conduits.
 - 5. Typical sheathing joint treatment, outside corner, inside corner where gaps occur.
 - 6. Detailing a penetration where sheathing has a wide gap from the penetration (Example: Large diameter oversized drilled hole receiving small conduit.)

- D. Preinstallation Conference: Submit meeting minutes of preinstallation conference. Include coordination requirements with trades that interface with weather barrier.
- E. Mockup Documentation: Submit photographic documentation of approved mockup installation and details.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications:
 - 1. Installer shall have experience with installation of specified weather barrier assemblies under similar conditions.
 - 2. Installation shall be in accordance with weather barrier manufacturer's installation guidelines and recommendations.
- B. Source Limitations: Provide weather barrier and accessory materials produced by single manufacturer to ensure total system compatibility and integrity.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Deliver weather barrier materials and components in manufacturer's original, unopened, undamaged containers with identification labels intact.
- B. Store weather barrier materials as recommended by weather barrier manufacturer.
 - 1. Store roll materials vertically on end in original packaging. Maintain in a dry condition.
 - 2. Protect rolls from direct sunlight and inclement weather until ready for use.
 - 3. Store between 40 degrees and 90 degrees F.

1.6 PROJECT CONDITIONS

- A. Weather Limitations: Proceed with installing weather barrier only when existing and forecasted weather conditions will permit work to be performed according to manufacturers' recommendations and warranty requirements, and when substrate is completely dry. Weather barrier shall not be applied when ambient air and substrate temperatures are less than 20 deg F.
- B. Substrate Conditions: Do not begin weather barrier installation until substrates have been inspected and are determined to be in satisfactory condition in accordance with manufacturer's requirements. All surfaces shall be sound, dry, even, and free of oil, grease, dirt, dust and other contaminants that are detrimental to the adhesion of the weather barrier membrane and flashing. No work shall proceed when moisture, ice or frost is present on the substrate materials.

1.7 SCHEDULING

- A. Review requirements for sequencing of installation of weather barrier assembly with installation of siding and trim, windows, doors, and trim flashings to provide a weather-tight barrier assembly.
 - 1. Contractor is solely responsible to make clear to Subcontractors the extent of their Work and coordinate overlapping Work to assure a weather tight building envelope.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Weather Barrier: WrapShield SA fully adhered water-resistive vapor permeable air barrier membrane system; VaproShield LLC; Gig Harbor, WA; Website: www.vaproshield.com.
 - 1. Local Representative: Bob McEachern, Roof Tech Sales LLC; phone: (603) 494-3757.
 - 2. Vapor-Permeable, Water-Resistive Barrier: Self-adhering, water-resistive, vapor-permeable, membrane consisting of multiple layers of UV stabilized spun-bonded polypropylene having the following properties:
 - a. Air Leakage: Less than 0.01 cfm/ft. sq. in accordance with ASTM E 2357 and less than 0.0000263 cfm/sq. ft. at 75 Pa when tested in accordance with ASTM E 2178.
 - b. Surface Burning Characteristics, ASTM E 84: Class A; Flame-spread index less than 10; Smoke-developed index less than 15.
 - c. Water Vapor Permeance: ASTM E 96 Method B, 50 perms, minimum.
 - d. Water Resistance: AATCC 127, 550 mm hydrostatic head for 5 hours, no leakage.
 - e. Tensile Strength: ASTM D 882, 44.8 lbf/inch, machine direction; 25 lbf/inch, cross-machine direction.
 - f. Thickness: 0.026 inches.
 - g. Weight: 8.26 oz per sq. yd.

2.2 INSTALLATION ACCESSORIES

- A. Transition and Flashing Membrane:
 - 1. Self-adhered weather barrier transition and flashing membrane shall be VaproShield VaproFlashing SA, zero VOC self-adhered water-resistive vapor permeable membrane.
- B. Liquid Applied Flashing for Rough Openings: Liquid-applied, vapor permeable, weather barrier flashing for exterior openings with vapor permeance and resistance to air leakage properties compatible with the primary air barrier membrane.
 - 1. Product: VaproShield LLC; VaproLiqui-Flash.
- C. Penetration Sealant: VaproShield LLC; VaproLiqui-Flash.
- D. Weather Barrier Flashing Tapes: For use to secure weather barrier to itself and to substrates.
 - 1. Single-Sided Tape: VaproTape (Single-Sided), 20 mil thick, 3 inches wide.
 - 2. Flashing Tape: VaproFlashing SA.
 - 3. Double-Sided Sealing Tape: VaproTape (Double -Sided), 30 mil thick, 1 inch wide.
 - 4. UV-Resistant Tape: VaproTape, 35 mil thick by 4 inches wide penetration seam tape.
 - 5. Foil-Faced Tape: VaproAluma Tape, 20 mil thick by 4.5 inches and 9 inches wide, foil faced, UV stable, moisture-resistant flashing and membrane transition tape for use with silicone sealants.

PART 3 - EXECUTION

3.1 EXAMINATION AND PREPARATION

- A. Examine substrates, areas, and surface conditions, with Installer present, to verify that surfaces are sound, dry, even, and free of oil, grease, dirt, dust and other contaminants that are

detrimental to the adhesion of the weather barrier membrane and flashings, and for compliance with requirements and other conditions affecting performance of weather barrier.

1. Sheathing: Verify that sheets are sufficiently attached with appropriate screws at proper spacing. Verify that fasteners are flush with sheathing.
2. Fill voids and gaps in substrate greater than 1/4 inch in width to provide an even surface.

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

3.2 INSTALLATION OF WEATHER BARRIER SYSTEM

A. General: Install weather barrier over exterior face of exterior wall substrate in accordance with manufacturer's recommendations and instructions to provide a weather resistant barrier system.

1. Apply materials within manufacturer's requirements for substrate and ambient temperatures and for weather conditions.
2. Do not apply to wet or frozen (ice and frost) substrates.
3. Install horizontally or vertically over the outside face of exterior sheathing. Horizontal joints shall be lapped in a weatherboard manner to shed water over membrane below.
4. Complete detail Work around corners, wall openings, building transitions and penetrations prior to field applications.
5. Install barrier sheet complete and continuous to substrate in a sequential overlapping weatherboard method starting at bottom or base of wall and working up.
6. Stagger all end lap seams.
7. Lap vertically a minimum of 6 inches and lap horizontally 3 inches. Do not place vertical laps above openings.
8. Align and position self-adhered air barrier transition and flashing membrane, remove protective film and press firmly into place.
9. Install membrane in tight intimate contact with substrate, without wrinkles and fishmouths. Lightly smooth out air bubbles with wallpaper brush.
10. Roll entire surface of flexible flashing membrane firmly to assure positive contact and full adhesion to substrates.

B. Tie-in to building transition conditions and at the interface of dissimilar materials with barrier transition and flashing membrane, providing a permanent weather tight seal.

C. Window, Door and Other Wall Openings:

1. Transition Membrane Installation:
 - a. Wrap self-adhered barrier transition and flashing membrane into wall openings to cover sill, jambs and head.
 - b. Remove release film, align flashing membrane and apply pressure to ensure positive contact. Roll Lap seams to ensure adhesion. Provide lap seams to shed water.
 - c. Install preformed corner flashing membrane into corners over flashing membrane. Secure preformed corners into position with flashing tape and seal to weather barrier.
 - d. Install aluminized tape around perimeter of opening to accommodate placement of backer rod and sealant between frame and weather barrier membrane.
2. Liquid Applied Flashing System:
 - a. Wrap self-adhered barrier transition and flashing membrane into wall openings to cover sill, jambs and head.

- b. Remove release film, align flashing membrane and apply pressure to ensure positive contact. Roll Lap seams to ensure adhesion. Provide lap seams to shed water.
 - c. Apply liquid flashing material around perimeter of opening, and around inner perimeter surfaces of rough opening. Spread material with trowel around face of opening, creating a border approximately 2 inches wide. Spread material with trowel around inner perimeter surfaces of rough opening full depth of stud. Completely cover surfaces so substrate is not longer visible, approximately 12 to 15 mils WFT. Inside corners shall be filled. After material dries to the touch, inspect surfaces for voids and apply additional material required to achieve complete coverage.
- 3. Flanged Windows: After flanged windows are installed, verify windows have been installed in accordance with window manufacturer's details. Cover nail flange with flashing tape. Install flashing tape along jamb and across head flanges of window and seal to installed weather barrier transition membrane. Roll tape to ensure positive contact to substrate. Seal exposed leading edge of tape. Caulk between edge of flashing tape and window frame with penetration sealant.
- D. Mechanical pipe, electrical conduit and similar penetration work shall be secured solid into position prior to installation of weather barrier membrane. Install penetration flashing and secure with tape in accordance with manufacturer's requirements.

3.3 PROTECTION

- A. Protect installed weather barrier from damage.
- B. Inspect exposed weather barrier just prior to installation of cladding. Remove water-resistive barrier materials that have been damaged and replace. Patch damaged areas as recommended by manufacturer.

END OF SECTION 072500

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SECTION 072726 - FLUID-APPLIED AIR/VAPOR BARRIER SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. A vapor-retarding fluid-applied air/vapor barrier system, including transition strip flashing at changes in substrate, joints in substrate penetrations, and other areas where required.
 - 2. Installation of transition strip flashing over window receptor flanges and tying into air/vapor barrier system.
 - 3. Photographic documentation of approved mockup installations.
- B. Related Sections include the following:
 - 1. Division 01 Section 014130 "Integrated Exterior Mockups" for on-site constructed mock-up requirements.
 - 2. Division 01 Section 070800 "Building Envelope Commissioning" for Contractor's responsibilities in commissioning of building enclosure and coordination with Owner's commissioning agent, including inspection and testing of air/vapor barrier system.
 - 3. Division 04 Section "Unit Masonry Assemblies" for masonry flashing tying into air/vapor barrier system.

1.3 PERFORMANCE REQUIREMENTS

- A. Air/Vapor Barrier: Shall be designed and constructed as a continuous air barrier to control air leakage into, or out of the conditioned space, and to act as an exterior watertight liquid-water drainage plane barrier to discharge to the outside any incidental condensation or water penetration. Air/vapor barrier membrane assemblies shall accommodate movements of building materials by providing expansion and control joints, with appropriate air seal materials at such locations, changes in substrate and perimeter conditions. Barrier shall be continuous with all joints made air-tight and shall have the following characteristics:
 - 1. Tensile Strength: ASTME D 412, 119 psi.
 - 2. Elongation: ASTM D 412, not less than 800 percent.
 - 3. Air Permeability: ASTM E 2178 & ASTM E 283: Shall not exceed 0.0012 cfm/sq.ft. at 1.57lbs/sq.ft.
 - 4. Water Vapor Permeance: ASTM E 96, Method B, not more than 0.08 perms.
 - 5. Surface Burning: ASTM E 84, flame spread index not more than 25 and smoke generation index not more than 450.
 - 6. Peel Strength, to Dry Concrete: ASTM C 836, 3319 lbf/ft.
 - 7. Long Term Flexibility: Pass to CGSB 71-GP-24M.
 - 8. Resistance to Mold, Mildew & Fungal Growth: ASTM D 5590, no growth.
 - 9. Fire Testing: Shall comply with NFPA 285 in the various wall assemblies.
 - 10. UV Resistance: Can be exposed to sunlight for 180 days according to manufacturer's written instructions.

11. Shall be capable of withstanding positive and negative combined design wind, fan and stack pressures on envelope without damage or displacement; shall transfer load to substrate; and shall not displace adjacent materials under full load.
12. Shall be joined in an airtight, watertight and flexible manner to the air barrier surface/material of adjacent systems, allowing for relative movement of systems due to thermal and moisture variations or creep. Air/vapor barrier shall be connected to the following system components:
 - a. Foundation and walls.
 - b. Doors and windows penetrating exterior walls.
 - c. Aluminum-framed entrances, storefronts and curtain walls.
 - d. Aluminum windows with flanged receptors.
 - e. Different wall systems.
 - f. Roof assemblies.
 - g. Wall and roof intersections.
 - h. Wall and floor assemblies spanning control and expansion joints.
 - i. Wall penetrations by masonry ties, screws, bolts and similar items.
 - j. Wall, floor and roof penetrations by pipes, ducts and conduits.

- B. Air/Vapor Barrier Penetrations: All penetrations of the air/vapor barrier and paths of air infiltration or exfiltration shall be made airtight to not less than the rating of the air/vapor barrier.

1.4 SUBMITTALS

- A. General: Submit in accordance with Division 01 Section "Submittal Procedures."
- B. Complete Shop Drawings and Product Data shall be submitted to the Architect at least 21 days before the Preinstallation Conference. No Preinstallation Conference will be held and no material shall be applied until submittals are complete and released for construction.
- C. Product Data: For each type of product indicated. Include technical data; certified test results; manufacturer's printed instructions for evaluating, preparing and treating substrate; and installation instructions, including temperature and other limitations of installation.
 1. Include manufacturer's list and description of wall assemblies, incorporating product, approved per NFPA 285.
- D. Shop Drawings: Show locations and extent of air/vapor barrier and details of intersections with other envelope systems and materials; details of membrane counter-flashings; details for construction of inside and outside corners; and details showing how expansion and control joints will be bridged. Identify materials, primers, sealers, support materials and other items detailed, including manufacturer's product names. Show relationship to adjacent materials, sequence of installation and materials, and methods for sealing penetrations. Shop drawing shall include connection details between the air/vapor barrier and for the following exterior envelope components as applicable to the project:
 1. Foundations and walls.
 2. Doors.
 3. Windows
 4. Aluminum-framed entrances, storefronts and curtain walls.
 5. Wall and roof assemblies.
 6. Wall penetrations by pipes, ducts and conduits.
 7. Detailing a penetration where gypsum sheathing has a wide gap from the penetration.

8. Masonry through-wall flashing attachment to sprayed surfaces. Proper surface prep and installation requirements.
 9. Masonry through-wall flashing with proper support across cavity, including what is acceptable gap width. Typical at lintel angles and relieving angles.
 10. Horizontal deflection joint and vertical control joint details in gypsum based sheathing, CMU, and plywood substrates, as applicable.
 11. Hollow metal door frames, mechanical louvers and vent penetrations.
- E. Product Certificates: For air/vapor barrier system, certifying compatibility of air/vapor barrier system and accessory materials with Project materials that connect to or that come in contact with the air/vapor barrier system; signed by product manufacturer.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer signed by manufacturer certifying that Installers comply with requirements.
- B. Product Test Reports: From a qualified independent testing agency indicating and interpreting test results of air/vapor barrier system for compliance with requirements, based on comprehensive testing of current air/vapor barrier system in accordance with ASTM E 2178 (material), ASTM E 2357 (assembly) and compliance with NFPA 285.
- C. Daily Reports: Installer shall maintain daily reports at the Project site. Copies of reports shall be submitted weekly.
- D. Filed Quality Reports: Installer shall maintain filed reports at the Project site. Copies of reports shall be submitted weekly.
- E. Contractor Field Testing Reports
- F. System Readiness Checklists (SRC): Submit in accordance with Section 070800 - Building Envelope Commissioning.
- G. Warranty: Special warranty specified in this Section.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: Shall meet the following requirements:
1. Shall be factory trained and approved in writing by air/vapor barrier membrane manufacturer.
- B. Mockups: Provide mockups of the air/vapor barrier.
1. Mockup Panel: Apply air/vapor barrier membrane to mockup to exterior wall assembly to comply with Section 014130 - Integrated Exterior Mockups and mock-up drawing. Mockup of exterior wall assembly shall include connections between wall and exterior wall openings, and through-wall flashings, showing relationship of materials with air/vapor barrier membrane and quality of workmanship. Mockup shall demonstrate surface preparation, crack and joint treatment, and sealing of gaps, terminations, and penetrations of air/vapor barrier membrane.

2. Mockup at Aluminum Window Installation: Provide a mockup demonstrating the installation of transition strip flashing over window flange, edge termination sealing, and to tie into air/vapor barrier.
 3. Mockup at Aluminum Storefront Installation: Provide a mockup demonstrating the installation of AVB to tie-in to aluminum storefront frame.
 4. Air/vapor barrier system manufacturer's representative shall be present for preparation, execution and inspection of air/vapor barrier mockup.
 5. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups, unless such deviations are specifically approved by Architect in writing.
 6. The Owner's commissioning agent will inspect the mockup.
 7. If Architect determines mockups do not comply with requirements, reconstruct mockups and apply air/vapor barrier until mockups are approved.
 8. Provide photographic documentation of approved air/vapor barrier mockup installation for establishment of quality standards for materials and execution on building (air/vapor barrier will be covered by other materials and will no longer be visible). Work shall not commence until Architect is in receipt of photographic documentation.
 9. Complete mockup for review at preinstallation conference.
 - a. Allow sufficient time for testing of mockup and preparation and submittal of test results prior to preinstallation conference.
- C. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination." Review methods and procedures related to air/vapor barrier membrane installation.
1. Complete Shop Drawings and Product Data shall be submitted to the Architect at least 21 days before the Preinstallation Conference.
 2. Meet with Owner, Architect, Owner's commissioning agent, air/vapor barrier membrane Installer, air/vapor barrier membrane system manufacturer's representative, testing agency representative, and installers whose work interfaces with or affects air/vapor barrier membrane including, but not limited to, installers of masonry, exterior sheathing, exterior wall assemblies, storefront and curtain wall assemblies, door and window assemblies, roofing assemblies, and flashings and trim.
 3. Review air/vapor barrier requirements including surface preparation, substrate condition and pretreatment, minimum substrate curing period, forecasted weather conditions, special details and sheet flashings, mockups, installation procedures, sequence of installation, testing and inspecting procedures, and protection and repairs.
 4. Review approved submittals.
 5. Review mock-ups.
 6. Review methods and procedures related to air/vapor barrier membrane installation, including manufacturer's written instructions, including surface preparation and substrate condition and pretreatment, if applicable.
 7. Review how mil thickness of applied material will be measured during application, to maintain specified thickness.
 8. Review compatibility of air/vapor barrier materials with building envelope materials.
 9. Review interface of flashings and trim with air/vapor barrier system.
 10. Review and coordinate sequence of installation with adjacent materials.
 11. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
 12. Review cold formed metal framing and sheathing installation report requirements.
 13. Review construction schedule for subsequent work covering air/vapor barrier.
 14. Review procedures for quality assurance, testing, and corrective procedures.

15. Review daily report, field quality reports and air testing requirements.
16. Review coordination of inspection of exterior air/vapor barrier before covering.
17. Review requirements of Section 070800 Building Envelope commissioning.
18. Review coordination of inspection of interior side of sheathing for holes before interior finishes are applied.
19. Review procedures for correcting holes made by screws missing framing during application of wall ties and other applicable wall attachments.
20. Review requirements for exterior insulation being in place before heating of building interior.
21. Document proceedings, including corrective measures and actions required, and furnish copy of record to each participant.
22. Provide 7 business days minimum advance notice to participants prior to convening preinstallation conference.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, and directions for storing and mixing with other components.
- B. Protect materials from damage from sunlight, weather, freezing, excessive temperatures, and construction operations. Store liquid materials at temperatures of not less than 40 deg F. Remove damaged material from site and replace at no additional cost to Owner.
- C. Remove and replace liquid materials that cannot be applied within their stated shelf life.
- D. Comply with the manufacturer's written instructions for proper material storage and handling.
- E. Protect stored materials from direct sunlight.

1.8 PROJECT CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted temperature and humidity conditions permit air/vapor barrier membrane to be installed according to manufacturers' written instructions and requirements.
 1. Do not apply air/vapor barrier system in snow, rain, fog, or mist.
- B. Environmental Conditions: Apply air/vapor barrier materials within the range of ambient and substrate temperatures recommended by air/vapor barrier manufacturer. Do not apply air/vapor barrier system to a damp or wet substrate.
- C. Maintain adequate ventilation during preparation and application of air/vapor barrier materials.
- D. Protect completed work from weather and exposure during construction.

1.9 DAILY REPORTS

- A. Installer shall maintain daily reports of all air/vapor barrier installation activity. As a minimum, report shall contain the following:
 1. Weather conditions, temperature.
 2. Substrate condition, defects and corrective action.
 3. Identify area of building where application took place.

4. List of certified installers at the site.
5. Identify applicators operating the spray gun.
6. Temperature at time of application and cure time of primers before application of membrane.
7. Temperature at time of spray application of air/vapor membrane.
8. Measurements of wet film thickness (WFT). Provide measurement for not less than one measurement per 1000 square feet.
9. Photos of installed areas.

1.10 SYSTEM READINESS CHECKLISTS (SRC):

- A. Before submitting requests for inspections, the applicator review and certify compliance of the following:
 1. Continuity of air-barrier system has been achieved throughout the building envelope with no gaps or holes.
 2. Air/vapor barrier dry film thickness (DFT).
 3. Continuous structural support of air-barrier system has been provided.
 4. Masonry and concrete surfaces were smooth, clean, and free of cavities, protrusions, and mortar droppings before air/vapor barrier application.
 5. Site conditions for application temperature and dryness of substrates have been maintained.
 6. Maximum exposure time of materials to UV deterioration has not been exceeded.
 7. Surfaces have been primed, if applicable.
 8. Laps in strips and transition strips have complied with minimum requirements and have been shingled in the correct direction (or mastic has been applied on exposed edges), with no fishmouths.
 9. Termination mastic has been applied on cut edges per manufacturer requirements and additional specification requirements.
 10. Strips and transition strips have been firmly adhered to substrate.
 11. Compatible materials have been used.
 12. Transitions at changes in direction and structural support at gaps have been provided.
 13. Connections between assemblies (air/vapor barrier and sealants) have complied with requirements for cleanliness, surface preparation and priming, structural support, integrity, and continuity of seal.
 14. All penetrations have been sealed.
- B. System readiness checklists (SRC) have been completed and submitted in accordance with Section 070800 - Building Envelope Commissioning.

1.11 CONTRACTOR FIELD TESTING

- A. Membrane Thickness: Installer contractor shall continually monitor application thickness with wet film gage. Provide measurement for not less than one measurement per 1000 square feet.
- B. Adhesion Testing: A written report documenting each test and results shall promptly be submitted to the Architect and Commissioning Agent.
 1. ASTM D4541 Standard Test Method for Pull-Off Strength of Coatings Using Portable Adhesion Testers: The contractor shall arrange for the manufacturer's representative to perform 2 tests for each of the first 100 square feet of air/vapor barrier assembly installation for each kind of substrate.

2. Perform an additional adhesion test for each kind of substrate for every additional 2,000 square feet installed.
3. At each adhesion test location, Installer shall remove and retain a sample of the installed membrane to measure the dry film thickness of the application.
 - a. Repair areas of air/vapor barrier assembly pulled from test area by applying new materials following same procedures used originally.
4. Correct areas of air/vapor barrier assembly that have failed adhesion tests at no additional expense to the Owner.

1.12 COORDINATION

- A. Coordinate installation of air/vapor barrier system with the schedule of temporary heating of the building. Air/vapor barrier system shall be fully covered by exterior insulation before heat is turned on within building to prevent buildup of moisture on the backside of the air/vapor barrier system.

1.13 WARRANTY

- A. General: Special warranties specified in this Section shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and will be in addition to and run concurrent with other warranties made by Contractor under requirements of the Contract Documents.
- B. Manufacturer's System Warranty: Written system warranty, signed by air/vapor barrier manufacturer agreeing to replace air/vapor barrier system materials and accessories which fail to achieve specified air tightness and vapor seal, exhibit loss of adhesion or cohesion, or do not cure within specified warranty period.
 1. Warranty Period: Manufacturer's standard warranty, not less than five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 FLUID-APPLIED AIR/VAPOR BARRIER SYSTEM MATERIALS

- A. Single Source Responsibility: Obtain air/vapor barrier materials, including transition tapes, sealant, primers, mastics and adhesives, from a single manufacturer for a complete assembly.
- B. Fluid-Applied Air/Vapor Barrier Membrane: Provide 60 mil DFT fluid-applied membrane and accessory products of inherent, fire-resistant composition complying with NFPA 285 for use as an air/vapor barrier on exterior walls, application temperature above 40 degrees F.
 1. Basis-of-Design: Subject to compliance with requirements, provide Air-Bloc 32MR manufactured by Henry Company, Contact - Scott Walker 978-317-9521, or the following product:
 - a. Carlisle Coatings and Waterproofing, Inc.; Fire Resist Barritech NP.
 - b. GCP Applied Technologies; Perm-A-Barrier NPL 10 Air and Vapor Barrier.
 2. Average dry film thickness of 60 mils is specified for the fluid-applied membrane. 60 mil air-vapor barrier provides material to provide consistent seal around cladding attachment screw fasteners to prevent water penetration.

- C. Detail Flashing Strip/Transition Strip: Self-adhering, membrane strip, varying widths as needed for detailing, but not less than 3 inches wide; approved for use with fire-resistant air barrier membrane in NFPA 285 wall assemblies and as recommended by air barrier manufacturer.
 - 1. Products:
 - a. Henry Company; Blueskin SA.
 - b. Carlisle Coatings and Waterproofing, Inc.; CCW 705 FR-A.
 - c. GCP Applied Technologies (formerly W. R. Grace); Perm-A-Barrier Detail Membrane.
 - 2. Detail flashing shall only be used in concealed locations behind wall insulation where it will not be exposed to ultraviolet light from sunlight.
- D. Aluminum Clad Flashing/Transition Strip: 40-mil thick, self-adhering membrane strip integrally bonded to a surface layer of metallic aluminium film with with silicone-coated release paper on adhesive side; approved for use with fire-resistant air barrier membrane in NFPA 285 wall assemblies.
 - 1. Products:
 - a. Henry Company; Blueskin Metal Clad.
 - b. Carlisle Coatings and Waterproofing, Inc.; AlumaGRIP-701.
 - c. Grace Construction Products; Perm-A-Barrier Aluminum Flashing.
 - 2. Aluminum clad flashing/transition strip shall be used to wrap all blocking, and to make all transitions exposed within the rainscreen cavity. Air vapor barrier components exposed within the rainscreen cavity shall be permanently resistant to UV light.
- E. Transition Strip between Air/Vapor System and EPDM Membrane Roofing: 30 mils thick minimum, consisting of slip-resisting polyethylene-film top surface laminated to layer of butyl rubber adhesive, with a disposable silicone-coated release-paper backing; cold applied; approved for use with fire-resistant air barrier membrane in NFPA 285 wall assemblies. Do not use asphaltic based flashing strips to transition between air/vapor barrier and roofing.
- F. Primer: Water-based liquid primer for concrete, masonry, gypsum sheathing, extruded polystyrene, wood, metal, and painted substrates as recommended by air/vapor barrier system manufacturer for application indicated.
- G. Transition Strip Primer: Water-based liquid primer for application indicated.
- H. Mastic, Adhesives, and Tape: Liquid mastics, adhesives, and tapes as recommended by air/vapor barrier manufacturer for indicated applications.
- I. Concrete Conditioner: Latex-based, water-dispersible liquid for concrete substrate preparation applied before application of self-adhered membranes and tapes.
- J. Termination Mastic: Two part, elastomeric, cold-applied, trowel grade material designed for use with self-adhered membranes and tapes; 100 g/l maximum VOC content.
- K. Preformed Silicone Extrusion: Manufacturer's standard system consisting of cured low-modulus silicone extrusion, sized to fit opening widths, with a single-component, neutral-curing, Class 100/50 (low-modulus) silicone sealant for bonding ex
- L. trusions to substrates.
 - 1. Products:
 - a. Pecora Sil-Span; Pecora Corporation.

- b. Dow 1-2-3; Dow Corning Corporation.
- M. Sealants: Provide in accordance with Division 07 Section "Joint Sealants" and ASTM C 920 classifications for type, grade, class, and uses.
 - 1. Sealant: Single component, neutral curing, low modulus, approved by the air/vapor system manufacturer.
 - a. Location: To seal sheet membrane flashing to polyethylene face of sheet rubberized-asphalt barrier and to seal between and to non-bituminous sheet systems.
 - b. Products:
 - 1) Dow Corning Corporation; Dow 790.
 - 2) GE Advanced Materials - Silicones; SilPruf or SilPruf LM.
 - 3) Pecora Corporation; 890, 891 or 895 Silicone Sealant.
 - 2. SPF (Sprayed Polyurethane Foam) Sealant: Provide one- or two-component, foamed-in-place, polyurethane foam sealant with the following characteristics:
 - a. Density: 1.5 to 2.0 PCF.
 - b. Flame Spread (ASTM E162): 25 or less.
 - c. Initial R-Value (at 1 inch): Not less than 7.
 - d. Products:
 - 1) Dow Chemical Co.; Great Stuff PRO Window & Door.
 - 2) Fomo Products Inc.; Handi-Seal Window and Door Sealant.
 - 3) Convenience Products; No-Warp Foam Window & Door Insulating Sealant.
 - 3. Termination Sealant: One part STPE polymer sealant.
 - a. Henry Company; 925 BRS Sealant, one part STPE polymer sealant.
 - b. Carlisle Coatings and Waterproofing, Inc.; BarriBond, one part STPE polymer sealant.
 - c. GCP Applied Technologies; Perm-A-Barrier; S-100 silicone
- N. Detailing Metal: 0.032 inch thick aluminum sheet.

2.2 EQUIPMENT

- A. Sprayer: Airless spray equipment approved by air/vapor barrier manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions as each area is completed for air/vapor barrier system application, with Installer present, to verify that surfaces are sound, dry, even, and free of oil, grease, dirt, excess mortar or other contaminants that are detrimental to the adhesion of air/vapor barrier system materials.
 - 1. Concrete Substrates: Verify that concrete has cured and aged for minimum time period recommended by air/vapor barrier system manufacturer; that concrete is visibly dry and free of moisture; and that concrete surfaces are smooth without large voids, spalled areas or sharp protrusions.
 - a. Test for capillary moisture by plastic sheet method according to ASTM D 4263.
 - 2. Masonry Surfaces: Verify that masonry joints are flush and completely filled with mortar, and all excess mortar sitting on masonry ties has been removed.

3. Gypsum Sheathing: Verify that boards are sufficiently stabilized with corners and edges fastened with appropriate screws at proper spacing.
 4. If unacceptable conditions are encountered, prepare written report, endorsed by Applicator, listing conditions detrimental to performance of work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 SURFACE PREPARATION

- A. Clean, prepare, and treat substrate according to manufacturer's written instructions. Provide clean, dust-free, and dry substrate for air/vapor barrier membrane application.
- B. Mask off adjoining surfaces not covered by air/vapor barrier system to prevent spillage and overspray affecting other construction.
- C. Concrete Substrates:
1. Remove grease, oil, bitumen, form-release agents, paints, curing compounds, and other penetrating contaminants or film-forming coatings from concrete. Remove fins, ridges, mortar, and other projections and fill honeycomb, aggregate pockets, holes, and other voids.
 2. Prime with conditioning primer when installing modified asphalt membrane transition membranes. Apply primer at required rate and allow to dry. Limit priming to areas that will be covered by air/vapor barrier in same day. Reprime areas exposed for more than 24 hours.
- D. Concrete and Masonry Joint Treatment: Prepare, treat, rout, and fill joints and cracks in substrate according to ASTM C 1193 and air/vapor barrier manufacturer's written instructions. Remove dust and dirt from joints and cracks complying with ASTM D 4258 before coating surfaces.
1. Seal cracks over 1/16 inches in masonry and concrete with a strip of self-adhering transition membrane lapped a minimum of 1-1/2 inches on both sides of the crack.
 - a. Prime surfaces as per manufacturers' instructions and allow to dry.
 - b. Align and position self-adhering transition membrane, remove protective film and press firmly into place. Ensure minimum 2 inches overlap at all end and side laps of membrane.
 - c. Roll all laps and membrane with a counter top roller to ensure seal.
 2. Prime substrate and apply a single thickness of preparation coat strip extending a minimum of 3 inches along each side of joints and cracks. Apply a double thickness of air barrier membrane and embed a joint reinforcing strip in preparation coat.
- E. Glass-Mat Gypsum Sheathing Panels:
1. Seal joints 1/4-inch or less between panels with manufacturer approved joint treatment sealant ensuring contact with all edges of board. Strike flush any excess sealant over joint layer to form a continuous layer over the joint.
 2. Seal gaps and voids or irregular joints greater than 1/4-inch between panels with a strip of self-adhered air barrier transition membrane lapped a minimum of 1-1/2 inches on both sides of the joint.
 - a. Prime surfaces as per manufacturers' instructions and allow to dry.
 - b. Align and position self-adhering air barrier transition membrane, remove protective film and press firmly into place. Ensure minimum 2 inches overlap at all end and side laps of membrane.

- c. Roll all laps and membrane with a counter top roller to ensure seal.
 - 3. Inside and Outside Corners: Seal inside and outside corners of sheathing boards with a strip of self-adhering transition membrane extending a minimum of 3 inches on each side of the corner detail.
 - a. Prime surfaces as per manufacturers' instructions and allow to dry.
 - b. Align and position self-adhering transition membrane, remove protective film and press firmly into place. Ensure minimum 2 inches overlap at all end and side laps of membrane.
 - c. Roll all laps and membrane with a counter top roller to ensure seal.
 - F. Prime wood, metal, and painted substrates with primer recommended by membrane manufacturer.
 - G. Fill gaps between different substrate systems to form a smooth transition from one plane to another; fill gaps between substrates and window, door, storefront systems, and curtain wall systems; and fill miscellaneous penetrations in substrates with sealant.
 - 1. Apply foam sealant in gaps up to 2 inches wide.
 - 2. Apply insulation foam sealant in gaps greater than 2 inches wide.
 - 3. Cover sealants with aluminum sheet metal or other substrate material approved by the air/vapor barrier manufacturer, providing a permanent air/vapor barrier transition attachment.
 - 4. Apply sealant within recommended application temperature ranges. Consult manufacturer when sealant cannot be applied within these temperature ranges.
 - H. Bridge and cover control joints, expansion joints, and discontinuous deck-to-wall and deck-to-deck joints with overlapping sheet strips.
 - 1. Invert and loosely lay first sheet strip over center of joint. Firmly adhere second sheet strip to first and overlap to substrate.
 - I. Prepare, treat, and seal vertical and horizontal surfaces at terminations and penetrations through air/vapor barrier system and at protrusions according to air/vapor barrier system manufacturer's written instructions.
- 3.3 INSTALLATION, GENERAL
- A. Strictly comply with air/vapor barrier membrane manufacturer's printed instructions, approved submittals and the following:
 - 1. Apply materials within manufacturer's requirements for temperature and weather conditions.
 - 2. Do not apply to wet or frozen substrates.
 - 3. Do not allow contamination with dust or dirt.
 - 4. Seal completely at edges, perimeter and penetrations.
 - 5. Wrap membrane around perimeter of window openings, so the window systems can be caulked around the interior perimeter of the opening, sealing between edge of window and air/vapor barrier membrane. In addition, strip flash nailing flanges around perimeter of windows.
 - 6. Wrap membrane around perimeter of openings for storefront and curtain wall systems, so the storefront and curtain wall systems can be caulked around the interior perimeter of the opening, sealing between edge of storefront/curtain wall systems and air/vapor barrier membrane.
 - 7. Dry film thickness shall be not less than specified.

- B. Spray apply air/vapor membrane using airless spray equipment. Use cross-hatching technique (alternating horizontal and vertical passes) to ensure complete coverage of substrate and transition strips and even thickness of air/vapor barrier. Seal to penetrations to achieve an airtight and watertight envelope.
- C. Treat construction joints and install flashings as recommended by manufacturer.

3.4 FLUID-APPLIED AIR/VAPOR BARRIER SYSTEM INSTALLATION

- A. Apply air/vapor barrier in a continuous, uniform film using multiple, overlapping passes to achieve an average dry film thickness of 60 mils. Thickness specified is required to assure proper coverage even if manufacturer allows thinner film thickness.
 - 1. 60 mil air-vapor barrier provides material that provides proper seal around cladding attachment screw fasteners.
- B. Inspect sprayed surfaces and fill any remaining gaps.
- C. Application of Transition Membrane:
 - 1. Allow spray-applied membrane to cure to tack-free. Apply transition membrane with an overlap of not less than 3 inches onto each surface at all beams, columns and joints as indicated in detail drawings and on approved Shop Drawings.
 - 2. Tie in to window and door frames, storefront framing, curtain wall systems, louvers, roof and floor intersections and changes in substrate.
 - 3. Use pre-cut, easily handled lengths for each location.
 - 4. Remove release paper and position flashing carefully before placing it against the surface. Install membrane in tight intimate contact with substrate without stretching. Bend membrane to fit tightly into inside corners, without gaps and without stretching membrane.
 - 5. When properly positioned, place against surface by pressing firmly into place with a hand roller.
 - 6. Overlap adjacent pieces not less than 2 inches and roll all seams with a hand roller.
 - 7. Seal top edge of transition membranes and flashing with termination mastic.
 - 8. Apply liquid membrane to all fastener heads, overlapping board not less than 1 inch.
- D. Transition Strip Flashing to Door and Louver Frames, and Storefront and Curtain Wall Perimeters: Prime all surfaces in accordance with recommendations of air/vapor barrier manufacturer. Lap transition strip from wall substrate with not less than 3 inches of full contact over firm bearing to penetration frame with not less than 1 inch of full contact.
 - 1. Apply primer to substrates at required rate and allow to dry thoroughly. Adjust time for drying, based upon ambient temperature, humidity and weather conditions. Limit priming to areas that will be covered by air/vapor barrier sheet in same day. Reprime areas exposed for more than 24 hours.
 - 2. Secure rubberized asphalt membrane flashings to substrates, membrane, and frames using roller to assure proper adhesion. Seal head, jamb and sill flashing at door, louvers, and windows, and aluminum storefront and curtain wall perimeters, making permanently weather tight.
 - 3. Set extruded preformed silicone flashings in full bed of low modulus silicone sealant.
- E. Aluminum Windows: After window receptors are installed, strip in around windows with transition strip flashing adhering to the air/vapor barrier and the nailing fin. Caulk around

perimeter of window with termination sealant, sealing the edge of the membrane and onto the window frame to provide a water tight seal.

- F. Transition Areas: Tie-in to structural beams, columns, floor slabs and intermittent floors, parapet curbs, foundation walls, roofing systems and at the interface of dissimilar materials as indicated in approved shop drawings with self-adhering air barrier transition membrane.
 - 1. Prime surfaces as per manufacturer's instructions and allow to dry.
 - 2. Align and position self-adhering transition membrane, remove protective film and press firmly into place. Provide minimum 3 inch lap to all substrates.
 - 3. Ensure minimum 2 inch overlap at all end and side laps of membrane.
 - 4. Roll all laps and membrane with a counter top roller to ensure seal.
- G. At base of walls, apply air/vapor barrier to seal transition between top of foundation and wall. Apply air/vapor to back and bottom of brick shelves, stopping barrier 1 inch back from outside face of foundation wall.
- H. Apply sealant within recommended application temperature ranges. Consult manufacturer when sealant cannot be applied within these temperature ranges.

3.5 APPLICATION OF TERMINATION SEALANT

- A. Seal membrane terminations, heads of mechanical fasteners, masonry tie fasteners, around penetrations, duct work, electrical and other apparatus extending through the primary water resistive air barrier membrane and around the perimeter edge of membrane terminations at window and door frames with specified termination sealant.

3.6 FIELD QUALITY CONTROL

- A. Commissioning Agent: In addition to testing performed by the Contractor, the Owner will hire a commissioning agent to perform field tests and inspections, and to prepare test reports. Allow inspectors access to scaffolding and work areas, as needed to perform inspections and tests.
 - 1. Air/vapor barrier system will be tested for air infiltration and bond adhesion in compliance with requirements.
 - 2. Air/vapor barrier system film thickness will be measured.
 - 3. Installed window tie-in with air/vapor barrier system will be tested for air leakage and water infiltration.
 - 4. Cooperate and coordinate with the Owner's commissioning agent.
- B. Remove and replace applications of air/vapor barrier membrane where test results indicate that it does not comply with specified requirements.
- C. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
- D. Do not cover air/vapor barrier membrane until field quality control testing has been completed.
- E. The Owner will be hiring a commissioning agent to perform water and air testing of installed windows. If air/vapor barrier tie-in to the window fails testing, correct the installation deficiencies. Windows shall be retested, with testing paid for by the Contractor.

3.7 CLEANING, PROTECTING, AND REPAIR

- A. Cleaning: Immediately after completing spraying operations, remove material overspray and fallout from surfaces of other construction not to be coated and clean exposed surfaces to remove evidence of soiling.
 - 1. Clean spillage and soiling from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.
- B. Repair damage to air/vapor barrier membrane caused by construction activities or subsequent work prior to covering membrane.
- C. Schedule work to ensure that the air/vapor barrier system is covered as soon as possible after application and inspection. Protect completed work from weather and exposure during application and cure of materials. Protect air/vapor barrier system from damage during subsequent operations. If the air/vapor barrier system cannot be covered within 30 days after installation, apply temporary UV protection such as dark plastic sheet or tarpaulins.

END OF SECTION 072726

SECTION 074113 - METAL ROOF PANELS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Standing-seam metal roof panels.
 - 2. Flat-seam metal roof and soffit panels.
- B. Related Sections:
 - 1. Division 07 Section "Joint Sealants" for field-applied sealants not otherwise specified in this Section.

1.3 DEFINITIONS

- A. Metal Roof Panel Assembly: Metal roof panels, attachment system components, insulation, and accessories necessary for a complete weathertight roofing system.

1.4 PERFORMANCE REQUIREMENTS

- A. General Performance: Metal roof panels shall comply with performance requirements without failure due to defective manufacture, fabrication, installation, or other defects in construction.
- B. Delegated Design: Design metal roof panel assembly, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- C. Air Infiltration: Air leakage through assembly of not more than 0.06 cfm/sq. ft. of roof area when tested according to ASTM E 1680 at the following test-pressure difference:
 - 1. Test-Pressure Difference: Negative 1.57 lbf/sq. ft..
 - 2. Test-Pressure Difference: Positive and negative 1.57 lbf/sq. ft..
 - 3. Positive Preload Test-Pressure Difference: Greater than or equal to 15.0 lbf/sq. ft. and the greater of 75 percent of building live load or 50 percent of building design positive wind-pressure difference.
 - 4. Negative Preload Test-Pressure Difference: 50 percent of design wind-uplift-pressure difference.
- D. Water Penetration: No water penetration when tested according to ASTM E 1646 at the following test-pressure difference:
 - 1. Test-Pressure Difference: 2.86 lbf/sq. ft..
 - 2. Test-Pressure Difference: 20 percent of positive design wind pressure, but not less than 6.24 lbf/sq. ft. and not more than 12.0 lbf/sq. ft..

3. Positive Preload Test-Pressure Difference: Greater than or equal to 15.0 lbf/sq. ft. and the greater of 75 percent of building live load or 50 percent of building design positive wind-pressure difference.
 4. Negative Preload Test-Pressure Difference: 50 percent of design wind-uplift-pressure difference.
- E. Hydrostatic-Head Resistance: No water penetration when tested according to ASTM E 2140.
- F. Wind-Uplift Resistance: Provide metal roof panel assemblies that comply with UL 580 for wind-uplift-resistance class indicated.
1. Uplift Rating: UL 90.
- G. Thermal Movements: Allow for thermal movements resulting from ambient and surface temperature changes. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

1.5 SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of roof panel and accessory.
- B. Shop Drawings: Show fabrication and installation layouts of metal roof panels; details of edge conditions, side-seam and endlap joints, panel profiles, corners, anchorages, trim, flashings, closures, and accessories; and special details. Distinguish between factory- and field-assembled work.
1. Accessories: Include details of the following items, at a scale of not less than 1-1/2 inches per 12 inches:
 - a. Flashing and trim.
 - b. Snow guards.
- C. Samples for Initial Selection: For each type of metal roof panel indicated with factory-applied color finishes.
1. Include similar Samples of trim and accessories involving color selection.
- D. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below:
1. Metal Roof Panels: 12 inches long by actual panel width. Include fasteners, clips, closures, and other metal roof panel accessories.
 2. Trim and Closures: 12 inches long. Include fasteners and other exposed accessories.
 3. Accessories: 12-inch- long Samples for each type of accessory.
- E. Delegated-Design Submittal: For metal roof panel assembly 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. Snow Retention System Calculations: Include calculation of number and location of snow guards based on snow load, roof slope, panel length and finish, and seam type and spacing.

- F. Coordination Drawings: Roof plans, drawn to scale, on which the following are shown and coordinated with each other, based on input from installers of the items involved:
 - 1. Roof panels and attachments.
 - 2. Roof-mounted items including roof hatches, equipment supports, pipe supports and penetrations, lighting fixtures, snow guards, and items mounted on roof curbs.
- G. Manufacturer Certificates: Signed by manufacturer certifying that roof panels comply with energy performance requirements specified in "Performance Requirements" Article.
 - 1. Submit evidence of meeting performance requirements.
- H. Qualification Data: For qualified Installer.
- I. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for each product.
- J. Field quality-control reports.
- K. Maintenance Data: For metal roof panels to include in maintenance manuals.
- L. Warranties: Samples of special warranties.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: An employer of workers trained and approved by manufacturer.
- B. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.
- C. Source Limitations: Obtain each type of metal roof panels from single source from single manufacturer.
- D. Preinstallation Conference: Conduct conference at Project site.
 - 1. Meet with Owner, Architect, Owner's insurer if applicable, testing and inspecting agency representative, metal roof panel Installer, metal roof panel manufacturer's representative, deck Installer, and installers whose work interfaces with or affects metal roof panels including installers of roof accessories and roof-mounted equipment.
 - 2. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
 - 3. Review methods and procedures related to metal roof panel installation, including manufacturer's written instructions.
 - 4. Examine deck substrate conditions for compliance with requirements, including flatness and attachment to structural members.
 - 5. Review structural loading limitations of deck during and after roofing.
 - 6. Review flashings, special roof details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that will affect metal roof panels.
 - 7. Review governing regulations and requirements for insurance, certificates, and testing and inspecting if applicable.
 - 8. Review temporary protection requirements for metal roof panel assembly during and after installation.
 - 9. Review roof observation and repair procedures after metal roof panel installation.
 - 10. Document proceedings, including corrective measures and actions required, and furnish copy of record to each participant.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver components, sheets, metal roof panels, and other manufactured items so as not to be damaged or deformed. Package metal roof panels for protection during transportation and handling.
- B. Unload, store, and erect metal roof panels in a manner to prevent bending, warping, twisting, and surface damage.
- C. Stack metal roof panels on platforms or pallets, covered with suitable weathertight and ventilated covering. Store metal roof panels to ensure dryness. Do not store metal roof panels in contact with other materials that might cause staining, denting, or other surface damage.
- D. Protect strippable protective covering on metal roof panels from exposure to sunlight and high humidity, except to extent necessary for period of metal roof panel installation.

1.8 PROJECT CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit metal roof panel work to be performed according to manufacturer's written instructions and warranty requirements.
- B. Field Measurements: Verify actual dimensions of construction contiguous with metal roof panels by field measurements before fabrication.

1.9 COORDINATION

- A. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.
- B. Coordinate metal roof panels with rain drainage work, flashing, trim, and construction of decks, parapets, walls, and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

1.10 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace metal roof panel assemblies that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures including rupturing, cracking, or puncturing.
 - b. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
 - 2. Warranty Period: Two years from date of Substantial Completion.
- B. Special Warranty on Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal roof panels that show evidence of deterioration of factory-applied finishes within specified warranty period.
 - 1. Exposed Panel Finish: Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.

- b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
 - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
 - 2. Finish Warranty Period: 20 years from date of Substantial Completion.
- C. Special Weathertightness Warranty for Standing-Seam Metal Roof Panels: Manufacturer's standard form in which manufacturer agrees to repair or replace standing-seam metal roof panel assemblies that fail to remain weathertight, including leaks, within specified warranty period.
- 1. Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PANEL MATERIALS

- A. Metallic-Coated Steel Sheet: Restricted flatness steel sheet metallic coated by the hot-dip process and prepainted by the coil-coating process to comply with ASTM A 755/A 755M.
- 1. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A 792/A 792M, Class AZ50 coating designation, Grade 40; structural quality.
 - 2. Surface: Smooth, flat finish.
 - 3. Exposed Coil-Coated Finish:
 - a. 2-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 - 4. Concealed Finish: Apply pretreatment and manufacturer's standard white or light-colored acrylic or polyester backer finish, consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil.
- B. Panel Sealants:
- 1. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape 1/2 inch wide and 1/8 inch thick.
 - 2. Joint Sealant: ASTM C 920; elastomeric polyurethane, polysulfide, or silicone sealant; of type, grade, class, and use classifications required to seal joints in metal roof panels and remain weathertight; and as recommended in writing by metal roof panel manufacturer.
 - 3. Butyl-Rubber-Based, Solvent-Release Sealant: ASTM C 1311.

2.2 UNDERLAYMENT MATERIALS

- A. Self-Adhering, High-Temperature Sheet (Waterproof Underlayment): 30 to 40 mils thick minimum, consisting of slip-resisting, polyethylene-film top surface laminated to layer of butyl or SBS-modified asphalt adhesive, with release-paper backing; cold applied. Provide primer when recommended by underlayment manufacturer.
- 1. Low-Temperature Flexibility: Passes after testing at minus 20 deg F; ASTM D 1970.
 - 2. Products: Subject to compliance with requirements, provide one of the following:
 - a. Carlisle Coatings & Waterproofing Inc., Div. of Carlisle Companies Inc.; CCW WIP 300HT.
 - b. CETCO; StrongSeal SA.
 - c. Grace Construction Products; a unit of Grace, W. R. & Co.; Ice & Water Shield HT.

- d. Henry Company; Blueskin PE200 HT.
 - e. Metal-Fab Manufacturing, LLC; MetShield.
- B. Felts: ASTM D 226, Type II (No. 30), asphalt-saturated organic felts.
- C. Slip Sheet: Manufacturer's recommended slip sheet, of type required for application.

2.3 MISCELLANEOUS MATERIALS

- A. Panel Fasteners: Self-tapping screws, bolts, nuts, self-locking rivets and bolts, end-welded studs, and other suitable fasteners designed to withstand design loads. Provide exposed fasteners with heads matching color of metal roof panels by means of plastic caps or factory-applied coating. Provide EPDM, PVC, or neoprene sealing washers.
- B. Bituminous Coating: Cold-applied asphalt mastic, SSPC-Paint 12, compounded for 15-mil dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.
- C. Molded Polystyrene Insulation Board, Type IX: ASTM C 578, Type IX, 25-psi minimum compressive strength.
1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Insulfoam LLC; a Carlisle company.

2.4 CONCEALED-FASTENER, LAP-SEAM METAL ROOF PANELS

- A. General: Provide factory-formed metal roof panels designed to be installed by lapping and interconnecting side edges of adjacent panels and mechanically attaching through panel to supports using concealed fasteners and factory-applied sealant in side laps. Include accessories required for weathertight installation.
- B. Standing-Seam-Profile, Concealed-Fastener Metal Roof Panels: Formed with raised, curved-top, standing-seam-shaped major rib at panel edge and flat pan between major rib and panel edge.
1. Basis-of-Design Product: Subject to compliance with requirements, provide SLR 12" and 18" by Morin or comparable product by one of the following:
 - a. Cheney Flashing Company.
 - b. Copper Sales, Inc.
 - c. Dimensional Metals, Inc.
 - d. Englert, Inc.
 - e. Firestone Metal Products.
 - f. Metal Fab Manufacturing.
 - g. Metal Sales Manufacturing Corporation.
 2. Material Aluminum-zinc alloy-coated steel sheet, 24 gage nominal thickness.
 - a. Exterior Finish: 2-coat fluoropolymer.
 - b. Color: As selected by Architect from manufacturer's full range.
 3. Panel Coverage:
 - a. Canopies: 12 inches.
 - b. Main Roofs: 18 inches.
 4. Panel Height: 1.5 inches. Provide 2 inches high at low slope roof areas.

2.5 ACCESSORIES

- A. Roof Panel Accessories: Provide components approved by roof panel manufacturer and as required for a complete metal roof panel assembly including trim, copings, fasciae, corner units, ridge closures, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal roof panels unless otherwise indicated.
 - 1. Closures: Provide closures at eaves and ridges, fabricated of same metal as metal roof panels.
 - 2. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch- thick, flexible closure strips; cut or premolded to match metal roof panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.
 - 3. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.
- B. Flashing and Trim: Formed from same material and thickness as roof panels. Provide flashing and trim as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, eaves, rakes, corners, bases, framed openings, ridges, fasciae, and fillers. Finish flashing and trim with same finish system as adjacent metal roof panels.

2.6 FABRICATION

- A. Fabricate and finish metal roof panels and accessories at the factory to greatest extent possible, by manufacturer's standard procedures and processes and as necessary to fulfill indicated performance requirements. Comply with indicated profiles and with dimensional and structural requirements.
- B. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel.
- C. Flat-Seam Roofing and Soffit: Form flat-seam panels from metal sheets 20 by 28 inches with 1/2-inch notched and folded edges.
- D. Fabricate metal roof panel side laps with factory-installed captive gaskets or separator strips that provide a tight seal and prevent metal-to-metal contact, in a manner that will seal weathertight and minimize noise from movements within panel assembly.
- E. Sheet Metal Accessories: Fabricate flashing and trim to comply with recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to the design, dimensions, metal, and other characteristics of item indicated.
 - 1. Form exposed sheet metal accessories that are without excessive oil canning, buckling, and tool marks and that are true to line and levels indicated, with exposed edges folded back to form hems.
 - 2. End Seams for Other Than Aluminum: Fabricate nonmoving seams with flat-lock seams. Tin edges to be seamed, form seams, and solder.
 - 3. Sealed Joints: Form nonexpansion but movable joints in metal to accommodate elastomeric sealant to comply with SMACNA standards.
 - 4. Conceal fasteners and expansion provisions where possible. Exposed fasteners are not allowed on faces of accessories exposed to view.

5. Fabricate cleats and attachment devices of size and metal thickness recommended by SMACNA's "Architectural Sheet Metal Manual" or by metal roof panel manufacturer for application, but not less than thickness of metal being secured.

2.7 FINISHES

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. 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, metal roof panel supports, and other conditions affecting performance of the Work.
- B. Examine primary and secondary roof framing to verify that rafters, purlins, angles, channels, and other structural panel support members and anchorages have been installed within alignment tolerances required by metal roof panel manufacturer.
- C. Examine solid roof sheathing to verify that sheathing joints are supported by framing or blocking and that installation is within flatness tolerances required by metal roof panel manufacturer.
- D. Examine roughing-in for components and systems penetrating metal roof panels to verify actual locations of penetrations relative to seam locations of metal roof panels before metal roof panel installation.
- E. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Clean substrates of substances harmful to insulation, including removing projections capable of interfering with insulation attachment.

3.3 THERMAL INSULATION INSTALLATION

- A. Board Insulation: Extend insulation in thickness indicated to cover entire area.

1. Erect insulation horizontally and hold in place with fasteners until metal roofing and soffit is installed.

3.4 UNDERLAYMENT INSTALLATION

- A. Self-Adhering Sheet Underlayment: Apply primer if required by manufacturer. Comply with temperature restrictions of underlayment manufacturer for installation. Apply at locations indicated below, wrinkle free, in shingle fashion to shed water, and with end laps of not less than 6 inches staggered 24 inches between courses. Overlap side edges not less than 3-1/2 inches. Roll laps with roller. Cover underlayment within 14 days.
 1. Over roof areas indicated on the drawings.
- B. Felt Underlayment: Apply at locations indicated below, in shingle fashion to shed water, and with lapped joints of not less than 2 inches.
 1. Apply on roof not covered by self-adhering sheet underlayment. Lap over edges of self-adhering sheet underlayment not less than 3 inches, in shingle fashion to shed water.
- C. Apply slip sheet over underlayment before installing metal roof panels.
- D. Install flashings to cover underlayment to comply with requirements specified in Division 07 Section "Sheet Metal Flashing and Trim."

3.5 METAL ROOF PANEL INSTALLATION, GENERAL

- A. Provide metal roof panels of full length from eave to ridge unless otherwise indicated or restricted by shipping limitations.
- B. Thermal Movement. Rigidly fasten metal roof panels to structure at one and only one location for each panel. Allow remainder of panel to move freely for thermal expansion and contraction. Predrill panels for fasteners.
 1. Point of Fixity: Fasten each panel along a single line of fixing located at center of panel length.
 2. Avoid attaching accessories through roof panels in a manner that will inhibit thermal movement.
- C. Install metal roof panels as follows:
 1. Commence metal roof panel installation and install minimum of 300 sq. ft. in presence of factory-authorized representative.
 2. Field cutting of metal panels by torch is not permitted.
 3. Install panels perpendicular to purlins.
 4. Locate and space fastenings in uniform vertical and horizontal alignment.
 5. Provide metal closures at rake edges.
 6. Flash and seal metal roof panels with weather closures at eaves, rakes, and perimeter of all openings.
 7. Install ridge caps as metal roof panel work proceeds.
 8. End Splices: Locate panel end splices over, but not attached to, structural supports. Stagger panel end splices to avoid a four-panel splice condition.
 9. Install metal flashing to allow moisture to run over and off metal roof panels.
- D. Fasteners:

1. Steel Roof Panels: Use stainless-steel fasteners for surfaces exposed to the exterior and galvanized-steel fasteners for surfaces exposed to the interior.
- E. Anchor Clips: Anchor metal roof panels and other components of the Work securely in place, using manufacturer's approved fasteners according to manufacturers' written instructions.
- F. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with bituminous coating, by applying rubberized-asphalt underlayment to each contact surface, or by other permanent separation as recommended by metal roof panel manufacturer.
 1. Coat back side of roof panels with bituminous coating where roof panels will contact wood, ferrous metal, or cementitious construction.
- G. Joint Sealers: Install gaskets, joint fillers, and sealants where indicated and where required for weatherproof performance of metal roof panel assemblies. Provide types of gaskets, fillers, and sealants indicated or, if not indicated, types recommended by metal roof panel manufacturer.
 1. Seal metal roof panel end laps with double beads of tape or sealant, full width of panel. Seal side joints where recommended by metal roof panel manufacturer.
 2. Prepare joints and apply sealants to comply with requirements in Division 07 Section "Joint Sealants."

3.6 METAL ROOF PANEL INSTALLATION

- A. Standing-Seam Metal Roof Panels: Fasten metal roof panels to supports with concealed clips at each standing-seam joint at location, spacing, and with fasteners recommended by manufacturer.
 1. Install clips to supports with self-tapping fasteners.
 2. Install pressure plates at locations indicated in manufacturer's written installation instructions.
 3. Seamed Joint: Crimp standing seams with manufacturer-approved, motorized seamer tool so clip, metal roof panel, and factory-applied sealant are completely engaged.
- B. Flat-Seam Roofing and Soffit: Attach flat-seam metal panels to substrate with cleats, starting at eave and working upward toward ridge. After panels are in place, mallet seams tight and solder.
 1. Attach roofing panels with cleats spaced not more than 24 inches o.c. Lock and solder panels to base flashing.
 2. Attach edge flashing to face of roof edge with continuous cleat fastened to roof substrate at 12-inch o.c. spacing. Lock panels to edge flashing and apply sealant.

3.7 ACCESSORY INSTALLATION

- A. General: Install accessories with positive anchorage to building and weathertight mounting and provide for thermal expansion. Coordinate installation with flashings and other components.
 1. Install components required for a complete metal roof panel assembly including trim, copings, ridge closures, seam covers, flashings, sealants, gaskets, fillers, closure strips, and similar items.
- B. Flashing and Trim: Comply with performance requirements, manufacturer's written installation instructions, and SMACNA's "Architectural Sheet Metal Manual." Provide concealed fasteners where possible, and set units true to line and level as indicated. Install work with laps, joints, and seams that will be permanently watertight and weather resistant.

1. Install exposed flashing and trim that is without excessive oil canning, buckling, and tool marks and that is true to line and levels indicated, with exposed edges folded back to form hems. Install sheet metal flashing and trim to fit substrates and to result in waterproof and weather-resistant performance.
 2. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet with no joints allowed within 24 inches of corner or intersection. Where lapped expansion provisions cannot be used or would not be sufficiently weather resistant and waterproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with mastic sealant (concealed within joints).
- C. Pipe Flashing: Form flashing around pipe penetration and metal roof panels. Fasten and seal to metal roof panels as recommended by manufacturer.

3.8 ERECTION TOLERANCES

- A. Installation Tolerances: Shim and align metal roof panel units within installed tolerance of 1/4 inch in 20 feet on slope and location lines as indicated and within 1/8-inch offset of adjoining faces and of alignment of matching profiles.

3.9 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect metal roof panel installation, including accessories. Report results in writing.
- B. Remove and replace applications of metal roof panels where inspections indicate that they do not comply with specified requirements.
- C. Additional inspections, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.10 CLEANING

- A. Remove temporary protective coverings and strippable films, if any, as metal roof panels are installed unless otherwise indicated in manufacturer's written installation instructions. On completion of metal roof panel installation, clean finished surfaces as recommended by metal roof panel manufacturer. Maintain in a clean condition during construction.
- B. Replace metal roof panels that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 074113

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SECTION 075323 - ETHYLENE-PROPYLENE-DIENE-MONOMER (EPDM) ROOFING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Adhered ethylene-propylene-diene-monomer (EPDM) roofing system.
 - 2. Substrate board.
 - 3. Vapor retarder.
 - 4. Roof insulation.
 - 5. Roof accessories, including expansion joints, and walkways.
 - 6. Protection sheet.
- B. Related Requirements:
 - 1. Division 07 Section 070800 "Building Envelope Commissioning" for Contractor's responsibilities in commissioning of building enclosure and coordination with Owner's commissioning agent..
 - 2. Division 06 Section "Rough Carpentry" for material description and installation requirements for wood nailers and blocking.
 - 3. Division 07 Section "Fluid-Applied Air/Vapor Barrier System" for tie-in with roof system.
 - 4. Division 07 Section "Sheet Metal Flashing and Trim" for metal roof flashings and counterflashings.
 - 5. Division 07 Section "Joint Sealants" for joint sealants, joint fillers, and joint preparation.
- C. Products installed, but not furnished, under this Section include the following:
 - 1. Installation of counterflashing portion of two-piece counterflashing furnished under Division 07 Section "Sheet Metal Flashing and Trim."

1.3 DEFINITIONS

- A. Roofing Terminology: Definitions in ASTM D 1079 and glossary of NRCA's "The NRCA Roofing and Waterproofing Manual" apply to work of this Section.
- B. Thermal Resistivity: Where the thermal resistivity of insulation products are designated by "r-values," they represent the reciprocal of thermal conductivity (k-values). Thermal conductivity is the rate of heat flow through a homogenous material exactly 1-inch thick. Thermal resistivities are expressed by the temperature difference in degrees F between the two exposed faces required to cause one BTU to flow through one square foot per hour at mean temperatures indicated.

1.4 PREINSTALLATION MEETINGS

- A. Preinstallation Roofing Conference: Conduct conference at Project site. Review methods and procedures related to roofing system including, but not limited to, the following:
1. Meet with Owner, Architect, Owner's commissioning agent, roofing Installer, roofing system manufacturer's representative, deck Installer, and installers whose work interfaces with or affects roofing.
 2. Review methods and procedures related to roofing installation, including manufacturer's written instructions.
 3. Review and finalize construction schedule, and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
 4. Review protection of building occupants and air handlers from adhesive fumes during roof installation.
 5. Examine deck substrate conditions and finishes for compliance with requirements, including flatness and fastening.
 6. Review structural loading limitations of roof deck during and after roofing.
 7. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that affects roofing system.
 8. Review governing regulations and requirements for insurance and certificates if applicable.
 9. Review construction schedule to minimize construction activities on completed roofing.
 10. Review temporary protection requirements for roofing system during and after installation.
 - a. Review staging, material placement, construction activity and pedestrian traffic protection requirements for work areas and access paths to areas where work will occur on completed roofing.
 11. Review roof observation and repair procedures after roofing installation. Establish monitoring procedures for construction activities and recording of damage by sub-trades.
 12. Document proceedings, including corrective measures and actions required, and furnish copy of record to each participant.
 13. Provide 7 business days minimum advance notice to participants prior to convening preinstallation conference.
- B. Building Envelope Commissioning: Participate in building envelope commissioning pre-construction meeting and progress meetings as required by the Contractor and the Commissioning Agent.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For roofing system. Include plans, elevations, sections, details, and attachments to other work. Customized detail sheets shall be prepared showing each condition and approved installation method conforming to construction drawing constraints and details. Provide the following:
1. Base flashings and membrane terminations.
 2. Layout of tapered insulation and cricket materials, including slopes.
 3. Roof plan showing orientation of steel roof deck and orientation of roofing and fastening spacings and patterns for mechanically fastened roofing.
 4. Insulation fastening patterns for corner, perimeter, and field-of-roof locations.

5. Roof flashing details shall be consistent with those shown on Drawings. Where cap flashing is shown, a standard manufacturer's bar anchor only detail is not acceptable. Membrane manufacturer's recommended flashing detail may be considered by the Architect when no detail is provided.
 6. Tie-in with air/vapor barrier system.
- C. Wind Uplift Resistance Submittal: For roofing system, indicating compliance with wind uplift performance requirements.

1.6 INFORMATIONAL SUBMITTALS

- A. Installer Qualification Data: For qualified Installer signed by roofing system manufacturer certifying that Installer factory trained and licensed by manufacturer to install roofing system.
- B. Product Test Reports: For components of roofing system, tests performed by manufacturer and witnessed by a qualified, independent testing agency, for components of roofing system.
1. Insulation Test Reports: Include insulation test reports evidencing compliance with specified requirements including those for thermal resistance, fire test response characteristics, water-vapor transmission, water absorption, and other properties, based on comprehensive testing of current products.
- C. Research/Evaluation Reports: For components of roofing system, from ICC-ES.
- D. Fastener-pullout test results and manufacturer's revised requirements for fastener patterns.
- E. Warranty Inspection Report: Copy of roofing system manufacturer's inspection report of completed roofing installation.
- F. Sample Warranties: For manufacturer's special warranties.

1.7 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For roofing system to include in maintenance manuals.
- B. Warranties: Special warranties specified in this Section.

1.8 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified firm that is factory trained and licensed by roofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's special warranty. Contractor shall have a minimum of 5 years experience installing the system, have installed a minimum of 500,000 square feet and shall employ personnel experienced and skilled in the application of the manufacturer's roofing system.
1. Work associated with membrane roofing including, but not limited to, insulation, flashing, and membrane sheet joint sealers, shall be performed by Installer of this Work.
- B. Roofing work shall be applied in strict accordance with the provisions of the specification criteria. No deviations shall be permitted without written consent from the Architect. Should a conflict between this specification and the manufacturer's requirements arise, the most restrictive provision as determined by the Architect shall govern.

- C. Warranty Inspection: Upon completion of the installation, an inspection shall be made by the roofing system manufacturer to ascertain that the roofing system has been installed according to applicable manufacturer's specifications and details. No "early bird" warranty will be accepted. Results of the warranty inspection shall be submitted in writing to Owner and Architect for their review and records.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Deliver roofing materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, shelf life of liquid materials, approval or listing agency markings, and manufacturer's written instructions for storing and mixing with other components. Comply with manufacturer's written instructions for proper material storage.
- B. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer. Protect stored liquid material from direct sunlight.
 - 1. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life. Replace discarded materials at no additional cost to Owner.
- C. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.
 - 1. Insulation and cover board shall be stored on pallets, not less than 4 inches off ground, tightly covered with waterproof, "breathable" materials. Protect insulation from direct sunlight.
- D. Handle and store roofing materials, and place equipment in a manner to avoid permanent deflection of deck.
 - 1. Do not overload any portion of building, either by use of or placement of equipment, storage of debris, or storage of materials. Construction loads shall not exceed 25 pounds per square foot.
- E. Materials shall be delivered in sufficient quantity to allow continuity of Work.
- F. Materials, which are damaged or beyond their stated shelf life, shall be removed and replaced at Installer's expense.

1.10 FIELD CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing system to be installed according to manufacturer's written instructions and warranty requirements.
 - 1. Weather protection shall mean the temporary protection of that work adversely affected by moisture, wind, heat, and cold by covering, patching and sealing, enclosing, ventilation, cooling and/or heat.
- B. Proceed with work so roofing materials are not subject to construction traffic. When construction traffic is necessary, roof sections shall be protected with plywood or other appropriate material to prevent damage; remove protection after construction traffic has ceased and re-inspected for possible damage to roofing.

- C. Substrate Conditions: Do not begin roofing installation until substrates have been inspected and are determined to be in satisfactory condition. All surfaces shall be smooth, dry, clean, free of fins or sharp edges, loose or foreign materials, oil or grease. No work shall proceed when moisture is present on roof or in substrate materials.
- D. Temporary Water Stops: Install at end of each workday and remove before proceeding with next day's work.
- E. Protect against fire and flame spread. Maintain proper and adequate fire extinguishers.
- F. Take precautions to prevent drains from clogging during roofing application. Remove debris at completion of each day's work and clean drains, if required. At completion, test drains to ensure system is free running and drains are watertight. Remove strainers and plug drains in areas where work is in progress. Install flags or other telltales on plugs. Remove plugs each night and screen drain.
- G. Protect roofing at access locations, work areas and construction traffic locations with plywood or other appropriate material to prevent damage to roof system. Remove upon completion of Work.
- H. If exterior walls are not erected at time of membrane installation, envelop flutes of metal deck to prevent moisture intrusion and wind damage.
- I. Coordinate shut down or covering of air-handling ducts whenever possible during roofing activities to prevent fumes from adhesives from entering the building. The covering or shut-down of air-handling ducts shall be approved by the Owner prior to starting the work.

1.11 WARRANTY

- A. Special Warranty: Manufacturer's standard or customized form, without monetary limitation, in which manufacturer agrees to repair or replace components of membrane roofing system that fail in materials or workmanship within specified warranty period. Failure includes roof leaks. The maximum wind speed coverage shall be peak gusts of 72 mph measured at 10 meters above ground level. Warrantor shall be the manufacturer of the roofing membrane. Warranty shall be written to building Owner.
 - 1. Special warranty includes membrane roofing, base flashings, roof insulation, fasteners, cover boards, substrate boards, roofing accessories, walkway products, and other components of roofing system.
 - 2. Warranty Period: 20 years from date of Substantial Completion.
- B. When the Warrantor is notified that there is a problem (leak or damage) with warranted roofing system and/or accessories by telephone, and/or in writing (fax, e-mail or mail), the response time to physically start repairs shall be within twenty-four hours from time of telephone or date of written notification.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain components including roof insulation, cover board, substrate boards, vapor barriers and fasteners for roofing system from same manufacturer as membrane roofing or manufacturer approved by membrane roofing manufacturer for a total system warranty.

2.2 PERFORMANCE REQUIREMENTS

- A. General Performance: Installed roofing and base flashings shall withstand specified uplift pressures, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Roofing and base flashings shall remain watertight.
 - 1. Accelerated Weathering: Roofing system shall withstand 2000 hours of exposure when tested according to ASTM G 152, ASTM G 154, or ASTM G 155.
 - 2. Impact Resistance: Roofing system shall resist impact damage when tested according to ASTM D 3746 or ASTM D 4272.
- B. Material Compatibility: Roofing materials shall be compatible with one another and adjacent materials under conditions of service and application required, as demonstrated by roofing manufacturer based on testing and field experience.
- C. Roofing System Design: Provide a membrane roofing system that is identical to systems that have been successfully tested by a qualified testing and inspecting agency to resist uplift pressures calculated according to IBC 2015 and ASCE 7-10 as follows:
 - 1. Ultimate Wind Speed: 120 MPH (3 Second Gust).
 - 2. Exposure Category: B.
 - 3. Roof Zone 1 - Field of Roof: Negative 26.8 psf and positive 16 psf.
 - 4. Roof Zone 2 - Perimeter (11.5 Feet from Roof Edge): Negative 36 psf and positive 16 psf.
 - 5. Roof Zone 3 - Corner (11.5 Feet from Corner in Each Direction): Negative 43.3 psf and positive 16 psf.
- D. Exterior Fire-Test Exposure: ASTM E 108 or UL 790, Class A; for application and roof slopes indicated; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
- E. Insulation Fire Performance Characteristics: Provide insulation and related materials with the fire test response characteristics specified elsewhere in this Section as determined by testing identical products per test method indicated below by UL or another testing and inspecting agency acceptable to authorities having jurisdiction. Identify materials with appropriate markings of applicable testing and inspecting agency.
 - 1. Surface Burning Characteristic: ASTM E 84.
 - 2. Fire Resistance Ratings: ASTM E 119.
 - 3. Combustion Characteristics: ASTM E 136.

2.3 ROOF SYSTEM ASSEMBLIES

- A. Fully Adhered EPDM Roof System Assembly, Roof System R1: Fully adhered roof membrane adhered to top layer of insulation. Mechanically fastened rigid insulation layers shall be installed over vapor retarder adhered to metal deck.
- B. Fully Adhered EPDM Roof System Assembly, Roof System R2: Fully adhered roof membrane adhered to tapered insulation. Mechanically fastened tapered and rigid insulation layers shall be installed over vapor retarder adhered to metal deck.
- C. Fully Adhered EPDM Roof System Assembly, Roof System R3: Fully adhered roof membrane adhered to rigid and tapered insulation. Rigid and tapered insulation mechanically fastened to the metal deck.
- D. Fully Adhered EPDM Roof System Assembly, Roof System R4: Fully adhered roof membrane adhered to tapered insulation. Tapered insulation adhered to rigid insulation shall be adhered to vapor barrier. Vapor barrier shall be installed on substrate board that is adhered to concrete deck.
- E. Fully Adhered EPDM Roof System Assembly, Roof System R5: Fully adhered roof membrane adhered to top layer of insulation. Vapor barrier shall be installed on substrate board mechanically fastened to acoustical metal deck. Fasteners shall not project below bottom of roof deck. Rigid insulation shall be adhered to vapor barrier. Second layer of roof insulation adhered to bottom layer. Tapered insulation adhered to rigid insulation
 - 1. Install acoustical insulation into deck flutes before installation of substrate board.
- F. Fully Adhered EPDM Roof System Assembly, Roof System R8 (Outbuildings – See A10-14 and A10-15): Fully adhered roof membrane adhered to cover board. Cover board mechanically fastened to plywood deck.

2.4 EPDM ROOFING

- A. EPDM: ASTM D 4637, Type I, nonreinforced, uniform, flexible EPDM sheet, providing Class A exterior rating.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Carlisle SynTec Incorporated.
 - b. Firestone Building Products.
 - c. Versico Incorporated.
 - 2. Thickness: 60 mils, nominal.
 - 3. Exposed Face Color: Black.
 - 4. Outbuildings Pitched Roofs: Provide 90 mil FR membrane.

2.5 AUXILIARY ROOFING MATERIALS

- A. General: Auxiliary materials recommended by roofing system manufacturer for intended use and compatible with roofing.
- B. Sheet Flashing: 60-mil- thick EPDM, partially cured or cured, according to application.

- C. Protection Sheet: Epichlorohydrin or neoprene nonreinforced flexible sheet, 55- to 60-mil-thick, recommended by EPDM manufacturer for resistance to hydrocarbons, non-aromatic solvents, grease, and oil.
 - 1. Provide around new kitchen exhaust hoods; extend not less than 10 feet from all sides of exhaust hood.
- D. Bonding Adhesive: Manufacturer's standard capable of withstanding Project wind uplift requirements.
- E. Seaming Material: Manufacturer's standard splice tape for sealing lapped joints, including edge sealer to cover exposed spliced edges as recommended by membrane manufacturer.
- F. Lap Sealant: Manufacturer's standard, single-component sealant.
- G. Membrane Adhesive: As recommended by membrane manufacturer for particular substrate and project conditions, formulated to withstand specified uplift force.
- H. Water Cutoff Mastic: Manufacturer's standard butyl mastic sealant.
- I. Metal Termination Bars: Manufacturer's standard, predrilled stainless-steel or aluminum bars, approximately 1 by 1/8 inch thick; with anchors.
- J. Crickets and Flashing Accessories: Types recommended by membrane manufacturer, including adhesive tapes, flashing cements, and sealants.
 - 1. Crickets: Tapered factory pre-cut crickets, extending to roof drain sumps, 1/2-inch taper.
- K. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Global 4470, designed for fastening membrane to substrate, and acceptable to roofing system manufacturer.
 - 1. Fasteners into Preservative Treated Lumber: Stainless steel only.
- L. Miscellaneous Accessories: Provide preformed cone and vent sheet flashings, molded pipe boot flashings, preformed inside and outside corner sheet flashings, reinforced EPDM securement strips, T-joint covers, in-seam sealants, termination reglets, cover strips, and other accessories.
 - 1. Pourable sealers not allowed.
 - 2. Field-formed pipe flashing not allowed.
- M. Expansion Joint Bulb: Preformed, compressible, resilient, nonstaining, nonwaxing, nonextruding strips of flexible, closed-cell polyethylene foam, nonabsorbent to liquid water and gas; size as needed to meet expansion joint conditions.
- N. Insulation Retainer and Insulation for Expansion Joints:
 - 1. Insulation Retainer: Continuous EPDM sheet, minimum 45-mil thickness, with sealed seams.
 - 2. Insulation: Unfaced, mineral wool blanket (batt) insulation, ASTM C 665, Type I; consisting of fibers bonded with thermosetting resin; with maximum flame-spread and smoke-developed indices of 25 and 50, respectively; passing ASTM E 136 for combustion characteristics
 - a. R-Value: Not less than R-21.

- O. Roof Walkways: Shall be premolded 30 inch wide rubber walkways supplied by membrane manufacturer.

2.6 SUBSTRATE BOARDS

- A. Substrate Board: ASTM C 1177/C 1177M, glass-mat, water-resistant gypsum substrate board, minimum 1/4 inch thick.
 - 1. Moisture- and Mold-Resistance: ASTM D 3273, rating of 10.
 - 2. Products: Subject to compliance with requirements, provide one of the following:
 - a. Georgia-Pacific Corporation; DensDeck Roof Board.
 - b. National Gypsum Company; DEXcell Glass Mat Roof Board.
- B. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Global 4470, designed for fastening substrate panel to roof deck.
 - 1. Fasteners for substrate board over acoustical deck shall be sized to resist project wind pressures without penetrating below bottom deck flute.

2.7 VAPOR RETARDER

- A. Self-Adhering-Sheet Vapor Retarder (Barrier): ASTM D 1970, Class I vapor barrier; composite sheet comprised of SBS modified bitumen adhesive, factory laminated to a tri-laminate woven, high-density, slip-resistant top layer with a release liner.
 - 1. Tensile Strength: ASTM D 412, 250 psi.
 - 2. Vapor Permeability: ASTM D 1970, 0.015 perms.
 - 3. Air Permeance: ASTM E 2178, less than 0.002 L/s/m².
 - 4. Products:
 - a. Carlisle SynTec Inc.; VapAir Seal MD Air and Vapor Barrier.
 - b. Firestone Building Products Co.; V-Force Vapor Barrier Membrane.
 - c. Versico Inc.; VAPAIR Seal MD Air & Vapor Barrier.
- B. Primer for Self-Adhering-Sheet Vapor Retarder (Barrier): Manufacturer's recommended primer for substrate board.

2.8 ROOF INSULATION

- A. General: Preformed roof insulation boards manufactured or approved by EPDM roofing manufacturer, selected from manufacturer's standard sizes suitable for application, of thicknesses indicated.
- B. Polyisocyanurate Board Insulation: ASTM C 1289, Type II, Class 2, Grade 2, 20 psi, glass-fiber mat facer on both major surfaces.
 - 1. Thickness:
 - a. At Pitched Steel Locations: 2 layers of 3 inch thick insulation for a total thickness of 6 inches.
 - b. At Flat Steel and Future Classroom Locations Roof Type R2 and R4: 1 layer of 3.7 inch thick insulation covered with tapered insulation; average insulation thickness shall be not less than 6 inches.
 - 2. Products:
 - a. Carlisle SynTec Inc.; SecurShield Polyiso Insulation.
 - b. Firestone Building Products Co.; ISO 95+ GL Insulation.
 - c. Versico Roofing Systems; SecurShield Polyiso Insulation.

3. Provide roofing manufacturer's required insulation for total system warranty.
- C. Tapered Insulation: Provide factory-tapered insulation boards fabricated to slope of 1/4 inch per 12 inches unless otherwise indicated.
 1. Tapered insulation shall meet requirements specified for board roof insulation. Provide tapered boards where indicated.
 2. Tapered insulation shall be manufactured by same manufacturer of board roof insulation.
 3. Provide roofing manufacturer's required tapered insulation for total system warranty.
 - D. Crickets: Tapered factory pre-cut crickets, extending to roof drain sumps; types as recommended by membrane manufacturer.
 1. Crickets (tapered insulation) at roof drains shall slope 1/2 inch per 12 inches, unless otherwise indicated.
 - E. Provide preformed saddles, crickets, tapered edge strips, and other insulation shapes where indicated for sloping to drain. Fabricate to slopes indicated.

2.9 INSULATION ACCESSORIES

- A. General: Roof insulation accessories recommended by insulation manufacturer for intended use and compatibility with roofing.
- B. Fasteners: Factory-coated steel or stainless steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Global 4470, designed for fastening roof insulation and cover boards to substrate, and acceptable to roofing system manufacturer.
- C. Adhesive for Installation of Insulation: Insulation manufacturer's recommended adhesive formulated to attach roof insulation and for attaching insulation to another insulation layer as follows:
 1. Full-spread spray-applied, low-rise, two-component urethane adhesive.
- D. Cover Board: High-density, closed-cell polyisocyanurate foam core laminated to coated glass-mat, water-resistant facer; 1/2-inch thick.
 1. Thermal Value: R-2.5.
 2. Compressive Strength: ASTM D 1621, minimum 100 psi.
 3. Water Absorption: ASTM C 209, less than 3 percent volume.
 4. Products:
 - a. Carlisle SynTec Incorporated; Securshield HD Cover Board Insulation.
 - b. Firestone Building Products Company; Isogard HD.
 - 1) Cover board less than 100 psi is not acceptable.
 - c. Versico Roofing Systems; Securshield HD Cover Board Insulation.
- E. Protection Mat: Woven or nonwoven polypropylene, polyolefin, or polyester fabric, water permeable and resistant to UV degradation, type and weight as recommended by roofing system manufacturer for application.

2.10 MISCELLANEOUS INSTALLATION MATERIALS

- A. Polyurethane Foam Insulation Sealant: Minimal expansive, single- or two-component, UL classified sealant, to seal, fill, and stop air infiltration.
 1. Fire-Test-Response Characteristics: ASTM E 84, as follows:

- a. Flame Spread: Not greater than 10.
 - b. Smoke Developed: Not greater than 20.
- 2. Products:
 - a. Dow Chemical Company (The); Great Stuff PRO Gaps & Cracks Insulating Foam Sealant.
 - b. Fomo Products Inc.; Handi-Seal Low Pressure One-Component Polyurethane Foam Sealant
 - c. Owens Corning Co.; Foam Sealant for Gaps & Cracks.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of the Work:
 - 1. Verify that roof openings and penetrations are in place, curbs are set and braced, and roof-drain bodies are securely clamped in place.
 - 2. Verify that wood blocking, curbs, and nailers are securely anchored to roof deck at penetrations and terminations and that nailers match thicknesses of insulation.
 - 3. Verify that surface plane flatness and fastening of steel roof deck complies with requirements in Division 05 Section "Steel Decking."
 - 4. Verify that minimum concrete drying period recommended by roofing system manufacturer has passed.
 - 5. Verify that concrete substrate is visibly dry and free of moisture. Test for capillary moisture by plastic sheet method according to ASTM D 4263.
 - 6. Verify that concrete-curing compounds that will impair adhesion of roofing components to roof deck have been removed.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. General: Comply with manufacturer's instructions to prepare substrate to receive EPDM membrane roof system.
- B. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing installation according to roofing system manufacturer's written instructions. Remove sharp projections.
- C. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction. Remove roof-drain plugs when no work is taking place or when rain is forecast.
- D. Install insulation strips according to acoustical roof deck manufacturer's written instructions.

3.3 ROOFING INSTALLATION, GENERAL

- A. Install roofing system according to roofing system manufacturer's written instructions.

- B. Complete terminations and base flashings and provide temporary seals to prevent water from entering completed sections of roofing system at the end of the workday or when rain is forecast. Remove and discard temporary seals before beginning work on adjoining roofing.

3.4 SUBSTRATE BOARD INSTALLATION

- A. Install substrate board with long joints in continuous straight lines, perpendicular to roof slopes with end joints staggered between rows. Tightly butt substrate boards together.
 - 1. Fasten substrate board to top flanges of steel deck to resist uplift pressure at corners, perimeter, and field of roof according to roofing system manufacturers' written instructions.
 - a. At acoustical metal deck, fasteners for substrate board shall not project below deck bottom flutes.

3.5 VAPOR-RETARDER INSTALLATION

- A. Install support plates for vapor retarder (barrier) furnished under Division 05 Section "Metal Fabrications."
- B. Self-Adhering-Sheet Vapor Retarder (Barrier): Install vapor retarder on clean, dry deck in accordance with manufacturer's written requirements. Prime substrate if required by manufacturer. Roll out vapor retarder flat without creases; align and set in position lapping side and ends a minimum of 2 inches. Remove release film and press sheet down uniformly; all laps must be rolled down with a hand roller.
 - 1. On profile decking, end laps shall be laid over with an additional strip of vapor retarder or flat metal plate not less than 6 inches wide.
 - 2. Large gaps at angle change shall be filled with insulation to support membrane.
- C. Completely seal vapor retarder at terminations, obstructions, and penetrations to prevent air movement into roofing system.

3.6 INSULATION INSTALLATION

- A. Coordinate installing roofing system components so insulation is not exposed to precipitation or left exposed at the end of the workday.
- B. Comply with roofing system and insulation manufacturer's written instructions for installing roof insulation.
- C. Install acoustical roof deck rib insulation strips, specified in Division 05 Section "Steel Decking," according to acoustical roof deck manufacturer's written instructions, immediately before installation of overlying construction and to remain dry. Protect acoustical roof deck rib insulation strips from exposure to water.
- D. Install tapered insulation under area of roofing to conform to slopes indicated, or if not indicated, as required for positive drainage to roof drains.
- E. Install insulation under area of roofing to achieve required thickness. Install layers, including tapered layers, with joints of each succeeding layer staggered from joints of previous layer a minimum of 12 inches in each direction with no gaps, to form a complete thermal envelope.

- F. Trim surface of insulation where necessary at roof drains so completed surface is flush and does not restrict flow of water.
- G. Install insulation with long joints of insulation in a continuous straight line with end joints staggered between rows, abutting edges and ends between boards. Fill gaps exceeding 1/4 inch with insulation with polyurethane foam insulation sealant.
 - 1. Taper insulation around roof drains, providing 4-foot square sump.
 - 2. Install tapered insulation and crickets to provide positive slope to drains without ponding of water.
 - 3. Cut and fit insulation within 1/4 inch of nailers, projections, and penetrations.
- H. Adhered Insulation over Vapor Retarder (Barrier) for Acoustical Deck: Install first layer of insulation and adhere to vapor retarder using manufacturer's recommended spray-applied, low-rise, two-component urethane adhesive. Adhesive shall resist specified uplift pressure at corners, perimeter, and field of roof.
 - 1. Adhere subsequent layer of flat or tapered insulation to proceeding layer using manufacturer's recommended spray-applied, low-rise, two-component urethane adhesive. Adhesive shall resist specified uplift pressures at corners, perimeter, and field of roof. Comply with adhesive manufacturer's and roof system manufacturer's requirements.
- I. Mechanically Fastened Insulation: Install each layer of flat and tapered insulation and secure to deck using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to deck type.
 - 1. Fasten insulation to resist specified uplift pressure at corners, perimeter, and field of roof, but in no case, provide less than one anchor per 4 sq. ft. of surface area (8 fasteners per 4 x 8 foot board).
 - 2. Screws shall be installed utilizing automatic, positive clutch disengaged and adjustable nosepiece.
 - 3. Install tapered edge strips at edges of tapered insulation to provide smooth transition to flat areas, free of gaps and voids.
 - 4. Fasten insulation and cover boards to resist uplift pressure at corners, perimeter, and field of roof.
- J. Do not install more insulation in a day than can be covered with membrane before end of day or before start of inclement weather.

3.7 ADHERED MEMBRANE ROOFING INSTALLATION

- A. Adhere roofing over area to receive roofing according to membrane roofing system manufacturer's written instructions and approved Shop Drawings. Unroll membrane roofing without stretching and allow to relax before installing.
- B. Start installation of roofing in presence of roofing system manufacturer's technical personnel.
- C. Fully Adhered Membrane: Install membrane by unrolling over prepared substrate, lapping adjoining sheets as recommended by manufacturer. Apply adhesive to surfaces to be bonded and roll into place when adhesive has properly cured. Clean and prime both faces of splice areas, apply splice tape, and firmly roll side and end laps of overlapping membrane roofing according to manufacturer's written instructions to ensure a watertight seam installation.

1. Accurately align roofing membrane and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps. Position sheets to accommodate contours of roof deck to avoid bucking water.
 2. Apply roofing membrane with side laps shingled with slope of roof deck where possible.
 3. Flashing details shall be done in accordance with the approved shop drawings. Base flashing shall be properly terminated and covered with counterflashing, providing not less than a 4-inch overlap.
 4. Apply 6-inch wide strip of uncured EPDM to all field sheet seams, which will underlie walkway.
- D. In addition to adhering, mechanically fasten roofing securely into wood blocking at terminations, penetrations, and perimeters.
- E. Repair tears, voids, and lapped seams in roofing that do not comply with requirements.
- F. Perimeter membrane shall extend down wall at least 1 inch past bottom of wood nailer, lapping over wall finish, but not exposed below flashing.
- G. Flashing details shall be done in accordance with the approved Shop Drawings. Base flashing shall be properly terminated and covered with counterflashing, providing not less than a 4-inch overlap.
- H. Adhere protection mat over roofing at kitchen exhaust fans, extending a minimum of 5 feet in all directions from units.
- I. Cut out and repair membrane defects at the end of each day's work.

3.8 BASE FLASHING INSTALLATION

- A. Install sheet flashings and preformed flashing accessories, and adhere to substrates according to roofing system manufacturer's written instructions and approved Shop Drawings.
- B. Flashing of parapets, curbs, expansion joints, and other parts of the roof shall be performed using EPDM membrane flashing.
- C. At roof edges, membrane shall run under metal roof edge flashing full length and width. Membrane shall extend down wall at least 1-inch past bottom of wood nailer, lapping over wall finish, but not exposed below flashing.
- D. Flash all projections including pipes, conduits, fall arrest anchors, and curbs passing through membrane.
1. Flash pipes and conduits with pre-molded cone type flashing boots. Field-formed pipe flashing not allowed.
 2. Pourable sealers not allowed.
- E. Base Flashing: Tops of elastomeric base flashing shall be secured with a continuous aluminum termination bar, sealed and counterflashed.
- F. All vertical flashings and membranes shall be adhered to substrates regardless of height.

- G. Apply bonding adhesive to substrate and underside of sheet flashing at required rate, and allow to partially dry. Do not apply to seam area of flashing.
 - 1. Keep exposed surface of EPDM free of adhesive.
- H. Flash penetrations and field-formed inside and outside corners with sheet flashing conforming to manufacturer's requirements. Provide a minimum overlap of 3-inches.
- I. Clean splice areas, apply splicing cement, and firmly roll side and end laps of overlapping sheets to ensure a watertight seam installation. Apply lap sealant and seal exposed edges of sheet flashing terminations.
 - 1. Keep exposed surface of EPDM free of adhesive.
- J. Terminate and seal top of sheet flashings and mechanically anchor to substrate through termination bars.

3.9 WALKWAY INSTALLATION

- A. Flexible Roof Walkways: Install walkway products in locations indicated. Adhere walkway products to substrate with compatible adhesive according to roofing system manufacturer's written instructions. Install roof walkways at all traffic concentration points (such as roof hatches, access doors, rooftop ladders, around mechanical equipment, etc.); all locations as identified on the Drawings; and all locations required by roofing manufacturer for obtaining warranty.

3.10 FIELD QUALITY CONTROL

- A. Final Roof Inspection: Arrange for roofing system manufacturer's technical personnel to inspect roofing installation on completion and submit report to Architect.
 - 1. Notify Architect not less than 5 business days in advance of date and time of inspection.
- B. Repair or remove and replace components of roofing system where inspections indicate that they do not comply with specified requirements.
- C. Additional testing and inspecting, at Contractor's expense, will be performed to determine if replaced or additional work complies with specified requirements.

3.11 PROTECTING AND CLEANING

- A. Protect membrane roofing system from damage and wear during remainder of construction period. When remaining construction does not affect or endanger roofing, inspect roofing for deterioration and damage, describing its nature and extent in a written report, with copies to Architect and Owner.
 - 1. Coordinate staging, material placement, construction activity and pedestrian traffic protection requirements for work areas and access paths to areas where work will occur on completed roofing.
- B. Correct deficiencies in or remove membrane roofing system that does not comply with requirements, repair substrates, and repair or reinstall membrane roofing system to a condition free of damage and deterioration at time of Substantial Completion and according to warranty requirements.

- C. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

END OF SECTION 075323

SECTION 076200 - SHEET METAL FLASHING AND TRIM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following sheet metal flashing and trim:
 - 1. Manufactured roof edge trim/fascia units.
 - 2. Formed counterflashing and base flashing.
 - 3. Formed low-slope roof flashing.
 - 4. Formed wall flashing and trim.
 - 5. Formed equipment support flashing.
 - 6. Miscellaneous sheet metal accessories.
- B. Related Sections include the following:
 - 1. Division 04 Section "Unit Masonry Assemblies" for installing receiver flashing in masonry.
 - 2. Division 06 Section "Rough Carpentry" for wood nailers, curbs, and blocking.
 - 3. Division 07 Section "Fluid-Applied Air/Vapor Barrier System >" for base flashing drip flashing and installing sheet metal flashing and trim tie into AVB system.
 - 4. Division 07 Section "Ethylene-Propylene-Diene-Monomer (EPDM) Roofing" for installing sheet metal flashing and trim integral with roofing membrane.
 - 5. Division 07 Section "Joint Sealants" for field-applied sheet metal flashing and trim sealants.

1.3 PERFORMANCE REQUIREMENTS

- A. General: Sheet metal flashing and trim assemblies shall withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Completed sheet metal flashing and trim shall not rattle, leak, or loosen, and shall remain watertight.
- B. SPRI Wind Design Standard for Manufactured Roof Edge Flashings: Manufacture and install roof-edge flashings tested according to SPRI ES-1 and capable of resisting the following design pressures calculated according to IBC 2015 and ASCE 7-10 as follows:
 - 1. Wind Speed and Exposure: 120 mph (3 second gusts), Exposure B.
 - 2. Design Wind Uplift: As follows:
 - a. Roof Zone 2 - Perimeter: Positive 16 psf and negative 36 psf.
 - b. Roof Zone 3 - Corners: Positive 16 psf and negative 43.3 psf.
- C. Thermal Movements: Provide sheet metal flashing and trim that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, hole elongation, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Provide clips that resist rotation and avoid shear stress as a result of sheet metal and trim thermal movements. Base

engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

- D. Water Infiltration: Provide sheet metal flashings and trim that do not allow water infiltration to building interior.

1.4 SUBMITTALS

- A. General: Submit in accordance with Division 01 Section "Submittal Procedures."
- B. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, finishes, and installation instructions.
1. Include waterproof underlayment manufacturer's written installation instructions. Variations between manufacturer's printed instructions and these Specifications shall be noted in the submittal.
- C. Shop Drawings: Show layouts of sheet metal flashing and trim, including plans and elevations. Distinguish between shop- and field-assembled work. Provide layouts at 1/4-inch scale and details at 3-inch scale. Include the following:
1. Identify material, thickness, weight, and finish for each item and location in Project.
2. Details for forming sheet metal flashing and trim, including profiles, shapes, seams, and dimensions.
3. Details for fastening, joining, supporting, and anchoring sheet metal flashing and trim, including fasteners, clips, cleats, and attachments to adjoining work.
4. Include details of termination points and assemblies.
5. Include details of roof-penetration flashing.
6. Details of edge conditions, including roof edges, counter flashings and miscellaneous fabrications as applicable.
7. Details of connections to adjoining work.
- D. Samples for Initial Selection: For each type of sheet metal flashing and trim indicated with factory-applied color finishes.
1. Include similar Samples of trim and accessories involving color selection.
- E. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below:
1. Sheet Metal Flashing: 12 inches long. Include fasteners, cleats, clips, closures, and other attachments.
- F. Qualification Data: For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.
- G. Product Certificates: For each type of roof edge flashing that is SPRI ES-1 tested.
- H. Warranties: Special warranties specified in this Section.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Engage an experienced Installer who has completed sheet metal flashing and trim work similar in material, design, forming method, and extent to that indicated for this Project and with a record of successful in-service performance for ten years.
- B. Sheet Metal Flashing and Trim Standard: Comply with SMACNA's "Architectural Sheet Metal Manual, Seventh Edition." Conform to dimensions and profiles shown unless more stringent requirements are indicated.
 - 1. Copper Standard: Comply with CDA's "Copper in Architecture Handbook."
- C. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."
 - 1. Meet with Owner, Architect, Installer, and installers whose work interfaces with or affects sheet metal flashing and trim including installers of roofing materials, roof accessories, and roof-mounted equipment.
 - 2. Review methods and procedures related to sheet metal flashing and trim.
 - 3. Examine substrate conditions for compliance with requirements, including flatness and attachment to structural members.
 - 4. Document proceedings, including corrective measures and actions required, and furnish copy of record to each participant.
 - 5. Provide not less than 7 business days advance notice to participants prior to convening preinstallation conference.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver sheet metal flashing materials and fabrications undamaged. Protect sheet metal flashing and trim materials and fabrications during transportation and handling.
- B. Deliver metal coils, components, and other sheet metal roofing materials so as not to be damaged or deformed. Package shop formed sheet metal roofing materials for protection during transportation and handling.
- C. Unload, store, and install sheet metal flashing materials and fabrications in a manner to prevent bending, warping, twisting, staining, and surface damage.
- D. Stack materials on platforms or pallets, covered with suitable weathertight and ventilated covering. Do not store sheet metal flashing and trim materials in contact with other materials that might cause staining, denting, or other surface damage.
 - 1. Store copper away from uncured concrete and masonry.
- E. Protect strippable protective covering on sheet metal flashing and trim from exposure to sunlight and high humidity, except to extent necessary for period of sheet metal flashing and trim installation.

1.7 COORDINATION

- A. Coordinate installation of sheet metal flashing and trim with interfacing and adjoining construction to provide a leakproof, secure, and noncorrosive installation.
- B. Coordinate Work of this Section with interfacing and adjoining Work for proper sequencing of each installation to ensure a weathertight installation.

1.8 WARRANTY

- A. General: Special warranties specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.
- B. Special Warranty on Painted Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace roof specialties that show evidence of deterioration of factory-applied finishes within specified warranty period.
 - 1. Fluoropolymer Finish: Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
 - b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
 - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
 - 2. Finish Warranty Period: Manufacturer's standard, not less than 20 years from date of Substantial Completion.
- C. Special Installer's Warranty: Installer's warranty, on warranty form at end of this Section, signed by Installer, in which Installer agrees to repair or replace components of custom-fabricated sheet metal flashing and trim that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures.
 - b. Loose parts.
 - c. Wrinkling or buckling.
 - d. Failure to remain weathertight, including uncontrolled water leakage.
 - 2. Warranty Period: Two years for date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Products: Subject to compliance with requirements, provide one of the products specified.

2.2 SHEET METALS

- A. Copper Sheet: ASTM B 370, Temper H00 or H01, cold-rolled copper sheet.
- B. Aluminum Sheet: ASTM B 209, Alloy 3003, 3004, 3105, or 5005, Temper suitable for forming and structural performance required, but not less than H14, finished as follows:
 - 1. High-Performance Organic Finish: AA-C12C42R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: acid-chromate-fluoride-phosphate conversion coating; Organic Coating: as specified below). Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 - a. Fluoropolymer 2-Coat System: Manufacturer's standard 2-coat, thermocured system consisting of specially formulated inhibitive primer and fluoropolymer

color topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight; complying with AAMA 2605, except as modified below:

- 1) Humidity Resistance: 2000 hours.
 - 2) Salt-Spray Resistance: 2000 hours.
 - b. Color: As indicated by manufacturer's designations; if not indicated, as selected by Architect from manufacturer's full range of standard options.
 2. Custom flashing used adjacent and in conjunction with prepainted, aluminum sheet metal siding (07F) shall be obtained from the siding manufacturer to match siding system finish, material and thickness.
 3. Custom flashing used adjacent and in conjunction with phenolic panels and high density fiber cement panels shall be .040 inch thick aluminum sheet in colors selected by Architect.
- C. Stainless-Steel Sheet: ASTM A 240/A 240M, Type 304.
1. Finish: No. 2D (dull, cold rolled).
- D. Prepainted, Metallic-Coated Steel Sheet: Steel sheet metallic coated by the hot-dip process and prepainted by the coil-coating process to comply with ASTM A 755/A 755M.
1. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A 792/A 792M, Class AZ50 coating designation, Grade 40; structural quality.
 2. Exposed Finishes: Apply the following coil coating:
 - a. High-Performance Organic Finish: Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 - 1) Fluoropolymer 2-Coat System: Manufacturer's standard 2-coat, thermocured system consisting of specially formulated inhibitive primer and fluoropolymer color topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight; complying with physical properties and coating performance requirements of AAMA 2605, except as modified below:
 - a) Humidity Resistance: 2000 hours.
 - b) Salt-Spray Resistance: 2000 hours.
 - 2) Colors: As indicated by manufacturer's designations in Exterior Materials Legend; if not indicated, as selected by Architect from manufacturer's full range.
 3. Custom flashing used adjacent and in conjunction with prepainted, metallic-coated steel sheet metal siding (07E) shall be obtained from the siding manufacturer to match siding system finish, material and thickness.

2.3 UNDERLAYMENT MATERIALS

- A. Self-Adhering Sheet Underlayment, High Temperature: Minimum of 30- to 40-mil- thick, slip-resisting, polyethylene-film-reinforced top surface laminated to layer of butyl or SBS-modified asphalt adhesive, with release paper backing; cold applied.
1. Thermal Stability: Stable after testing at 240 deg F; ASTM D 1970.
 2. Low-Temperature Flexibility: Passes after testing at minus 20 deg F; ASTM D 1970.
 3. Products:
 - a. Dri-Start "HR"; Carlisle Coatings & Waterproofing, Div. of Carlisle Co., Inc.
 - b. Vycor Ultra; GCP Applied Technologies (formerly W. R. Grace).

2.4 MISCELLANEOUS MATERIALS

- A. General: Provide materials and types of fasteners, solder, welding rods, protective coatings, separators, sealants, and other miscellaneous items as required for complete sheet metal flashing and trim installation.
- B. Fasteners: Wood screws, annular threaded nails, self-tapping screws, self-locking rivets and bolts, and other suitable fasteners designed to withstand design loads.
 - 1. Nails for Tin-Zinc Alloy Coated Copper Sheet: Copper or hardware bronze, 0.109 inch minimum and not less than 7/8 inch long, barbed with large head.
 - 2. Exposed Fasteners: Heads matching color of sheet metal by means of plastic caps or factory-applied coating.
 - 3. Fasteners for Flashing and Trim: Blind fasteners or self-drilling screws, gasketed, with hex washer head, 304 stainless steel.
 - 4. Blind Fasteners: High-strength aluminum or stainless-steel rivets.
 - 5. Fasteners into Preservative Treated Lumber: Stainless steel.
- C. Solder for Zinc-Tin Alloy-Coated Copper: ASTM B 32, 100 percent tin.
- D. Sealing Tape: Pressure-sensitive, 100 percent solids, polyisobutylene compound sealing tape with release-paper backing. Provide permanently elastic, nonsag, nontoxic, nonstaining tape.
- E. Elastomeric Sealant: ASTM C 920, elastomeric polymer sealant; of type, grade, class, and use classifications required to seal joints in sheet metal flashing and trim and remain watertight.
- F. Butyl Sealant: ASTM C 1311, single-component, solvent-release butyl rubber sealant, polyisobutylene plasticized, heavy bodied for hooked-type expansion joints with limited movement.
- G. Epoxy Seam Sealer: Two-part, noncorrosive, aluminum seam-cementing compound, recommended by aluminum manufacturer for exterior nonmoving joints, including riveted joints.
- H. Bituminous Coating: Cold-applied asphalt mastic, SSPC-Paint 12, compounded for 15-mil dry film thickness per coat. Provide inert-type noncorrosive compound free of asbestos fibers, sulfur components, and other deleterious impurities.
- I. Elastic Flashing Filler: Closed cell polyethylene or other soft closed cell material recommended by elastic flashing manufacturer as fill under flashing loops to ensure movement with minimum stress on flashing sheet.

2.5 MANUFACTURED ROOF EDGE FLASHINGS

- A. Roof-Edge Fascia, Identified as Item 7H, 07J: Manufactured two-piece, roof-edge fascia consisting of snap-on metal fascia cover in section lengths not exceeding 12 feet; a continuous extruded aluminum bar with integral drip-edge to engage fascia cover and secure single-ply roof membrane; and necessary splice plates. Provide matching factory-mitered and welded corner units and tapered spillout type scupper unit.
 - 1. Performance: Per IBC 2015 low-slope membrane roof system metal edge securement shall be designed and installed for wind loads and tested in accordance with ANSI/SPRI ES-1.
 - 2. Face Height: 7 inches.

3. Fascia Cover Material: Fabricate from prefinished, sheet aluminum, not less than 0.040 inch thick.
 - a. Color: As indicated in Exterior Materials Legend.
4. Accessories: Provide overflow scuppers with perforated screen. Scuppers shall be all welded construction and shall match color of roof edge fascia.
5. Basis-of-Design: Subject to compliance with requirements, provide Anchor-Tite Standard Fascia by Metal-Era, Inc. or comparable product matching indicated colors by one of the following:
 - a. MM Systems Corporation.
 - b. W. P. Hickman Company.

2.6 CUSTOM FABRICATION, GENERAL

- A. General: Custom fabricate sheet metal flashing and trim to comply with recommendations in SMACNA's "Architectural Sheet Metal Manual, Seventh Edition" that apply to design, dimensions, metal, and other characteristics of item indicated. Shop fabricate items where practicable. Obtain field measurements for accurate fit before shop fabrication.
- B. Fabricate sheet metal flashing and trim in thickness or weight needed to comply with performance requirements, but not less than that specified for each application and metal.
- C. Fabricate sheet metal flashing and trim in minimum 96-inch- lengths, but not exceeding 10-foot- long sections.
- D. Fabricate sheet metal flashing and trim without excessive oil canning, buckling, and tool marks and true to line and levels indicated, with exposed edges folded back to form hems.
 1. Seams for Aluminum: Fabricate nonmoving seams with flat-lock seams. Form seams and seal with epoxy seam sealer. Rivet joints for additional strength.
 2. Seams for Other Than Aluminum: Fabricate nonmoving seams in accessories with flat-lock seams. Tin edges to be seamed, form seams, and solder.
- E. Sealed Joints: Form nonexpansion but movable joints in metal to accommodate elastomeric sealant to comply with SMACNA recommendations.
- F. Expansion Provisions: Where lapped or bayonet-type expansion provisions in the Work cannot be used or would not be sufficiently water/weatherproof, form expansion joints of intermeshing hooked flanges, not less than 1 inch (25 mm) deep, filled with elastomeric sealant concealed within joints.
- G. Separations: Provide for separation of metal from noncompatible metal or corrosive substrates by coating concealed surfaces at locations of contact, with bituminous coating, by applying rubberized-asphalt underlayment to each contact surface, or other permanent separation as recommended by manufacturer/fabricator.
- H. Conceal fasteners and expansion provisions where possible on exposed-to-view sheet metal flashing and trim, unless otherwise indicated.
- I. Fabricate cleats and attachment devices from same material as accessory being anchored or from compatible, noncorrosive metal.
 1. Thickness: As recommended by SMACNA's "Architectural Sheet Metal Manual" for application but not less than thickness of metal being secured.

2.7 CUSTOM FABRICATED FLASHING SCHEDULE

- A. Sill Flashing for Windows in Brick: Shop formed to detail; fabricated from prefinished, aluminum sheet, 0.040 inch thick minimum, color as selected by Architect; seal corners of pan type sill flashing.
- B. Roof Drip Edge Strip: SMACNA Figure 4-18 C and 4-18D modified; fabricate with minimum 6 inch flange on roof and 3 inch vertical leg with continuous clip; continuous cleats, not less than 20 gage; provide backer plates at end joints; fabricate roof edge strip from prefinished, aluminum-zinc alloy-coated sheet steel, not less than 24 gage; color as selected by Architect.
 - 1. Performance: Roof edge fascia shall be fabricated and installed in accordance with SMACNA and the National Roofing Contractors Association's Embedded Edge for compliance with ANSI/SPRI ES-1 requirements.
- C. Flashings, Drips, Window Sills and Trim: Fabricate to details and profiles indicated; hemmed exposed edges; minimum 0.040 inch thick prefinished aluminum unless indicated otherwise.
 - 1. Prefinished Window Sills and Louver Sills: minimum 0.050 inch thick prefinished aluminum.
- D. Metal Cap Flashing for Pipe Box and Condenser Box: Fabricate to detail with continuous cleats; fabricate from copper sheet, not less than 20 ounce.
- E. Drip Flashing at Base of Foundation Walls at Siding and Wall Panels: 3-inch wide metal drip flashing with hemmed edge; stainless steel sheet, minimum .019 inch (26 gage) thickness.
- F. Miscellaneous Flashing at Masonry: Formed to detail; not less than 16 oz. tin-zinc alloy coated copper.

2.8 FINISHES

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Protect mechanical and painted 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 substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions and other conditions affecting performance of work.
 - 1. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.

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

3.2 INSTALLATION, GENERAL

- A. General: Anchor sheet metal flashing and trim and other components of the Work securely in place, with provisions for thermal and structural movement. Use fasteners, solder, welding rods, protective coatings, separators, sealants, and other miscellaneous items as required to complete sheet metal flashing and trim system.
 - 1. Torch cutting of sheet metal flashing and trim is not permitted.
- B. Metal Protection: Where dissimilar metals will contact each other or corrosive substrates, protect against galvanic action by painting contact surfaces with bituminous coating or by other permanent separation as recommended by fabricator or manufacturers of dissimilar metals.
 - 1. Underlayment: Where installing metal flashing directly on cementitious or wood substrates, install a course of felt underlayment and cover with a slip sheet or install a course of polyethylene underlayment.
 - 2. Bed flanges in thick coat of water cutoff mastic where required for waterproof performance.
- C. Install sheet metal flashing and trim with minimum number of joints practical, using manufactured or shop fabricated full-length pieces. Provide one piece flashing and trim using full-length pieces without joints where run is less than the 8 to 10 foot fabricated lengths. Do not use pieces less than 24 inches long.
 - 1. Sill Flashing at Openings: Provide one piece flashing, full width of opening except where opening exceeds available manufactured/fabricated lengths. Provide sealed metal end dams at ends of sills. Sills flashing shall turn up on back side to form pan, directing water to the exterior.
- D. Install exposed sheet metal flashing and trim without excessive oil canning, buckling, and tool marks.
- E. Install sheet metal flashing and trim true to line and levels indicated. Provide uniform, neat seams with minimum exposure of solder, welds, and elastomeric sealant.
- F. Install sheet metal flashing and trim to fit substrates and to result in watertight performance. Verify shapes and dimensions of surfaces to be covered before fabricating sheet metal.
 - 1. Cleats shall be continuous, unless otherwise noted.
- G. Expansion Provisions: Provide for thermal expansion of exposed flashing and trim. Space movement joints at a maximum of 10 feet with no joints allowed within 24 inches of corner or intersection. Where lapped or bayonet-type expansion provisions cannot be used or would not be sufficiently watertight, form expansion joints of intermeshing hooked flanges, not less than 1 inch deep, filled with elastomeric sealant concealed within joints.
- H. Fasteners: Use fasteners of sizes that will penetrate substrate not less than 1-1/4 inches for nails and not less than 3/4 inch for wood screws.
 - 1. Prepainted, Metallic-Coated Steel: Use stainless-steel fasteners.
 - 2. Aluminum: Use aluminum or stainless-steel fasteners.
 - 3. Zinc-Tin Alloy-Coated Copper: Use copper or stainless steel fasteners.
- I. Seal joints with elastomeric sealant as required for watertight construction.

1. Where sealant-filled joints are used, embed hooked flanges of joint members not less than 1 inch into sealant. Form joints to completely conceal sealant. When ambient temperature at time of installation is moderate, between 40 and 70 deg F, set joint members for 50 percent movement either way. Adjust setting proportionately for installation at higher ambient temperatures. Do not install sealant-type joints at temperatures below 40 deg F.
 2. Prepare joints and apply sealants to comply with installation requirements in Division 07 Section "Joint Sealants."
- J. Soldered Joints: Clean surfaces to be soldered, removing oils and foreign matter. Prein edges of sheets to be soldered to a width of 1-1/2 inches except where pretinned surface would show in finished Work.
1. Do not solder prepainted, metallic-coated steel and aluminum sheet.
 2. Pretinning is not required for zinc-tin alloy-coated copper.
 3. Do not use open-flame torches for soldering. Heat surfaces to receive solder and flow solder into joints. Fill joints completely. Completely remove flux and spatter from exposed surfaces.

3.3 INSTALLATION OF MANUFACTURED ROOF FLASHINGS

- A. General: Install manufactured roof specialties according to manufacturer's written instructions. Anchor with manufacturer's required devices, fasteners, and fastener spacing to meet performance requirements. Use fasteners, separators, sealants, and other miscellaneous items as required to complete manufactured roof specialty systems.
1. Install manufactured roof specialties with provisions for thermal and structural movement.
 2. Torch cutting of manufactured roof specialties is not permitted.
- B. Install manufactured roof specialties level, plumb, true to line and elevation, and without warping, jogs in alignment, excessive oil canning, buckling, or tool marks.
- C. Install manufactured roof specialties to fit substrates and to result in watertight performance. Verify shapes and dimensions of surfaces to be covered before manufacture.
- D. Fasteners: Use fasteners of type and size recommended by manufacturer but of sizes that will penetrate substrate not less than 1-1/4 inches for nails and not less than 3/4 inch for wood screws.
- E. Seal joints with elastomeric sealant as required by manufacturer of roofing specialties.

3.4 CUSTOM FABRICATED FLASHING AND TRIM INSTALLATION

- A. General: Except as otherwise indicated, install sheet metal flashing and trim comply with fabricator's installation instructions, performance requirements, and SMACNA "Architectural Sheet Metal Manual, Seventh Edition." Anchor units of work securely in place by methods indicated, providing for thermal expansion of metal units; conceal fasteners where possible; and set units true to line and level as indicated. All edge strips shall be neatly folded; external and internal corners shall be mitered and soldered for copper, and sealed in full bed of water cut off mastic for pre-finished metal. Install work with laps, joints, and seams that will be permanently watertight and weatherproof.
1. Fabricate in minimum 96-inch- long sections, but not exceeding 10-foot-long sections.

- B. Back-Up Plates: Where specified, set flashing ends in full bed of water cut-off mastic, allowing 1/4-inch between sections.
- C. Counterflashing: Coordinate installation of counterflashing with installation of base flashing. Insert counterflashing in reglets or receivers and fit tightly to base flashing. Extend counterflashing 4 inches over base flashing. Lap counterflashing joints a minimum of 4 inches and bed with elastomeric sealant.
 - 1. Install receivers to receive counterflashing in manner and by methods indicated.
 - a. Where receivers are shown in masonry, provide reglets to mason for installation as specified in Division 04 Section "Unit Masonry Assemblies."
 - 2. Secure in a waterproof manner by means of snap-in installation or welding in-place. Fill reglets with mastic or elastomeric sealant, as indicated and depending on degree of sealant exposure.
 - 3. Verify correct installation of receiver flashing with back-up plates properly set and sealed at joints for two-piece counter flashing detail.
- D. Install flashing and sheet metal with concealed fasteners, unless indicated otherwise. Metal edge flashing shall be installed to resist wind blow-off and prevent flutter and vibration. Allow for expansion and contraction, making square, straight corners and tight overlaps, free of gaps and openings, properly sealed to be watertight.
- E. Electrolytic Action: Where two dissimilar metals adjoin or lap each other (example: galvanized metal ducts and copper cap flashing), an approved separating strip or other insulating material shall be installed.
- F. Bed flanges of work in water cut off mastic where required for waterproof performance.

3.5 CLEANING AND PROTECTION

- A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.
- B. Clean and neutralize flux materials. Clean off excess solder and sealants.
- C. Remove temporary protective coverings and strippable films as sheet metal flashing and trim are installed. On completion of installation, clean finished surfaces, including removing unused fasteners, metal filings, pop rivet stems, and pieces of flashing. Maintain in a clean condition during construction.
- D. Replace sheet metal flashing and trim that have been damaged or that have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

3.6 INSTALLER'S WARRANTY

- A. WHEREAS <Insert name> of <Insert address>, herein called the "Installer," has performed siding, roofing, flashing and associated work ("work") on the following project:
 - 1. Owner: <Insert name of Owner.>
 - 2. Address: <Insert address.>
 - 3. Building Name/Type: <Insert information.>
 - 4. Address: <Insert address.>
 - 5. Area of Work: <Insert information.>

6. Acceptance Date: **<Insert date.>**
7. Warranty Period: **<Insert time.>**
8. Expiration Date: **<Insert date.>**

- B. AND WHEREAS Installer has contracted (either directly with Owner or indirectly as a subcontractor) to warrant said work against leaks and faulty or defective materials and workmanship for designated Warranty Period,
- C. NOW THEREFORE Installer hereby warrants, subject to terms and conditions herein set forth, that during Warranty Period he will, at his own cost and expense, make or cause to be made such repairs to or replacements of said work as are necessary to correct faulty and defective work and as are necessary to maintain said work in a watertight condition.
- D. This Warranty is made subject to the following terms and conditions:
1. Specifically excluded from this Warranty are damages to work and other parts of the building, and to building contents, caused by:
 - a. lightning;
 - b. peak gust wind speed exceeding 130 mph;
 - c. fire;
 - d. failure of siding and roofing system substrate, including cracking, settlement, excessive deflection, deterioration, and decomposition;
 - e. faulty construction of parapet walls, copings, chimneys, skylights, vents, equipment supports, and other edge conditions and penetrations of the work;
 - f. vapor condensation on bottom of work; and
 - g. activity on work by others, including construction contractors, maintenance personnel, other persons, and animals, whether authorized or unauthorized by Owner.
 2. When work has been damaged by any of foregoing causes, Warranty shall be null and void until such damage has been repaired by Installer and until cost and expense thereof have been paid by Owner or by another responsible party so designated.
 3. Installer is responsible for damage to work covered by this Warranty but is not liable for consequential damages to building or building contents resulting from leaks or faults or defects of work.
 4. During Warranty Period, if Owner allows alteration of work by anyone other than Installer, including cutting, patching, and maintenance in connection with penetrations, attachment of other work, and positioning of anything on roof, this Warranty shall become null and void on date of said alterations, but only to the extent said alterations affect work covered by this Warranty. If Owner engages Installer to perform said alterations, Warranty shall not become null and void unless Installer, before starting said work, shall have notified Owner in writing, showing reasonable cause for claim, that said alterations would likely damage or deteriorate work, thereby reasonably justifying a limitation or termination of this Warranty.
 5. During Warranty Period, if original use of roof is changed and it becomes used for, but was not originally specified for, a promenade, work deck, spray-cooled surface, flooded basin, or other use or service more severe than originally specified, this Warranty shall become null and void on date of said change, but only to the extent said change affects work covered by this Warranty.
 6. Owner shall promptly notify Installer of observed, known, or suspected leaks, defects, or deterioration and shall afford reasonable opportunity for Installer to inspect work and to examine evidence of such leaks, defects, or deterioration.

7. This Warranty is recognized to be the only warranty of Installer on said work and shall not operate to restrict or cut off Owner from other remedies and resources lawfully available to Owner in cases of siding, roofing, flashing, or trim failure. Specifically, this Warranty shall not operate to relieve Installer of responsibility for performance of original work according to requirements of the Contract Documents, regardless of whether Contract was a contract directly with Owner or a subcontract with Owner's General Contractor.

E. IN WITNESS THEREOF, this instrument has been duly executed this **<Insert day>** day of **<Insert month>**, **<Insert year>**.

1. Authorized Signature: **<Insert signature.>**
2. Name: **<Insert name.>**
3. Title: **<Insert title.>**

END OF SECTION 076200

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SECTION 079200 - JOINT SEALANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes joint sealants for the following applications, including those specified by reference to this Section:
 - 1. Exterior joints in the following vertical surfaces and horizontal nontraffic surfaces:
 - a. Construction and control joints in cast-in-place concrete.
 - b. Joints between precast architectural concrete units and between precast architectural concrete units and adjacent materials.
 - c. Control and expansion joints in unit masonry.
 - d. Joints between different materials listed above.
 - e. Perimeter joints between materials listed above and frames of doors, windows, curtain wall, aluminum storefront and louvers.
 - f. Other joints as indicated.
 - 2. Exterior joints in the following horizontal traffic surfaces:
 - a. Isolation and contraction joints in exposed cast-in-place concrete slabs.
 - b. Other joints as indicated.
 - 3. Interior joints in the following vertical surfaces and horizontal nontraffic surfaces:
 - a. Control joints on exposed interior surfaces of exterior walls.
 - b. Perimeter joints of exterior openings where indicated.
 - c. Tile control and expansion joints.
 - d. Vertical joints on exposed surfaces of interior unit masonry walls and partitions.
 - e. Perimeter joints between interior wall surfaces and frames of interior doors, aluminum storefront, borrowed lites and elevator entrances.
 - f. Joints between plumbing fixtures and adjoining walls, floors, and counters.
 - g. Other joints as indicated.
 - 4. Interior joints in the following horizontal traffic surfaces:
 - a. Isolation and control joints in exposed cast-in-place concrete slabs.
 - b. Control and expansion joints in tile flooring.
 - c. Other joints as indicated.
- B. Related Sections include the following:
 - 1. Division 01 Section "General Commissioning Requirements" for Contractor's responsibilities in commissioning of building enclosure and coordination with Owner's commissioning agent.
 - 2. Division 04 Section "Unit Masonry Assemblies" for masonry control joint fillers and gaskets.
 - 3. Division 06 Section "Finish Carpentry" for sealants installed with FRP panels.
 - 4. Division 07 Section "Sheet Metal Flashing and Trim" for sealing joints related to flashing and sheet metal for roofing.
 - 5. Division 07 Section "Penetration Firestopping" for sealing penetrations in fire-resistance-rated construction.

6. Division 07 Section "Fire-Resistive Joint Systems" for sealing joints in fire-resistance-rated construction.
7. Division 07 Section "Expansion Control" for expansion joint assemblies.
8. Division 08 Section "Glazing" for glazing sealants.
9. Division 09 Section "Gypsum Board Assemblies" for sealing perimeter joints of gypsum board partitions to reduce sound transmission.
10. Divisions 21, 22, 23, and 26 for acoustically sealing of perimeter joints of plumbing, HVAC systems, automatic fire protection systems, telecommunication systems, and electrical systems.
11. Division 32 Sections for sealing joints in pavements, walkways, and curbing.

1.3 PERFORMANCE REQUIREMENTS

- A. Provide elastomeric joint sealants that have been produced and installed to establish and maintain watertight and airtight continuous joint seals without staining or deteriorating joint substrates.
- B. Provide joint sealants for interior applications that establish and maintain airtight and water-resistant continuous joint seals without staining or deteriorating joint substrates.

1.4 SUBMITTALS

- A. General: Submit in accordance with Division 01 Section "Submittal Procedures."
- B. Product Data: For each joint-sealant product indicated.
 1. For sealants and sealant primers used inside the weatherproofing system, including printed statement of VOC content.
- C. Joint-Sealant Schedule: Include the following information:
 1. Joint-sealant application, joint location, and designation.
 2. Joint design, including width and depth of joint sealant, and backer rod or bond-breaker size and location.
 3. Joint-sealant manufacturer and product name.
 4. Joint-sealant formulation.
 5. Joint-sealant color.
 6. Primer for each substrate type.
 7. Solvent wipe cleaner for each substrate type.
- D. Samples for Selection: Manufacturer's color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Product Test Reports: For each kind of joint sealant, for tests performed by a qualified testing agency.
- C. Field-Adhesion Test Reports: For each sealant test.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: Engage an experienced Installer who has completed joint sealant applications similar in materials, design, and extent to that indicated for Project that have resulted in construction with a record of successful in-service performance.
- B. Source Limitations: Obtain each type of joint sealant through one source from a single manufacturer.
- C. Mockups: Build mockups incorporating sealant joints, as follows, to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution:
 - 1. Joints in mockups of assemblies specified in other Sections that are indicated to receive elastomeric joint sealants, which are specified by reference to this Section.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to Project site in original unopened containers or bundles with labels indicating manufacturer, product name and designation, color, expiration period for use, shelf/pot life, curing time, and mixing instructions for multi-component materials.
- B. Store and handle materials in compliance with manufacturer's recommendations to prevent their deterioration or damage due to moisture, high or low temperatures, contaminants, or other causes.
- C. Remove and replace materials, at no cost to Owner, that cannot be applied within their stated shelf life.

1.8 PROJECT CONDITIONS

- A. Environmental Conditions: Do not proceed with installation of joint sealants under the following conditions:
 - 1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F.
 - 2. When joint substrates are wet.
 - 3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
 - 4. Contaminants capable of interfering with adhesion have not yet been removed from joint substrates.
- B. Joint Width Conditions: Do not proceed with installation of joint sealants where joint widths are less than allowed by joint sealant manufacturer for application indicated.
- C. Joint Substrate Conditions: Do not proceed with installation of joint sealants until contaminants capable of interfering with their adhesion are removed from joint substrates.

1.9 SEQUENCING AND SCHEDULING

- A. Coordinate Work of this Section with interfacing and adjoining Work for proper sequencing of each installation to ensure a weathertight installation.

PART 2 - PRODUCTS

2.1 MATERIALS, GENERAL

- A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by sealant manufacturer, based on testing and field experience.
- B. VOC Content of Interior Sealants: Provide sealants and sealant primers for use inside the weatherproofing system that comply with the following limits for VOC content when calculated according to 40 CFR 59, Part 59, Subpart D (EPA Method 24):
 - 1. Architectural Sealants: 250 g/L.
 - 2. Sealant Primers for Nonporous Substrates: 250 g/L.
 - 3. Sealant Primers for Porous Substrates: 775 g/L.
- C. Liquid-Applied Joint Sealants: Comply with ASTM C 920 and other requirements indicated for each liquid-applied joint sealant specified, including those referencing ASTM C 920 classifications for type, grade, class, and uses related to exposure and joint substrates.
- D. Stain-Test-Response Characteristics: Where sealants are specified to be nonstaining to porous substrates, provide products that have undergone testing according to ASTM C 1248 and have not stained porous joint substrates indicated for Project.
- E. Colors of Exposed Joint Sealants: As selected by Architect from manufacturer's full range.

2.2 JOINT SEALANTS

- A. Type 1 - General Purpose Exterior Sealant: Polyurethane; ASTM C920, Type S, Grade NS, Class 25; single component.
 - 1. Sonolastic NP-1; Sonneborn, Division of ChemRex Inc.
 - 2. Dymonic; Tremco.
 - 3. Sikaflex-1a; Sika Corporation, Inc.
 - 4. Dynatrol 1; Pecora Corporation.
 - 5. Vulkem 116; Tremco.
 - 6. Chem-Calk 900; Bostik Findley.
- B. Type 2 - General Purpose Exterior Sealant: Single-component, nonsag, neutral-curing silicone joint sealant; ASTM C 920, Type S, Grade NS, Class 50, for Use NT. Shall be non-staining on precast concrete and brick per ASTM C 1248.
 - 1. Dow Corning Corporation; 795.
 - 2. GE Advanced Materials - Silicones; SilPruf NB SCS9000.
 - 3. Pecora Corporation; 864NST.
 - 4. Tremco Incorporated; Spectrem 3.
- C. Type 3 - General Purpose Interior Sealant: Acrylic emulsion latex; ASTM C834, single component, paintable.
 - 1. Tremflex 834; Tremco.
 - 2. AC-20; Pecora Corporation.
 - 3. Chem-Calk 600; Bostik Findley.

- D. Type 4 - Plumbing Fixture/Tile Sealant: Silicone; ASTM C920, Uses M and A; single component, mildew resistant, color selected by Architect.
 - 1. 898 Silicone; Pecora Corporation.
 - 2. Tremsil 200 Sanitary; Tremco, Inc.
- E. Type 5 - Interior Floor Joint Sealant: Polyurethane, self-leveling; ASTM C920, Grade P, Class 25, Uses T, M and A; single component.
 - 1. Sonolastic SL-1; Sonneborn, Division of ChemRex Inc.
 - 2. Tremflex S/L; Tremco.
 - 3. Sikaflex-1CSL; Sika Corporation, Inc.
 - 4. NR-201; Pecora Corporation.
 - 5. Vulkem 45; Tremco.
 - 6. Chem-Calk 950; Bostik Findley.
- F. Type 6 - Interior Sealant for Food Service Areas: Elastomeric, self-leveling; ASTM C 920; Type S, Grade NS, Class 25, Use NT. Provide elastomeric sealant NSF certified for end-use application indicated. Provide sealant that, when cured and washed, meets requirements of Food and Drug Administration's 21 CFR, Section 177.2600 for use in areas that come in contact with food.
- G. Type 7 - Interior Acoustical Sealant for Exposed and Concealed Joints in Masonry Walls: Manufacturer's standard nonsag, paintable, nonstaining latex acoustical sealant complying with ASTM C 834 that 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. Ohio Sealants, Inc.; Pro-Series SC-175 Acoustical Sound Sealant.
 - 2. Pecora Corp.; AIS-919 Acoustical and Insulation Sealant.
- H. Acoustical Sealant in Gypsum Board Assemblies: Specified in Division 09 Section "Gypsum Board Assemblies."

2.3 JOINT-SEALANT BACKING

- A. General: Provide sealant backings (backer rods) of material and type that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.
- B. Plastic Foam Joint Fillers (Backer Rods): ASTM C 1330, Type B (bicellular material with a surface skin), preformed, compressible, resilient, nonstaining, nonwaxing, nonextruding strips of flexible plastic foam of material indicated below and of size, shape, and density to control sealant depth and otherwise contribute to producing optimum sealant performance:
 - 1. Bicellular polyethylene foam, nonabsorbent to liquid water and gas, nonoutgassing in unruptured state.
 - 2. Product: Industrial Thermo Polymers LTD; ITP Soft Type Backer Rod.
- C. Cylindrical Sealant Backings (Backer Rods): ASTM C 1330, Type O (open-cell material) , and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance.
 - 1. For Silicone Sealant (within painted or metal joint surfaces to promote cure from both sides of joint): Open cell polyurethane foam, where required by the joint sealant manufacturer.

- D. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint where such adhesion would result in sealant failure. Provide self-adhesive tape where applicable.

2.4 MISCELLANEOUS MATERIALS

- A. Primer: Material recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.
- B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants to joint substrates.
- C. Masking Tape: Nonstaining, nonabsorbent material compatible with joint sealants and surfaces adjacent to joints.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions and the following requirements:
 - 1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings tested and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
 - 2. Clean concrete, masonry, unglazed surfaces of ceramic tile, and similar porous joint substrate surfaces by brushing, grinding, blast cleaning, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles and dust remaining after cleaning operations above by vacuuming or blowing out joints with oil-free compressed air.
 - 3. Remove laitance and form-release agents from concrete.
 - 4. Clean metal, glass, porcelain enamel, glazed surfaces of ceramic tile, and other nonporous surfaces with chemical cleaners or other means that do not stain, harm substrates, or leave residues capable of interfering with adhesion of joint sealants.
- B. Joint Priming: Prime joint substrates, where indicated or recommended in writing by joint-sealant manufacturer, based on field-adhesion testing 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.

1. Precast architectural concrete, masonry and concrete surfaces shall be primed, unless adhesion test is passed without primer.

- C. Masking Tape: Use masking tape where required to prevent contact of sealant with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

3.3 INSTALLATION OF JOINT SEALANTS

- A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated, unless more stringent requirements apply.
- B. Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.
- C. Acoustical Sealant Application Standard: Comply with recommendations in ASTM C 919 for use of joint sealants in acoustical applications as applicable to materials, applications, and conditions indicated.
- D. Installation of Sealant Backings (Backer Rods): Install sealant backings to comply with the following requirements:
 1. Install sealant backings of type indicated to provide support of 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.
 - a. Do not leave gaps between ends of sealant backings.
 - b. Do not stretch, twist, puncture, or tear sealant backings.
 2. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and joint fillers or backs of joints.
- E. Installation of Sealants: Install sealants using proven techniques that result in sealants directly contacting and fully wetting joint substrates, completely filling recesses provided for each joint configuration, and providing uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability. Install sealants at the same time sealant backings and primer 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 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 configuration per Figure 5A 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. Extent of Testing: Test completed elastomeric sealant joints as follows:
 - a. Perform 5 tests for the first 500 feet of joint length for each type of elastomeric sealant and joint substrate.
 - b. Perform 1 test for each 1000 feet of joint length thereafter or 1 test per each floor per elevation, whichever is more frequent.
 2. Test Method: Test joint sealants according to Method A, Field-Applied Sealant Joint Hand Pull Tab in Appendix X1 in ASTM C 1193 or Method A, Tail Procedure, in ASTM C 1521.
 - a. For joints with dissimilar substrates, verify adhesion to each substrate separately; do this by extending cut along one side, verifying adhesion to opposite side. Repeat procedure for opposite side.
 3. Inspect joints for complete fill, for absence of voids, and for joint configuration complying with specified requirements. Record results in a field-adhesion-test log.
 4. Inspect tested joints and report on the following:
 - a. 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 type of product and joint substrate. Compare these results to determine if adhesion passes sealant manufacturer's field-adhesion hand-pull test criteria.
 - b. Whether sealants filled joint cavities and are free of voids.
 - c. Whether sealant dimensions and configurations comply with specified requirements.
 5. Record test results in a field-adhesion-test log. Include dates when sealants were installed, names of persons who installed sealants, test dates, test locations, whether joints were primed, adhesion results and percent elongations, sealant fill, sealant configuration, and sealant dimensions.
 6. 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.
- B. Evaluation of Field Test Results: Sealants not evidencing adhesive failure from testing or noncompliance with other indicated requirements will be considered satisfactory. Remove sealants that fail to adhere to joint substrates during testing or to comply with other requirements. Retest failed applications until test results prove sealants comply with indicated requirements.

3.5 CLEANING

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

3.6 PROTECTION

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

3.7 JOINT-SEALANT SCHEDULE

- A. Control and Soft Joints in Masonry and between Masonry and Adjacent Work: Type 2; colors as selected. Prime masonry.
- B. Exterior Joints between Precast Architectural Concrete Units and Adjacent Work: Type 2; colors as selected.
- C. Exterior Joints between Precast Architectural Concrete Panels and Concrete: Type 2; colors as selected. Prime precast architectural concrete panels and concrete.
- D. Joints between Exterior Metal Frames and Adjacent Work (except masonry): Type 2; colors as selected.
- E. Under Exterior Door Thresholds: Type 1.
- F. Exterior Joints for Which No Other Sealant Type is Indicated: Type 2; colors as selected.
- G. Concealed Interior Perimeter Joints of Exterior Openings: Type 1 or Type 2.
- H. Exposed Interior Perimeter Joints of Exterior Openings: Type 3; colors as selected.
- I. Interior Ceramic Tile Expansion, Control, Contraction, and Isolation Joints in Horizontal Traffic Surfaces: Type 2; color as selected.
- J. Control and Expansion Joints in Interior Concrete Slabs and Floors Left Exposed: Type 5; colors as selected.
- K. Joints between Plumbing Fixtures and Walls and Floors and Between Countertops and Walls: Type 4; colors as selected.
- L. Interior Acoustical Sealant in Masonry Walls: Type 7; colors as selected. Prime masonry.
- M. Interior Joints in Food Service Areas: Type 6; colors as selected.
- N. Interior Joints for Which No Other Sealant is Indicated: Type 3; colors as selected.

END OF SECTION 079200

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SECTION 080671 – DOOR HARDWARE SCHEDULE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section references specification sections relating to commercial door hardware for the following:
 - 1. Swinging doors.
 - 2. Sliding Doors.
 - 3. Other doors to the extent indicated.
- B. Commercial door hardware includes, but is not necessarily limited to, the following:
 - 1. Mechanical door hardware.
 - 2. Electromechanical and access control door hardware.
 - 3. Electromechanical and access control door hardware power supplies, back-ups and surge protection.
 - 4. Automatic operators.
 - 5. Cylinders specified for doors in other sections.
- C. Related Sections:
 - 1. Division 08 Section “Door Hardware”.
- D. Codes and References: Comply with the version year adopted by the Authority Having Jurisdiction.
 - 1. ANSI A117.1 - Accessible and Usable Buildings and Facilities.
 - 2. ICC/IBC - International Building Code.
 - 3. NFPA 70 - National Electrical Code.
 - 4. NFPA 80 - Fire Doors and Windows.
 - 5. NFPA 101 - Life Safety Code.
 - 6. NFPA 105 - Installation of Smoke Door Assemblies.
 - 7. State Building Codes, Local Amendments.
- E. Standards: Reference Related Sections for requirements regarding compliance with applicable industry standards.

1.3 SUBMITTALS

- A. Product Data: Manufacturer's product data sheets including installation details, material descriptions, dimensions of individual components and profiles, operational descriptions and finishes.

- B. Door Hardware Schedule: Prepared by or under the supervision of supplier, detailing fabrication and assembly of door hardware, as well as procedures and diagrams. Coordinate the final Door Hardware Schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.
1. Format: Comply with scheduling sequence and vertical format in DHI's "Sequence and Format for the Hardware Schedule."
 2. Organization: Organize the Door Hardware Schedule into door hardware sets indicating complete designations of every item required for each door or opening. Organize door hardware sets in same order as in the Door Hardware Sets at the end of Part 3. Submittals that do not follow the same format and order as the Door Hardware Sets will be rejected and subject to resubmission.
 3. Content: Include the following information:
 - a. Type, style, function, size, label, hand, and finish of each door hardware item.
 - b. Manufacturer of each item.
 - c. Fastenings and other pertinent information.
 - d. Location of door hardware set, cross-referenced to Drawings, both on floor plans and in door and frame schedule.
 - e. Explanation of abbreviations, symbols, and codes contained in schedule.
 - f. Mounting locations for door hardware.
 - g. Door and frame sizes and materials.
 4. Submittal Sequence: Submit the final Door Hardware Schedule at earliest possible date, particularly where approval of the Door Hardware Schedule must precede fabrication of other work that is critical in the Project construction schedule. Include Product Data, Samples, Shop Drawings of other work affected by door hardware, and other information essential to the coordinated review of the Door Hardware Schedule.
- C. Keying Schedule: Prepared under the supervision of the Owner, separate schedule detailing final keying instructions for locksets and cylinders in writing. Include keying system explanation, door numbers, key set symbols, hardware set numbers and special instructions. Owner to approve submitted keying schedule prior to the ordering of permanent cylinders.
- D. Product Test Reports: Indicating compliance with cycle testing requirements, based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified independent testing agency.
- E. Operating and Maintenance Manuals: Provide manufacturers operating and maintenance manuals for each item comprising the complete door hardware installation in quantity as required in Division 01, Closeout Submittals. The manual to include the name, address, and contact information of the manufacturers providing the hardware and their nearest service representatives. The final copies delivered after completion of the installation test to include "as built" modifications made during installation, checkout, and acceptance.
- F. Warranties and Maintenance: Special warranties and maintenance agreements specified in the Related Sections.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Inventory door hardware on receipt and provide secure lock-up and shelving for door hardware delivered to Project site. Do not store electronic access control hardware, software or accessories at Project site without prior authorization.

- B. Tag each item or package separately with identification related to the final Door Hardware Schedule, and include basic installation instructions with each item or package.
- C. Deliver, as applicable, permanent keys, cylinders, cores, access control credentials, software and related accessories directly to Owner via registered mail or overnight package service. Instructions for delivery to the Owner shall be established at the "Keying Conference".

1.5 WARRANTY

- A. General Warranty: Reference Division 01, General Requirements. Special warranties specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.

1.6 MAINTENANCE SERVICE

- A. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions as needed for Owner's continued adjustment, maintenance, and removal and replacement of door hardware.

PART 2 - PRODUCTS

2.1 SCHEDULED DOOR HARDWARE

- A. Refer to "PART 3 – EXECUTION" for required specification sections.

PART 3 - EXECUTION

3.1 DOOR HARDWARE SETS

- A. The door hardware sets represent the design intent and direction of the owner and architect. They are a guideline only and should not be considered a detailed hardware schedule. Discrepancies, conflicting hardware and missing items should be brought to the attention of the architect with corrections made prior to the bidding process. Omitted items not included in a hardware set should be scheduled with the appropriate additional hardware required for proper application and functionality.
 - 1. Quantities listed are for each pair of doors, or for each single door.
 - 2. The supplier is responsible for handing and sizing all products.
 - 3. Where multiple options for a piece of hardware are given in a single line item, the supplier shall provide the appropriate application for the opening.
 - 4. At existing openings with new hardware the supplier shall field inspect existing conditions prior to the submittal stage to verify the specified hardware will work as required. Provide alternate solutions and proposals as needed.
- B. Products listed in the hardware sets shall be supplied by and in accordance with the requirements described in the specification section as noted for each item.
 - 1. Section 08 71 00 – Door Hardware.

C. Manufacturer's Abbreviations:

1. MK - McKinney
2. PE - Pemko
3. SU - Securitron
4. RO - Rockwood
5. SA - SARGENT
6. MC - Medeco
7. RF - Rixson
8. NO - Norton
9. LU - Lund Equipment Co
10. SC – Schlage

Hardware Sets

Exterior – Main Entry

AL x AL x Single Entry

Door: A101A, A115A

Electromechanical and access control door hardware coordinated with owner's system and hardware shown below.

Each Door Shall Have: Hinges, Rim Exit Device with Trim, (Entry Function), Closer, Surface Overhead Stop, Kick Plates, Threshold, Door Bottoms, Sweeps w/Drip, Weatherstripping, Cylinders, Electrohydraulic Door Operator

Entry Vestibule

HM x HM x Single

Door: A101B, A115B

Each Door Shall Have: Hinges, Rim Exit Device with Trim (Office Function), Closer, Wall Stop, Silencers, Kick Plates, Cylinders

Single User Toilet and Shower Compartments

HM x HM x Single

Doors: A110A, A110B, A110C, A110D, A110E, A110F, A110G

Each Door Shall Have: Hinges, Lockset (Institutional Privacy Function with Occupied Indicator, outside key overrides thumb turn), Kick Plates, Overhead Stop, Silencers, Cylinder

Custodial, Utility

HM x HM x Single

Doors: A113, A114

Each Door Shall Have: Hinges, Lockset (Storeroom Function), Kick Plates, Silencers, Cylinder

Interior Single Doors

HM x WD x Single

Doors: A103, A104, A106, A107, A108, A109

Each Door Shall Have: Hinges, Lockset (Office Function), Kick Plates, Wall Stops, Gasketing, Cylinder

Interior Single Doors

HM x WD x Single

Doors: A110, A111

Each Door Shall Have: Hinges, Lockset (Office Function), Closer, Kick Plates, Gasketing, Cylinder

Closet

HM x HM x Single

Doors: A105

Each Door Shall Have: Hinges, Lockset (Storeroom), Wall Stop, Kick Plates, Silencers, Cylinder

END OF SECTION 080671

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SECTION 081110 - HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 DESCRIPTION OF WORK

- A. Work Included: Provide labor, materials and equipment necessary to complete the work of this Section, including but not limited to the following:
 - 1. Interior standard steel doors and frames.
 - 2. Hollow metal frames with kerf for smoke seals, sound seals, and weather stripping.
 - 3. Hollow metal borrowed lite frames.
 - 4. Smoke seals and weather stripping gaskets for kerfed frames.
- B. Related Work: The following items are not included in this Section and are specified under the designated Sections:
 - 1. Section 087100 - DOOR HARDWARE for door hardware for steel doors.
 - 2. Section 088000 - GLAZING for glazed lites.
 - 3. Section 092110 - GYPSUM BOARD ASSEMBLIES for insulation.
 - 4. Section 099000 - PAINTING AND COATING for field painting steel doors and frames.

1.3 SUBMITTALS

- A. Submittals for the following sections shall be made concurrently:
 - 1. Section 081110 - HOLLOW METAL DOORS AND FRAMES.
 - 2. Section 087100 - DOOR HARDWARE.
- B. Product Data: Include construction details, material descriptions, core descriptions, label compliance, fire-resistance rating, temperature-rise ratings, and finishes for each type of steel door and frame specified.
- C. Shop Drawings:
 - 1. Elevations of each door design.
 - 2. Details of doors, including vertical and horizontal edge details and metal thicknesses.
 - 3. Frame details for each frame type, including dimensioned profiles and metal thicknesses.
 - 4. Locations of reinforcement and preparations for hardware.
 - 5. Details of each different wall opening condition.
 - 6. Details of anchorages, joints, field splices, and connections.
 - 7. Details of accessories.
 - 8. Details of moldings, removable stops, and glazing.
 - 9. Details of conduit and preparations for power, signal, and control systems.
- D. Schedule: Provide a schedule of hollow metal work prepared by or under the supervision of supplier, using same reference numbers for details and openings as those on Drawings. Coordinate with door hardware schedule.

- E. Qualification Data: For Installer.
- F. Product Test Reports: Based on evaluation of comprehensive fire tests performed by a qualified testing agency, for each type of standard steel door and frame.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: An employer of workers trained and approved by manufacturer.
- B. Source Limitations: Obtain standard steel doors and frames through one source from a single manufacturer.
- C. Fire-Rated Door, Assemblies: Assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire-protection ratings and temperature-rise limits indicated, based on testing at positive pressure according to NFPA 252 or UL 10C.
 - 1. Smoke- and Draft-Control Assemblies: Provide an assembly with gaskets listed and labeled for smoke and draft control by a qualified testing agency acceptable to authorities having jurisdiction, based on testing according to UL 1784 and installed in compliance with NFPA 105.
- D. Fire-Rated, Borrowed-Light Assemblies (Including Sidelights and Transoms): Complying with NFPA 80 and listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction for fire-protection ratings indicated, based on testing according to NFPA 257 or UL 9.

1.5 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01. Review methods and procedures related to door installation including, but not limited to the following:
 - 1. Meet with Owner, Architect, door installer, hardware installer, door supplier and door manufacturer's representative. Door preinstallation conference shall run concurrently with hardware preinstallation conference.
 - 2. Review methods and procedures related to door installation, including manufacturer's written instructions.
 - 3. Review installation of fire doors, including hinge screw application to fire rated doors and requirements for door removal from frame if required after installation.
 - 4. Review door swing and closer installation to permit maximum swing without binding at frame opening.
 - 5. Review floor covering requirements to provide proper door undercut clearances.
 - 6. Review fire rated door requirements regarding no field modifications to labeled doors.
 - 7. Document proceedings, including corrective measures and actions required, and furnish a copy of record to each participant.
 - 8. Provide 7 business days minimum advance notice to participants prior to convening preinstallation conference.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver doors and frames palletized, wrapped, or crated to provide protection during transit and Project-site storage. Do not use nonvented plastic.

- B. Deliver welded frames with two removable spreader bars across bottom of frames, tack welded to jambs and mullions.
- C. Store hollow metal work under cover at Project site. Place in stacks of five units maximum in a vertical position with heads up, spaced by blocking, on minimum 4-inch-high wood blocking. Do not store in a manner that traps excess humidity.
 - 1. Provide minimum 1/4-inch space between each stacked door to permit air circulation.

1.7 PROJECT CONDITIONS

- A. Field Measurements: Verify actual dimensions of openings by field measurements before fabrication.

1.8 COORDINATION

- A. Coordinate installation of anchorages 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.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Ceco Door Products; an ASSA ABLOY Group Company.
 - 2. CURRIES Company; an ASSA ABLOY Group Company.
 - 3. J/R Metal Frames Manufacturing, Inc.
 - 4. Steelcraft; an Allegion (formerly Ingersoll-Rand) company.

2.2 MATERIALS

- A. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B; suitable for exposed applications.
- B. Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, Commercial Steel (CS), Type B; free of scale, pitting, or surface defects; pickled and oiled.
- C. Metallic-Coated, (Galvanized/Galvannealed) Steel Sheet: ASTM A 653/A 653M, Commercial Steel (CS), Type B; with minimum G60/A60 metallic coating.
- D. Frame Anchors: ASTM A 591/A 591M, Commercial Steel (CS), 40Z coating designation; mill phosphatized.
 - 1. For anchors built into exterior walls, steel sheet complying with ASTM A 1008/A 1008M or ASTM A 1011/A 1011M, hot-dip galvanized according to ASTM A 153/A 153M, Class B.
- E. Inserts, Bolts, and Fasteners: Hot-dip galvanized according to ASTM A 153/A 153M.

- F. Powder-Actuated Fasteners in Concrete: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with clips or other accessory devices for attaching hollow metal frames of type indicated.
- G. Insulation: Comply with requirements in Section 092110 - GYPSUM BOARD ASSEMBLIES.
- H. Glazing: Comply with requirements in Section 088000 - GLAZING.

2.3 STANDARD STEEL DOORS

- A. General: Provide doors of design indicated, not less than thickness indicated; fabricated with smooth surfaces, without visible joints or seams on exposed faces, unless otherwise indicated. Comply with ANSI A250.8.
 - 1. Design: Flush panel.
 - 2. Core Construction: Manufacturer's standard kraft-paper honeycomb, polystyrene, polyurethane, mineral-board, or vertical steel-stiffener core that produces doors complying with ANSI A250.8.
 - a. Fire Door Core: As required to provide fire-protection and temperature-rise ratings indicated.
 - b. Thermal-Rated (Insulated) Exterior Doors: Where indicated, provide doors fabricated with thermal-resistance value (R-value) of not less than 2.5 when tested according to ASTM C 1363.
 - 3. Top and Bottom Edges: Closed with flush or inverted 0.042-inch-thick end closures or channels of same material as face sheets.
 - 4. Tolerances: Comply with SDI 117, "Manufacturing Tolerances for Standard Steel Doors and Frames."
- B. Exterior Doors: Face sheets fabricated from metallic-coated (galvanized/galvannealed) steel sheet. Provide doors complying with requirements indicated below by referencing ANSI A250.8 for level and model and ANSI A250.4 for physical-endurance level:
 - 1. Level 3 and Physical Performance Level A (Extra Heavy Duty), Model 2 (Seamless), 1-3/4 inches thick.
- C. Interior Doors: Face sheets fabricated from cold-rolled steel sheet. Provide doors complying with requirements indicated below by referencing ANSI A250.8 for level and model and ANSI A250.4 for physical-endurance level:
 - 1. Level 3 and Physical Performance Level A (Extra Heavy Duty), Model 2 (Seamless), 1-3/4 inches thick.
- D. Hardware Reinforcement: Fabricate according to ANSI/SDI A250.6 with reinforcing plates from same material as door face sheets.
- E. Fabricate concealed stiffeners and hardware reinforcement from either cold- or hot-rolled steel sheet.

2.4 STANDARD STEEL FRAMES

- A. General: Comply with ANSI A250.8 and with details indicated for type and profile.
- B. Exterior Frames: Fabricated from metallic-coated (galvanized/galvannealed) steel sheet.
 - 1. Fabricate frames with full profile welded joints.

2. Frames for Level 3 Steel Doors: 0.067-inch-thick steel sheet.
 3. Provide frames with kerf seal gaskets at fire rated doors and doors indicated to receive seals.
 - a. Where the note "Kerf smoke/sound/weatherstripping seals provided in Section 081110" is listed in the hardware sets specified in Section 087100 - DOOR HARDWARE, provide doors listed for the hardware sets with a kerfed hollow metal frame and seal gaskets.
 4. Exposed Finish: Prime.
- C. Interior Frames: Fabricated from cold-rolled steel sheet.
1. Fabricate frames with full profile welded joints.
 2. Frames for Level 3 Steel Doors: 0.053-inch-thick steel sheet.
 3. Provide frames with kerf seal gaskets at fire rated doors and doors indicated to receive seals.
 - a. Where the note "Kerf smoke/sound/weatherstripping seals provided in Section 081110" is listed in the hardware sets specified in Section 087100 - DOOR HARDWARE, provide doors listed for the hardware sets with a kerfed hollow metal frame and seal gaskets.
 4. Exposed Finish: Prime.
- D. Hardware Reinforcement: Fabricate according to ANSI/SDI A250.6 with reinforcement plates from same material as frames.

2.5 FRAME ANCHORS

- A. Jamb Anchors:
1. Masonry Type: Adjustable strap-and-stirrup or T-shaped anchors to suit frame size, not less than 0.042 inch thick, with corrugated or perforated straps not less than 2 inches wide by 10 inches long; or wire anchors not less than 0.177 inch thick.
 2. Stud-Wall Type: Designed to engage stud, welded to back of frames; not less than 0.042 inch thick.
 3. Compression Type for Drywall Slip-on Frames: Adjustable compression anchors.
 4. Postinstalled Expansion Type for In-Place Concrete or Masonry: Minimum 3/8-inch-diameter bolts with expansion shields or inserts. Provide pipe spacer from frame to wall, with throat reinforcement plate, welded to frame at each anchor location.
- B. Floor Anchors: Formed from same material as frames, not less than 0.042 inch (1.0 mm) thick, and as follows:
1. Monolithic Concrete Slabs: Clip-type anchors, with two holes to receive fasteners.
 2. Separate Topping Concrete Slabs: Adjustable-type anchors with extension clips, allowing not less than 2-inch height adjustment. Terminate bottom of frames at finish floor surface.

2.6 HOLLOW METAL PANELS

- A. Provide hollow metal panels of same materials, construction, and finish as specified for adjoining hollow metal work.

2.7 STOPS AND MOLDINGS

- A. Moldings for Glazed Lites in Doors: Minimum 0.032 inch thick, fabricated from same material as door face sheet in which they are installed.
- B. Fixed Frame Moldings: Formed integral with hollow metal frames, a minimum of 5/8 inch high unless otherwise indicated.
- C. Loose Stops for Glazed Lites in Frames: Minimum 0.032 inch thick, fabricated from same material as frames in which they are installed.

2.8 LOUVERS

- A. Provide louvers for interior doors, where indicated, that comply with SDI 111C, with blades or baffles formed of 0.020-inch-thick, cold-rolled steel sheet set into 0.032-inch-thick steel frame.
 - 1. Sightproof Louver: Stationary louvers constructed with inverted V-shaped or Y-shaped blades.

2.9 ACCESSORIES

- A. Mullions and Transom Bars: Join to adjacent members by welding or rigid mechanical anchors.
- B. Ceiling Struts: Minimum 1/4-inch-thick by 1-inch-wide steel.

2.10 HARDWARE REINFORCEMENT

- A. Hardware Reinforcement for Doors: Fabricate according to ANSI/SDI A250.6 with reinforcing plates of sufficient strength from same material as door face sheets to support hardware without through bolting and to comply with the following minimum sizes:
 - 1. Hinges: Minimum 0.123 inch thick, 10 gage, by 1-1/2 inches wide and by 6 inches longer than hinge, secured by not less than 6 spot welds.
 - a. Continuous Hinges: Minimum 0.067 inch thick, 14 gage, full height of door.
 - 2. Lock Face, Flush Bolts, Closers, Overhead Stops, and Concealed Holders: Minimum 0.067 inch thick, 8 gage.
 - 3. All other surface mounted hardware: Minimum 0.067 inch thick, 8 gage.
- B. Hardware Reinforcement for Frames: Fabricate according to ANSI/SDI A250.6 with reinforcing plates of sufficient strength from same material as door face sheets to support hardware without through bolting and to comply with the following minimum sizes:
 - 1. Hinges: Minimum 0.123 inch thick, 10 gage, by 1-1/2 inches wide and by 6 inches longer than hinge, secured by not less than 6 spot welds.
 - a. Continuous Hinges: Minimum 0.067 inch thick, 14 gage, full height of door.
 - 2. Lock Face, Flush Bolts, Closers, Overhead Stops, and Concealed Holders: Minimum 0.067 inch thick, 8 gage.
 - 3. All other surface mounted hardware: Minimum 0.067 inch thick, 8 gage.
- C. Locate hardware reinforcement plates as indicated on Shop Drawings or if not indicated according to ANSI/SDI A250.6.
- D. Plaster Guards: Formed from same material as frames, not less than 0.016-inch thick, 28 gage steel sheet to close off interior openings; place at back of hardware cutouts where mortar or other materials might obstruct hardware operation.

2.11 FABRICATION

- A. Fabricate hollow metal work to be rigid and free of defects, warp, or buckle. Accurately form metal to required sizes and profiles, with minimum radius for thickness of metal. Where practical, fit and assemble units in manufacturer's plant. To ensure proper assembly at Project site, clearly identify work that cannot be permanently factory assembled before shipment.
- B. Tolerances: Fabricate hollow metal work to tolerances indicated in SDI 117.
- C. Hollow Metal Doors:
 - 1. Exterior Doors: Provide weep-hole openings in bottom of exterior doors to permit moisture to escape. Seal joints in top edges of doors against water penetration.
 - 2. Glazed Lites: Factory cut openings in doors.
 - 3. Astragals: Provide overlapping astragal on one leaf of pairs of doors where required by NFPA 80 for fire-performance rating or where indicated. Extend minimum 3/4 inch beyond edge of door on which astragal is mounted.
- D. Hollow Metal Frames: Where frames are fabricated in sections due to shipping or handling limitations, provide alignment plates or angles at each joint, fabricated of same thickness metal as frames.
 - 1. Full Profile Welded Frames: Weld joints continuously; grind, fill, dress, and make smooth, flush, and not visible.
 - a. For kerf frames, weld along joint profile (soffit, returns, stop interior), except the kerfed stop portion.
 - 2. Full Profile Welded Frames at Fire-Rated Doors and Exterior Doors: Weld joints continuously; grind, fill, dress, and make smooth, flush, and not visible.
 - 3. Sidelight and Transom Bar Frames: Provide closed tubular members with no visible face seams or joints, fabricated from same material as doorframe. Fasten members at crossings and to jambs by butt welding.
 - 4. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.
 - 5. Floor Anchors: Weld anchors to bottom of jambs and mullions with at least four spot welds per anchor.
 - 6. Jamb Anchors: Provide number and spacing of anchors as follows:
 - a. Masonry Type: Locate anchors not more than 18 inches from top and bottom of frame. Space anchors not more than 32 inches o.c. and as follows:
 - 1) Two anchors per jamb up to 60 inches high.
 - 2) Three anchors per jamb from 60 to 90 inches high.
 - 3) Four anchors per jamb from 90 to 120 inches high.
 - 4) Four anchors per jamb plus 1 additional anchor per jamb for each 24 inches or fraction thereof above 120 inches high.
 - b. Stud-Wall Type: Locate anchors not more than 18 inches from top and bottom of frame. Space anchors not more than 32 inches o.c. and as follows:
 - 1) Three anchors per jamb up to 60 inches high.
 - 2) Four anchors per jamb from 60 to 90 inches high.
 - 3) Five anchors per jamb from 90 to 96 inches high.
 - 4) Five anchors per jamb plus 1 additional anchor per jamb for each 24 inches or fraction thereof above 96 inches high.
 - 5) Two anchors per head for frames above 42 inches wide and mounted in metal-stud partitions.
 - c. Compression Type: Not less than two anchors in each jamb.

- d. Postinstalled Expansion Type: Locate anchors not more than 6 inches from top and bottom of frame. Space anchors not more than 26 inches o.c.
 - 7. Door Silencers: Except on weather-stripped doors, 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. Double-Door Frames: Drill stop in head jamb to receive two door silencers.
- E. Borrowed Lites: Fabricate of uncoated steel sheet, minimum thickness of 0.053 inch (16 gage).
 - 1. Borrowed Lites: receiving security or laminated glazing shall be fabricated from 0.067 inch thick, 14 gage steel sheet.
 - 2. Glazing stops for lites receiving security or laminated glazing shall not be less than 3/4 inches high.
 - 3. Construction: Face welded.
 - 4. 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 frames.
 - 5. Provide countersunk, flat- or oval-head exposed screws and bolts for exposed fasteners unless otherwise indicated.
- F. Fabricate concealed stiffeners, edge channels, and hardware reinforcement from either cold- or hot-rolled steel sheet.
- G. Hardware Preparation: Factory prepare hollow metal work to receive templated mortised hardware; include cutouts, reinforcement, mortising, drilling, and tapping according to the Door Hardware Schedule and templates furnished as specified in Section 087100 - DOOR HARDWARE.
 - 1. Locate hardware as indicated, or if not indicated, according to ANSI/SDI A250.8.
 - 2. Reinforce doors and frames to receive nontemplated, mortised and surface-mounted door hardware.
 - 3. Comply with applicable requirements in ANSI/SDI A250.6 and ANSI/DHI A115 Series specifications for preparation of hollow metal work for hardware.
 - 4. Coordinate locations of conduit and wiring boxes for electrical connections with Division 26 - ELECTRICAL.
- H. Stops and Moldings: Provide stops and moldings around glazed lites where indicated. Form corners of stops and moldings with butted or mitered hairline joints.
 - 1. Single Glazed Lites: Provide fixed stops and moldings welded on secure side of hollow metal work.
 - 2. Multiple Glazed Lites: Provide fixed and removable stops and moldings, so that each glazed lite is capable of being removed independently.
 - 3. Provide fixed frame moldings on outside of exterior and on secure side of interior doors and frames.
 - 4. Provide loose stops and moldings on inside of hollow metal work.
 - 5. Coordinate rabbet width between fixed and removable stops with type of glazing and type of installation indicated.

2.12 STEEL FINISHES

- A. Prime Finish: Apply manufacturer's standard epoxy primer immediately after cleaning and pretreating.

1. Shop Primer: Manufacturer's standard, fast-curing, lead- and chromate-free primer complying with ANSI/SDI A250.10 acceptance criteria; recommended by primer manufacturer for substrate; compatible with substrate and field-applied coatings despite prolonged exposure.
2. Refer to Section 099000 – PAINTING AND COATING for field-applied coating.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for embedded and built-in anchors to verify actual locations before frame installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Remove welded-in shipping spreaders installed at factory. Restore exposed finish by grinding, filling, and dressing, as required to make repaired area smooth, flush, and invisible on exposed faces.
- B. Prior to installation, adjust and securely brace welded hollow metal frames for squareness, alignment, twist, and plumbness to the following tolerances:
 1. Squareness: Plus or minus 1/16 inch, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
 2. Alignment: Plus or minus 1/16 inch, measured at jambs on a horizontal line parallel to plane of wall.
 3. Twist: Plus or minus 1/16 inch, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
 4. Plumbness: Plus or minus 1/16 inch, measured at jambs on a perpendicular line from head to floor.
- C. Drill and tap doors and frames to receive nontemplated, mortised, and surface-mounted door hardware.

3.3 INSTALLATION

- A. General: Install hollow metal work plumb, rigid, properly aligned, and securely fastened in place; comply with Drawings and manufacturer's written instructions.
- B. Hollow Metal Frames: Install hollow metal frames of size and profile indicated. Comply with ANSI/SDI A250.11.
 1. Set frames accurately in position, plumbed, aligned, and braced securely until permanent anchors are set. After wall construction is complete, remove temporary braces, leaving surfaces smooth and undamaged.
 - a. At fire-protection-rated openings, install frames according to NFPA 80.

- b. Where frames are fabricated in sections because of shipping or handling limitations, field splice at approved locations by welding face joint continuously; grind, fill, dress, and make splice smooth, flush, and invisible on exposed faces.
 - c. Install frames with removable glazing stops located on secure side of opening.
 - d. Remove temporary braces necessary for installation only after frames have been properly set and secured.
 - e. Check plumbness, squareness, and twist of frames as walls are constructed. Shim as necessary to comply with installation tolerances.
- 2. Floor Anchors: Provide floor anchors for each jamb and mullion that extends to floor, and secure with postinstalled expansion anchors.
 - a. Floor anchors may be set with powder-actuated fasteners instead of postinstalled expansion anchors if so indicated and approved on Shop Drawings.
- 3. Metal-Stud Partitions: Solidly pack insulation behind frames.
- 4. Masonry Walls: Coordinate installation of frames to allow for filling space between frames and masonry with insulation.
- 5. Concrete Walls: Solidly fill space between frames and concrete with insulation.
- 6. In-Place Concrete or Masonry Construction: Secure frames in place with postinstalled expansion anchors. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.
- 7. In-Place Gypsum Board Partitions: Secure frames in place with postinstalled expansion anchors through floor anchors at each jamb. Countersink anchors, and fill and make smooth, flush, and invisible on exposed faces.
- 8. Ceiling Struts: Extend struts vertically from top of frame at each jamb to overhead structural supports or substrates above frame unless frame is anchored to masonry or to other structural support at each jamb. Bend top of struts to provide flush contact for securing to supporting construction. Provide adjustable wedged or bolted anchorage to frame jamb members.
- 9. Installation Tolerances: Adjust hollow metal door frames for squareness, alignment, twist, and plumb to the following tolerances:
 - a. Squareness: Plus or minus 1/16 inch, measured at door rabbet on a line 90 degrees from jamb perpendicular to frame head.
 - b. Alignment: Plus or minus 1/16 inch, measured at jambs on a horizontal line parallel to plane of wall.
 - c. Twist: Plus or minus 1/16 inch, measured at opposite face corners of jambs on parallel lines, and perpendicular to plane of wall.
 - d. Plumbness: Plus or minus 1/16 inch, measured at jambs at floor.
- C. Hollow Metal Doors: Fit hollow metal doors accurately in frames, within clearances specified below. Shim as necessary.
 - 1. Non-Fire-Rated Standard Steel Doors:
 - a. Jambs and Head: 1/8 inch plus or minus 1/16 inch.
 - b. Between Edges of Pairs of Doors: 1/8 inch plus or minus 1/16 inch.
 - c. Between Bottom of Door and Top of Threshold: Maximum 3/8 inch.
 - d. Between Bottom of Door and Top of Finish Floor (No Threshold): Maximum 3/4 inch.
 - 2. Fire-Rated Doors: Install doors with clearances according to NFPA 80.
 - 3. Smoke-Control Doors: Install doors according to NFPA 105.
- D. Glazing: Comply with hollow metal manufacturer's written instructions.
 - 1. Secure stops 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.

3.4 ADJUSTING AND CLEANING

- A. Final Adjustments: Check and readjust operating hardware items immediately before final inspection. Leave work in complete and proper operating condition. Remove and replace defective work, including hollow metal work that is warped, bowed, or otherwise unacceptable.
- B. 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.
- C. Metallic-Coated (Galvanized/Galvannealed) Surfaces: Clean abraded areas and repair with galvanizing repair paint according to manufacturer's written instructions.

END OF SECTION 081110

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SECTION 081416 - WOOD DOORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Solid-core doors with wood-veneer faces.
 - 2. Factory finishing flush wood doors.
 - 3. Factory fitting flush wood doors to frames and factory machining for hardware.
 - 4. Factory glazing of wood doors with glazed openings indicated to receive tempered glass and fire- resistive rated glass.
- B. Related Requirements:
 - Division 08 Section "Door Hardware" for hardware and templates, and door hardware preinstallation conference.

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination." Review methods and procedures related to door installation including, but not limited to, the following:
 - 1. Meet with Owner, Architect, door installer, hardware installer, door supplier and door manufacturer's representative. Door preinstallation conference shall run concurrently with door hardware preinstallation conference.
 - 2. Review methods and procedures related to door installation, including manufacturer's written instructions.
 - 3. Review installation of fire doors, including hinge screw application to fire rated doors and requirements for door removal from frame if required after installation.
 - 4. Review door swing and closer installation to permit maximum swing without binding at frame opening.
 - 5. Review floor covering requirements to provide proper door undercut clearance.
 - 6. Review fire rated door requirements regarding no field modifications to labeled doors.
 - 7. Document proceedings, including corrective measures and actions required, and furnish copy of record to each participant.
 - 8. Provide 7 business days minimum advance notice to participants prior to convening preinstallation conference.

1.4 ACTION SUBMITTALS

- A. General: Submit in accordance with Division 01 Section "Submittal Procedures."
 - 1. Submittals for Division 08 Sections "Hollow Metal Doors and Frames," "Wood Doors," "Aluminum-Framed Entrances and Storefronts," and "Door Hardware" shall be made concurrently.

- B. Product Data: For each type of door. Include details of core and edge construction and trim for openings. Include factory-finishing specifications.
- C. Shop Drawings: Indicate location, size, and hand of each door; dimensioned elevations of each type of door; construction details not covered in Product Data; and the following:
 - 1. Dimensions and locations of blocking for hardware attachment.
 - 2. Dimensions and locations of mortises and holes for hardware.
 - 3. Dimensions and locations of cutouts.
 - 4. Undercuts and clearances.
 - a. Verify tile locations for proper clearance of door bottoms and hardware.
 - 5. Requirements for veneer matching.
 - 6. Doors to be factory finished and finish requirements.
 - 7. Fire-protection ratings for fire-rated doors.
 - 8. Details of electrical raceway and preparation for electrified hardware, access control systems, and security systems, as applicable.
- D. Door Schedule: Submit schedule of doors using same reference numbers for details and openings as those on Contract Drawings.
 - 1. Indicate coordination of glazing frames and stops with glass thickness and glazing requirements.
- E. Samples:
 - 1. Factory finishes applied to actual door face materials, approximately 8 by 10 inches, for each material and finish. For each wood species and transparent finish, provide set of three Samples showing typical range of color and grain to be expected in finished Work.
 - 2. Corner sections of doors, approximately 8 by 10 inches, 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.
 - 3. Frames for light openings, 6 inches long, for each material, type, and finish required.
 - 4. Fire-resistive glazing products, 12 inches square.

1.5 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports for fire-rated doors and egress doors.
- B. Sample Warranty: For special warranty.
- C. Preinstallation conference meeting notes.

1.6 CLOSEOUT SUBMITTALS

- A. Special warranties.
- B. Record Documents:
 - 1. For fire-rated doors, list of door numbers and applicable room name and number to which door accesses.
 - 2. For egress doors, list of door numbers and applicable room name and number to which door accesses.

- C. Fire-Rated Door Inspector Qualifications: Inspector for field quality-control inspections of fire-rated door assemblies shall comply with qualifications set forth in NFPA 80, Section 5.2.3.1 and the following:
 - 1. DHI's Fire and Egress Door Assembly Inspector (FDAI) certification.
- D. Egress Door Inspector Qualifications: Inspector for field quality-control inspections of egress door assemblies shall comply with qualifications set forth in NFPA 101, Section 7.2.1.15.4 and the following:
 - 1. DHI's Fire and Egress Door Assembly Inspector (FDAI) certification.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Comply with requirements of referenced standard and manufacturer's written instructions.
- B. Protect wood doors during transit, storage, and handling to prevent damage, soiling and deterioration. Comply with requirements of referenced standard, manufacturer's instructions, and recommendations of WDMA I.S.1, Appendix, "How to Store, Handle, Finish, Install and Maintain Wood Doors."
 - 1. Package doors at factory prior to shipping.
 - 2. Protect doors from extremes of heat and cold. Relative humidity shall not be less than 30 percent nor more than 60 percent.
 - 3. Compare prefinished doors to approved finish sample upon delivery. Notify Architect if sample does not match.
- C. Mark each door on bottom rail with opening number used on Shop Drawings.

1.8 FIELD CONDITIONS

- A. Environmental Limitations: Do not deliver or install doors until spaces are enclosed and weathertight, wet work in spaces is complete and dry, and HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during remainder of construction period.

1.9 WARRANTY

- 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. Delamination of veneer.
 - b. Warping (bow, cup, or twist) more than 1/4 inch in a 42-by-84-inch section.
 - c. Telegraphing of core construction in face veneers exceeding 0.01 inch in a 3-inch span.
 - 2. Warranty shall also include installation and finishing that may be required due to repair or replacement of defective doors.
 - 3. Warranty Period for Solid-Core Interior Doors: Life of installation.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Masonite Architectural Doors, Aspiro Select Wood Veneer Doors.
 - 2. VT Industries Inc.; Heritage Collection.
- 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 WDMA I.S.1-A, "Architectural Wood Flush Doors."
- B. WDMA I.S.1-A Performance Grade: Extra Heavy Duty.
- C. 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 (positive pressure), Category A (concealed intumescent sealing system).
 - 1. Cores: Provide core specified or mineral core as needed to provide fire-protection rating indicated.
 - 2. Edge Construction: Provide edge construction with intumescent seals concealed by outer stile. Comply with specified requirements for exposed edges.
 - 3. Blocking: Top rail blocking, lock blocks and mid rail blocking for exit devices.
 - 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.
- D. Smoke- and Draft-Control Door Assemblies: Listed and labeled for smoke and draft control by a qualified testing agency acceptable to authorities having jurisdiction, based on testing in accordance with UL 1784 and installed in compliance with NFPA 105.
- E. Particleboard-Core Doors:
 - 1. Particleboard: ANSI A208.1, Grade LD-2, complying with extra heavy duty performance level.
 - 2. Blocking: Provide wood blocking in particleboard-core doors as needed to eliminate through-bolting hardware. Provide wood blocking rails per manufacturer requirements for doors receiving parallel arm closers.
 - 3. Provide doors with 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, to eliminate through-bolting hardware to the maximum extent possible. Provide top rail blocking for closer, overhead stop and magnetic hold open attachment, lock blocks, and mid rail blocks for exit device attachment.
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.
4. Top and Bottom Rails: Structural composite lumber.
 - a. Provide top rail height not less 2-1/2 inches at doors receiving overhead stops for surface mounting of stops without through-bolting.

2.3 VENEER-FACED DOORS FOR TRANSPARENT FINISH

A. Interior Solid-Core Doors:

1. Grade: Premium, with Grade A faces.
2. Species: Select white birch or Select white maple.
3. Cut: Plain sliced (flat sliced).
4. Match between Veneer Leaves: Book match for birch veneer. Slip match if maple veneer provided.
5. Assembly of Veneer Leaves on Door Faces: Running match.
6. Match: Provide door faces of compatible color and grain for doors hung in same opening or separated only by mullions.
7. Exposed Vertical Edges: Same species as faces.
8. Core: Particleboard, except as noted otherwise.
 - a. Provide mineral cores for fire-protection rated doors.
 - b. Provide structural composite lumber cores for stile and rail configured flush doors.
 - c. Provide structural composite lumber cores for doors to receive exit devices.
9. Construction: Five 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. No substitutions.
10. WDMA I.S.1-A Performance Grade: Extra Heavy Duty.

2.4 LIGHT FRAMES

A. Metal Frames for Light Openings in Doors: Frame formed of 0.048-inch- thick, cold-rolled steel sheet; with baked-enamel- or powder-coated finish; and approved for use in doors of fire-protection rating indicated.

1. Metal frames shall be able to accommodate 1/4-inch tempered glass, 5/16-inch laminated security glass, 5/16-inch laminated glazing and 5/16-inch fire-rated glazing as applicable.
2. Metal frames shall have a not less than a 1/2-inch bite on the laminated glass and shall allow for structural silicone glazing of laminated glass on protected (interior) side of door.
3. Provide same frame profile for all glass lite kits in wood doors.
4. Product: Curries Co.; Glass Kit No. 10 or approved equal.
 - a. Frame Color: As selected by Architect from manufacturer's standard color options.

2.5 GLAZING IN DOORS

- A. Safety Glass for Non-Rated Doors: ASTM C 1048; Kind FT (fully tempered), Condition A (uncoated), Type I (transparent flat glass); Class 1 (clear); Quality q3 (glazing select).
 - 1. Thickness: 6.0 mm (0.23 inch) thick minimum.
 - 2. Safety Glazing Labeling: Permanently mark glazing with certification label of the SGCC. Label shall indicate manufacturer's name, type of glass, thickness, and safety glazing standard with which glass complies.
- B. Laminated Ceramic Glazing for Fire-Rated Doors: Laminated glass made from 2 plies of clear, ceramic flat glass; not less than 5/16-inch total nominal thickness; complying with testing requirements in 16 CFR 1201 for Category II materials; UL 10C compliant; hose stream tested.
 - 1. Fire-Protection Rating: As indicated for the assembly in which glazing material is installed.
 - 2. Fire-Protection-Rated Glazing: Listed and labeled by Underwriters Laboratories (UL), for fire-protection ratings indicated, based on testing according to NFPA 252 for door assemblies.
 - a. Labeling: Permanently mark fire-protection-rated glazing with certification label of a testing agency. Label shall indicate manufacturer's name, test standard, whether glazing is for use in fire doors or other openings, whether or not glazing passes hose-stream test, whether or not glazing has a temperature rise rating of 450 deg F, and the fire-resistance rating in minutes.
 - 3. Products:
 - a. Technical Glass Products; FireLite Plus.
 - b. Schott North America, Inc.; PYRAN Platinum L.
 - c. Vetrotech Saint-Gobain; Keralite Select L.
- C. Doors with laminated glass that is not fire-rated shall be field glazed in Division 08 "Glazing." Provide metal frame glass lite kits for the doors.

2.6 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.
 - 2. Coordinate sizing of pairs of doors to provide the following maximum gap between leaves to permit proper functioning of dead latching feature:
 - a. Rated Doors: Maximum 1/8-inch gap.
 - b. Non-Rated Doors: Maximum 3/16-inch gap.
- 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 glazed. Comply with applicable installation requirements in Division 08 Section "Glazing."

2.7 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 bottom edges, edges of cutouts, and mortises.
- B. Factory finish doors.
- C. Transparent Finish:
 - 1. Grade: Custom.
 - 2. Finish: WDMA TR-6 catalyzed polyurethane.
 - 3. Staining: None required.
 - 4. Sheen: Satin.

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 Division 08 Section "Door Hardware."
 - 1. Hinges shall be shimmed with metal shims at each door to provide equal clearance at each jamb.
 - 2. Locks, exit devices, door closers and other hardware shall be installed in accordance with the manufacturer's instructions. Pilot holes of recommended size, for wood screws required to fasten hardware, shall be drilled by installing Contractor before screws are fastened to wood doors.
- 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-control doors according to NFPA 105.
- C. Factory-Fitted Doors: Align in frames for uniform clearance at each edge. Coordinate pairs of doors to provide the following maximum gap between leafs and accurate alignment of strike to permit proper functioning of dead latching feature:
 - 1. Rated Doors: Maximum 1/8-inch gap.
 - 2. Non-Rated Doors: Maximum 3/16-inch gap.
- D. Factory-Finished Doors: Restore finish before installation if fitting or machining is required at Project site.

3.3 FIELD QUALITY CONTROL

- A. Inspection Agency: Engage a qualified inspector to perform inspections and to furnish reports to Architect.
- B. Inspections:
 - 1. Fire-Rated Door Inspections: Inspect each fire-rated door in accordance with NFPA 80, Section 5.2.
 - 2. Egress Door Inspections: Inspect each door equipped with panic hardware, each door equipped with fire exit hardware, each door located in an exit enclosure, each electrically controlled egress door, and each door equipped with special locking arrangements in accordance with NFPA 101, Section 7.2.1.15.
- C. Repair or remove and replace installations where inspections indicate that they do not comply with specified requirements.
- D. Reinspect repaired or replaced installations to determine if replaced or repaired door assembly installations comply with specified requirements.
- E. Prepare and submit separate inspection report for each fire-rated door assembly indicating compliance with each item listed in NFPA 80 and NFPA 101.

3.4 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 083113 - ACCESS DOORS AND FRAMES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawing and general provisions of the Contract, including General and Supplementary Conditions apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Wall access doors and frames.
 - 2. Ceiling access doors and frames.
- B. Related Sections include the following:
 - 1. Division 23 Sections for heating and air-conditioning duct access doors.

1.3 SUBMITTALS

- A. General: Submit in accordance with Division 01 Section "Submittal Procedures."
- B. Product Data: For each type of door and frame indicated. Include construction details, fire ratings, materials, individual components and profiles, and finishes.
- C. Shop Drawings: Show fabrication and installation details of access doors and frames for each type of substrate. Include plans, elevations, sections, details, and attachments to other Work.
- D. Access Door and Frame Schedule: Provide complete access door and frame schedule, including types, locations, sizes, latching or locking provisions, and other data pertinent to installation.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain access door(s) and frame(s) through one source from a single manufacturer.
- B. Fire-Rated Access Doors and Frames: Units complying with NFPA 80 that are identical to access door and frame assemblies tested for fire-test-response characteristics according to the following test method and that are labeled and listed by UL or another testing and inspecting agency acceptable to authorities having jurisdiction:
 - 1. NFPA 252 or UL 10B for fire-rated access door assemblies installed vertically.
 - 2. NFPA 288 for fire-rated access door assemblies installed horizontally.
- C. Size Variations: Obtain Architect's acceptance of manufacturer's standard-size units, which may vary slightly from sizes indicated.

1.5 COORDINATION

- A. Verification: Determine specific locations and sizes for access doors needed to gain access to concealed equipment. Coordinate with architectural, plumbing and mechanical drawings for locations of wall and ceiling access doors and frames.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products: Subject to compliance with requirements, provide one of the products listed in other Part 2 articles.

2.2 STEEL MATERIALS

- A. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.
 - 1. ASTM A 123/A 123M, for galvanizing steel and iron products.
 - 2. ASTM A 153/A 153M, for galvanizing steel and iron hardware.
- B. Steel Sheet: Uncoated cold-rolled steel sheet substrate complying with ASTM A 1008/A 1008M, Commercial Steel (CS), exposed.
- C. Steel Finishes: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
 - 1. Surface Preparation for Steel Sheet: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, or other contaminants that could impair paint bond. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or SSPC-SP 8, "Pickling."
 - 2. Factory-Primed Finish: Apply shop primer immediately after cleaning and pretreating.
- D. Drywall Beads: Edge trim formed from 0.0299-inch zinc-coated steel sheet formed to receive joint compound and in size to suit thickness of gypsum board.

2.3 STAINLESS-STEEL MATERIALS

- A. Stainless-Steel Sheet, Strip, Plate, and Flat Bars: ASTM A 666, Type 304. Remove tool and die marks and stretch lines or blend into finish.
 - 1. Finish: Directional Satin Finish, No. 4.

2.4 PAINT

- A. Shop Primer for Ferrous Metal: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with performance requirements in FS TT-P-664; selected for good resistance to normal atmospheric corrosion, compatibility with finish paint systems indicated, and capability to provide a sound foundation for field-applied topcoats despite prolonged exposure.

2.5 ACCESS DOORS AND FRAMES

- A. Flush, Insulated, Fire-Rated Access Doors and Trimless Frames for Drywall: Fabricated from steel sheet, except as indicated otherwise. Provide stainless steel sheet for units in walls within locker rooms, shower rooms, kitchens, toilet rooms, and janitor's closets and for units adjacent to sinks, water closets, urinals and similar fixtures that could cause fluids to come into contact with access door and frame.
 - 1. Locations: Gypsum board wall and ceiling surfaces.
 - 2. Fire-Resistance Rating: Not less than that of adjacent construction.
 - 3. Door: Flush panel with a core of mineral-fiber insulation enclosed in sheet metal with a minimum thickness of 0.036 inch (20 gage).

4. Frame: Minimum 0.060-inch- (16 gage) thick sheet metal with drywall bead.
 5. Hinges: Concealed pin type or continuous piano hinge (stainless steel for stainless steel units).
 6. Automatic Closer: Spring type.
 7. Latch: Self-latching bolt operated by flush screwdriver with interior release.
 8. Lock: Self-latching device with cylinder lock in locations accessible by the public. Cylinder locks shall be keyed alike with two keys per lock.
 9. Products:
 - a. J. L. Industries, Inc.; FDWB.
 - b. Karp Associates, Inc.; KRP-350 FR.
 - c. The Williams Brothers Corporation of America; WB-FR Standard for drywall.
 - d. Provide comparable products where stainless steel units are indicated.
- B. Flush Access Doors and Trimless Frames for Drywall: Fabricated from steel sheet, except as indicated otherwise. Provide stainless steel sheet for units in walls within locker rooms, shower rooms, kitchens, toilet rooms, and janitor's closets and for units adjacent to sinks, water closets, urinals and similar fixtures that could cause fluids to come into contact with access door and frame.
1. Locations: Gypsum board wall and ceiling surfaces.
 2. Door: Minimum 0.070-inch- thick (14 gage) sheet metal, set flush with surrounding finish surfaces.
 3. Frame: Minimum 0.060-inch- thick (16 gage) sheet metal with drywall bead.
 4. Hinges: Spring-loaded concealed pin type or continuous piano hinge (stainless steel for stainless steel units).
 5. Latch: Screwdriver- operated cam latch.
 6. Lock: Key-operated cylinder lock in locations accessible by the public. Cylinder locks shall be keyed alike with two keys per lock.
 7. Products:
 - a. J. L. Industries, Inc.; Model WB.
 - b. Karp Associates, Inc.; KDW.
 - c. The Williams Brothers Corporation of America; WB-DW.
 - d. Provide comparable products where stainless steel units are indicated.

2.6 FABRICATION

- A. General: Provide access door and frame assemblies manufactured as integral units ready for installation.
- B. Metal Surfaces: For metal surfaces exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.
- C. Steel Doors and Frames: Grind exposed welds smooth and flush with adjacent surfaces. Furnish attachment devices and fasteners of type required to secure access panels to types of supports indicated.
 1. Exposed Flanges: Nominal 1 to 1-1/2 inches wide around perimeter of frame.
 2. For trimless frames with drywall bead for installation in gypsum board assembly, provide edge trim for gypsum board securely attached to perimeter of frames.
 3. Provide mounting holes in frames to attach frames to metal framing.
 4. Provide mounting holes in frame for attachment of masonry anchors. Furnish adjustable metal masonry anchors.

- D. Latching Mechanisms: Furnish number required to hold doors in flush, smooth plane when closed.
 - 1. For cylinder lock, furnish two keys per lock and key all locks alike.

2.7 FINISHES, GENERAL

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Finish metal fabrications after assembly.

2.8 STEEL FINISHES

- A. Surface Preparation: Prepare uncoated ferrous-metal surfaces to comply with minimum requirements indicated below for SSPC surface-preparation specifications and environmental exposure conditions of installed metal fabrications:
 - 1. Interiors (SSPC Zone 1A): SSPC-SP 3, "Power Tool Cleaning."
- B. Apply shop primer to uncoated surfaces of metal fabrications. Comply with SSPC-PA 1, "Paint Application Specification No. 1," for shop painting.

2.9 STAINLESS-STEEL FINISHES

- A. Remove tool and die marks and stretch lines or blend into finish.
- B. Grind and polish surfaces to produce uniform, directionally textured, polished finish indicated, free of cross scratches. Run grain with long dimension of each piece.
- C. Bright, Directional Polish: No. 4 finish.
 - 1. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with manufacturer's written instructions for installing access doors and frames.
- B. Set frames accurately in position and attach securely to supports with plane of face panels aligned with adjacent finish surfaces.
- C. Install access doors with trimless frames flush with adjacent finish surfaces or recessed to receive finish material.

3.2 ADJUSTING AND CLEANING

- A. Adjust doors and hardware after installation for proper operation.
- B. Remove and replace doors and frames that are warped, bowed, or otherwise damaged.

END OF SECTION 083113

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SECTION 084113 - ALUMINUM-FRAMED ENTRANCES AND STOREFRONTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Exterior and interior storefront framing.
 - 2. Exterior and interior manual-swing entrance doors.
 - 3. Interior door frames, sidelights, and borrow lights.
 - 4. Brake metal in conjunction with frames.
 - 5. Door hardware.
 - 6. Sealant at interior and exterior perimeter of storefront.
- B. Related Requirements:
 - 1. Division 01 Section "Integrated Exterior Mockups" for on-site constructed mock-up requirements.
 - 2. Division 07 Section 070800 "Building Envelope Commissioning" for Contractor's responsibilities in commissioning of building enclosure and coordination with Owner's commissioning agent.
 - 3. Division 07 Section "Joint Sealants" for installation requirements of joint sealants installed with aluminum-framed systems and for sealants to the extent not specified in this Section.
 - 4. Division 08 Section "Glazing" for glazing and spandrel panel requirements to the extent not specified in this Section.
 - 5. Division 26 and 27 sections for conduits, access control and intrusion low voltage wiring, mag switches door operators, and miscellaneous equipment and accessories installed in conjunction with aluminum framed entrances and storefronts.
- C. Products installed, but not furnished, under this Section include the following:
 - 1. Balance of door hardware for aluminum doors furnished in Division 08 Section "Door Hardware."

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site. Comply with requirements in Division 01 Section "Project Management and Coordination." Review methods and procedures related to glazed aluminum storefront and entrance systems including, but not limited to, the following:
 - 1. Meet with Owner; Architect; Owner's commissioning agent, storefront and entrance systems Installer; storefront and entrance systems manufacturer's representative; and installers whose work interfaces with or affects storefront and entrance systems.
 - 2. Inspect and discuss condition of substrate and other preparatory work performed by other trades.
 - 3. Review structural loading limitations.

4. Review coordination and tie in to air vapor barrier.
 5. Review requirements for low voltage wiring concealed within storefront framing for access controls and intrusion detection systems.
 6. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
 7. Review required inspecting, testing, and certifying procedures.
 8. Review weather and forecasted weather conditions and procedures for coping with unfavorable conditions.
 9. Review temporary protection requirements for existing construction during and after installation.
 10. Document proceedings, including corrective measures and actions required, and furnish copy of record to each participant.
 11. Provide minimum advance notice of 7 business days to participants prior to convening preinstallation conference.
- B. Building Envelope Commissioning: Participate in building envelope commissioning pre-construction meeting and progress meetings as required by the Contractor and the Commissioning Agent.

1.4 ACTION SUBMITTALS

- A. General: Submit in accordance with Division 01 Section "Submittal Procedures."
1. Submittals for Division 08 Sections "Hollow Metal Doors and Frames," "Wood Doors," "Aluminum-Framed Entrances and Storefronts," and "Door Hardware" shall be made concurrently.
- B. Product Data: For each type of product.
1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes. Include manufacturer's installation instructions for system(s) specified.
 2. For sealants and sealant primers used inside the weatherproofing system, include printed statement of VOC content.
- C. Shop Drawings: For aluminum-framed entrances and storefronts prepared by or under the supervision of a qualified professional structural engineer. Include plans, elevations, sections, full-size details of components, masonry openings, flashing, and attachments to other work.
1. Include details of provisions for assembly expansion and contraction and for draining moisture occurring within the assembly to the exterior.
 2. Include full-size isometric details of each vertical-to-horizontal intersection of aluminum-framed entrances and storefronts, showing the following:
 - a. Joinery, including concealed welds.
 - b. Anchorage.
 - c. Expansion provisions.
 - d. Glazing.
 - e. Flashing and drainage.
 - f. Wet glazing to retain laminated insulating glass and security glass.
 3. Show connection to and continuity with adjacent thermal, weather, air, and vapor barriers.
 4. For entrance doors, include hardware schedule and indicate operating hardware types, functions, quantities, and locations.

- a. Provide details for hardware reinforcement for closers, overhead stops, hinges and miscellaneous auxiliary hardware.
 - b. Obtain templates for hardware furnished in Section 087100 and prep doors and frames for proper installation and operation.
- 5. Indicate fastener layout and size for transferring loads back to supporting structure.

D. Samples for Initial Selection:

- 1. Initial Selection of Sealant Color: Manufacturer's color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view.
- 2. Aluminum: Factory applied color finishes as selected by Architect.

E. Entrance Door Hardware Schedule: Prepared by or under supervision of supplier, detailing fabrication and assembly of entrance door hardware, as well as procedures and diagrams. Coordinate final entrance door hardware schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of entrance door hardware.

F. Delegated-Design Submittal: For aluminum-framed entrances and storefronts 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. Calculations shall be prepared by a professional structural engineer registered in the state where the project is located.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer signed by manufacturer certifying that Installers comply with requirements in "Quality Assurance" Article and professional engineer.
- B. Product Test Reports: For aluminum-framed entrances and storefronts, for tests performed by a qualified independent testing agency. Tests shall be based on manufacturer's current system and shall indicate compliance with performance requirements.
- D. Field quality-control reports.
- E. Inspection report of egress doors.
- F. Preinstallation conference meeting notes.
- G. Sample Warranties: For special warranties.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For aluminum-framed entrances and storefronts to include in maintenance manuals.
 - 1. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions as needed for Owner's continued adjustment, maintenance, and removal and replacement of entrance door hardware.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.
 - 1. Engineering Responsibility: Preparation of data for glazed aluminum storefront systems including the following:
 - a. Shop Drawings based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project and submission of reports of tests performed on manufacturer's standard assemblies.
- B. Professional Engineer Qualifications: A professional structural engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of kind indicated. Engineering services are defined as those performed for installations of glazed storefront systems that are similar to those indicated for this Project in material, design, and extent.
- C. Product Options: Information on Drawings and in Specifications establishes requirements for aesthetic effects and performance characteristics of assemblies. Aesthetic effects are indicated by dimensions, arrangements, alignment, and profiles of components and assemblies as they relate to sightlines, to one another, and to adjoining construction. Performance characteristics are indicated by criteria subject to verification by one or more methods including preconstruction testing, field testing, and in-service performance.
 - 1. Do not change intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If changes are proposed, submit comprehensive explanatory data to Architect for review.

1.8 MOCKUPS

- A. Mockups: Build mockups to verify selections made under Sample submittals and to demonstrate aesthetic effects and set quality standards for fabrication and installation.
 - 1. Build mockup of typical curtain wall at location on the building as directed by the commissioning agent. Comply with requirements of Section 014130 "Integrated Exterior Mockups" for on-site constructed mock-up requirements.
 - 2. Comply with requirements of Section 070800 "Building Envelope Commissioning."
 - 3. The Owner's commissioning agent will inspect the mockup.
 - 4. If Architect determines mockups do not comply with requirements, reconstruct mockups until mockups are approved.
 - 5. Testing shall be performed on mockups according to requirements in "Field Quality Control" Article.
 - 6. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.

1.9 PROJECT CONDITIONS

- A. Field Measurements: Verify actual locations of structural supports for aluminum-framed systems by field measurements before fabrication and indicate measurements on Shop Drawings.
 - 1. Coordinate rough opening, masonry opening, and wood blocking requirements.

1.10 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of aluminum-framed entrances and storefronts that do not comply with requirements or that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures including, but not limited to, excessive deflection.
 - b. Failure of system to meet performance requirements.
 - c. Noise or vibration created by wind and thermal and structural movements.
 - d. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
 - e. Adhesive or cohesive sealant failures.
 - f. Water penetration through fixed glazing and framing areas.
 - g. Failure of operating components.
 - h. Glazing breakage.
 - 2. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Division 01 Section "Quality Requirements," to design aluminum-framed entrances and storefronts.
 - 1. Calculations shall be prepared by a professional structural engineer registered in the state where the project is located.
- B. General Performance: Comply with performance requirements specified, as determined by testing of aluminum-framed entrances and storefronts representing those indicated for this Project without failure due to defective manufacture, fabrication, installation, or other defects in construction.
 - 1. Aluminum-framed entrances and storefronts shall withstand movements of supporting structure including, but not limited to, column shortening, long-term creep, and deflection from uniformly distributed and concentrated live loads..
 - 2. Failure also includes the following:
 - a. Thermal stresses transferring to building structure.
 - b. Deflection exceeding specified limits.
 - c. Framing members transferring stresses, including those caused by thermal and structural movements to glazing.
 - d. Glass breakage.
 - e. Noise or vibration created by wind and thermal and structural movements.
 - f. Loosening or weakening of fasteners, attachments, and other components.
 - g. Failure of operating units.
 - h. Sealant failure.
- C. Structural Loads: Aluminum-framed entrances and storefronts shall be capable of withstanding the effects of the following loads as required by IBC 2015 and ASCE 7-10 as follows:
 - 1. Wind Loads:
 - a. Basic Wind Speed: 120 MPH (3 Second Gust).
 - b. Exposure Category: B.
 - 2. Wind Design Pressures:

- a. Zone 4 - Field of Wall Pressures: Positive 23.4 psf and negative 25.6 psf.
 - b. Zone 5 - Building Corners (Within 11 Feet in Each Direction of Corner): Positive 23.4 psf and negative 29.4 psf.
- D. Deflection of Framing Members: At design wind pressure, as follows:
 - 1. Deflection Normal to Wall Plane: Limited to 1/175 of clear span for spans up to 13 feet 6 inches and to 1/240 of clear span plus 1/4 inch for spans greater than 13 feet 6 inches or an amount that restricts edge deflection of individual glazing lites to 3/4 inch, whichever is less.
 - 2. Deflection Parallel to Glazing Plane: Limited to 1/360 of clear span or 1/8 inch, whichever is smaller.
 - a. Operable Units: Provide a minimum 1/16-inch clearance between framing members and operable units.
 - 3. Cantilever Deflection: Where framing members overhang an anchor point, as follows:
 - a. Perpendicular to Plane of Wall: No greater than 1/240 of clear span plus 1/4 inch for spans greater than 11 feet 8-1/4 inches or 1/175 times span, for spans less than 11 feet 8-1/4 inches.
- E. Structural: Test according to ASTM E 330 as follows:
 - 1. When tested at positive and negative wind-load design pressures, assemblies do not evidence deflection exceeding specified limits.
 - 2. When tested at 150 percent of positive and negative wind-load design pressures, assemblies, including anchorage, do not evidence material failures, structural distress, or permanent deformation of main framing members exceeding 0.2 percent of span.
 - 3. Test Durations: As required by design wind velocity, but not less than 10 seconds.
- F. Air Infiltration: Test according to ASTM E 283 for infiltration as follows:
 - 1. Fixed Framing and Glass Area:
 - a. Maximum air leakage of 0.06 cfm/sq. ft. at a static-air-pressure differential of 1.57 lbf/sq. ft..
 - 2. Entrance Doors:
 - a. Pair of Doors: Maximum air leakage of 1.0 cfm/sq. ft. at a static-air-pressure differential of 1.57 lbf/sq. ft.
- G. Water Penetration under Static Pressure: Test according to ASTM E 331 as follows:
 - 1. No evidence of water penetration through fixed glazing and framing areas when tested according to a minimum static-air-pressure differential of 20 percent of positive wind-load design pressure, but not less than 6.24 lbf/sq. ft..
- H. Energy Performance: Certify and label energy performance according to NFRC as follows:
 - 1. Thermal Transmittance (U-factor): Fixed glazing and framing areas shall have U-factor of not more than 0.69 Btu/sq. ft. x h x deg F as determined according to NFRC 100.
 - 2. Solar Heat Gain Coefficient: Fixed glazing and framing areas shall have a solar heat gain coefficient of no greater than 0.20 as determined according to NFRC 200.
 - 3. Condensation Resistance: Fixed glazing and framing areas shall have an NFRC-certified condensation resistance rating of no less than 62 as determined according to NFRC 500.
- I. Thermal Movements: Allow for thermal movements resulting from ambient and surface temperature changes:
 - 1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

2. Thermal Cycling: No buckling; stress on glass; sealant failure; excess stress on framing, anchors, and fasteners; or reduction of performance when tested according to AAMA 501.5.
 - a. High Exterior Ambient-Air Temperature: That which produces an exterior metal-surface temperature of 180 deg F.
 - b. Low Exterior Ambient-Air Temperature: 0 deg F.
 - c. Interior Ambient-Air Temperature: 75 deg F.

2.2 MANUFACTURERS

- A. Products: Subject to compliance with requirements, provide one of the following:
 1. Kawneer North America:
 - a. Exterior Storefront and Entrances: Trifab 451T frames with 500 Heavy Wall Entrances with glazing stops from 500 IR Heavy Wall Entrances.
 - b. Interior Storefront and Entrances (Vestibules): Trifab VG 451 frames with 500 Heavy Wall Entrances with glazing stops from 500 IR Heavy Wall Entrances.
 - c. Interior Storefront and Entrances: Trifab 451 frames with 500 Heavy Wall Entrances.
 2. Oldcastle Building Envelope:
 - a. Exterior Storefront and Entrances: Series 3000 Thermal MultiPlane Storefront System with Rugged WS (Wide Stile) Entrances with glazing stops from WSD-500 StormMax Entrance Doors.
 - b. Interior Storefront and Entrances (Vestibules): Series 3000 with Series 500 Rugged WS (Wide Stile) Entrances with glazing stops from WSD-500 StormMax Entrance Doors.
 - c. Interior Storefront and Entrances: Series 3000 with Series 500 Rugged WS (Wide Stile) Entrances.
 3. Tubelite:
 - a. Exterior Storefront and Entrances: T14000 I/O Series Multiplane frames with Monumental Wide Stile Entrances with glazing stops from ForceFront Storm Monumental Wide Stile Doors.
 - b. Interior Storefront and Entrances (Vestibules): E14000 frames with Monumental Wide Stile Entrances with glazing stops from ForceFront Storm Monumental Wide Stile Doors.
 - c. Interior Storefront and Entrances: E14000 frames with Monumental Wide Stile Entrances.
- B. Source Limitations: Obtain all components of aluminum-framed entrance and storefront system, including framing, entrance doors, and accessories, from single manufacturer.
 1. Aluminum-framed entrances and storefront systems specified in this Section and curtain wall system specified in Division 08 Section "Glazed Aluminum Curtain Wall" shall be from same manufacturer.

2.3 FRAMING

- A. Framing Members: Manufacturer's extruded- or formed-aluminum framing members of thickness required and reinforced as required to support imposed loads.
 1. Construction: As follows:
 - a. Exterior Framing Members: Composite assemblies of two separate extruded-aluminum components permanently bonded by an elastomeric material of low thermal conductance.

- 1) Where required by wind loads, provide heavy wall members or internal reinforcement.
 - b. Interior Framing Members: Nonthermal.
 2. Glazing System: As follows:
 - a. For Storefront and Entrances Indicated to Receive LAM, LAM-IG or SG Glazing: Retained mechanically with gaskets on unprotected side (exterior side) and wet glazed with structural silicone sealant on protected side (interior side).
 - 1) Structural silicone sealant required to retain the laminated glass, security glass and laminated IG units in place during forced entry attack.
 - b. For Storefront Transoms Indicated to Receive IG Glass or Tempered Glass: Retained mechanically with gaskets on four sides.
 3. Glazing Plane: Center.
 4. Finish: Clear anodic finish for storefront and entrances used within the interior of the building, and high-performance organic finish for storefront and entrances used in exterior walls.
 5. Fabrication Method: Screw spline system.
 6. Provide components having face width indicated on Drawings.
 7. Provide thermally broken extruded aluminum subframes for storefront sills.
 8. Provide thermally broken extruded aluminum sill flashing with end dams for exterior storefronts.
 9. Provide operable door units manufactured by storefront system manufacturer.
- B. Backer Plates: Manufacturer's standard, continuous backer plates for framing members, if not integral, where framing abuts adjacent construction.
- C. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum with nonstaining, nonferrous shims for aligning system components.
1. Provide extra-heavy reinforcement for hinges and closers for doors and frames.
 2. Provide extra-heavy reinforcement for doors and frames receiving concealed overhead stops. Specified stop manufacturer's installation indicates doors and frames be properly reinforced with 3/16-inch minimum thickness plate.
- D. Materials:
1. Aluminum: Alloy and temper recommended by manufacturer for type of use and finish indicated.
 - a. Sheet and Plate: ASTM B 209.
 - b. Extruded Bars, Rods, Profiles, and Tubes: ASTM B 221.
 - c. Extruded Structural Pipe and Tubes: ASTM B 429/B 429M.
 - d. Structural Profiles: ASTM B 308/B 308M.
 2. Steel Reinforcement: Manufacturer's standard zinc-rich, corrosion-resistant primer complying with SSPC-PS Guide No. 12.00; applied immediately after surface preparation and pretreatment. Select surface preparation methods according to recommendations in SSPC-SP COM, and prepare surfaces according to applicable SSPC standard.
 - a. Structural Shapes, Plates, and Bars: ASTM A 36/A 36M.
 - b. Cold-Rolled Sheet and Strip: ASTM A 1008/A 1008M.
 - c. Hot-Rolled Sheet and Strip: ASTM A 1011/A 1011M.

2.4 ENTRANCE DOOR SYSTEMS

- A. Entrance Doors: Manufacturer's standard glazed entrance doors for manual- and power-assisted-swing operation.

1. Door Construction: 2-inch overall thickness, with minimum 0.188-inch- thick, extruded-aluminum tubular rail and stile members. Mechanically fasten corners with reinforcing brackets that are deeply penetrated and fillet welded or that incorporate concealed tie rods.
2. Door Design: Wide stile; 5-inch nominal width with 10-inch high bottom rail, and 6-inch cross rail.
3. Glazing Stops and Gaskets: As follows:
 - a. Provide nonremovable glazing stops on outside of exterior doors and to nonsecured side of interior doors.
 - b. Glazing Stops for Exterior Doors and Interior Vestibule Doors: Stops shall be stops from hurricane-resistant door assemblies; finished to match frame.
 - 1) Stops shall provide a minimum 1/2-inch bite on the security glass (SG) and insulated laminated glass (LAM-IG) to retain the glass during forced entry attack.
 - 2) Glazing to be wet glazed with structural silicone sealant on protected side (interior side) as specified in Division 08 Section "Glazing" to retain the glass during forced entry attack.
 - c. Glazing Stops for Interior Doors, Sidelites and Borrowlites: Manufacturer's standard height stops.
 - 1) Glazing to be wet glazed with structural silicone sealant on protected side (interior side) as specified in Division 08 Section "Glazing" to retain the glass during forced entry attack.
4. Reinforcing: Provide supplemental reinforcing plates for door hardware attachment, including hinges, closers and overhead stops.

2.5 DOOR HARDWARE

- A. General: Provide heavy-duty units in sizes, numbers, and types recommended by entrance system and hardware manufacturers for entrances and uses indicated. Finish exposed parts to match door finish, unless otherwise indicated. Provide specified manufacturers without substitution.
 1. Opening-Force Requirements:
 - a. Egress Doors: Not more than 15 lbf to release the latch and not more than 30 lbf to set the door in motion and not more than 15 lbf to open the door to its minimum required width.
 - b. Accessible Interior Doors: Not more than 5 lbf to fully open door.
- B. Continuous, Gear-Type Hinges: Heavy-duty, extruded aluminum, pinless, concealed geared hinge leaves; joined by a continuous extruded aluminum channel cap; with concealed, self-lubricating with stainless-steel bearings between knuckles; fabricated one piece without splices full height of door and frame. Finish to match doors. Provide continuous hinges for interior and exterior aluminum doors.
 1. Manufacturer: Select Hinges. No substitution.
 - a. Coordinate EPT product being supplied and template cutout requirements with Section 087100 hardware supplier
- C. Weather Stripping: Manufacturer's standard replaceable components.
 1. Compression Type: Made of ASTM D 2000, molded neoprene, or ASTM D 2287, molded PVC. Provide at head and jamb of all exterior doors for weather control.

- D. Weather Sweeps: Manufacturer's standard exterior-door bottom sweep with concealed fasteners on mounting strip.
- E. Silencers: BHMA A156.16, Grade 1.
- F. Thresholds: BHMA A156.21, raised thresholds beveled with a slope of not more than 1:2, with maximum height of 1/2 inch, thermally broken. Coordinate cutouts for operating hardware with anchors and jamb clips. Provide 1/4 inch high
 - 1. Material: Aluminum, mill finish.
 - 2. Provide 1/4 inch high thresholds at door openings C101D, C101E, C101F.
 - 3. Provide half saddle threshold to butt tight to entrance mat frames or tile at door openings A101, A101A, A101B, B132, A101C, B132, B132A, C108B, C108C, D139.
- G. Balance of Hardware: Furnished in Division 08 Section "Door Hardware" for installation with the aluminum door and frame installation.

2.6 GLAZING

- A. Glazing: Specified in Section 088000 "Glazing."
- B. Weatherseal Sealants: ASTM C 920 for Type S; Grade NS; Class 25; Uses NT, G, A, and O; chemically curing silicone formulation that is compatible with structural sealant and other system components with which it comes in contact; recommended by structural-sealant, weatherseal-sealant, and structural-sealant-glazed storefront manufacturers for this use.
 - 1. Color: As selected by Architect.

2.7 ACCESSORIES

- A. Fasteners and Accessories: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding fasteners and accessories compatible with adjacent materials.
 - 1. Use self-locking devices where fasteners are subject to loosening or turning out from thermal and structural movements, wind loads, or vibration.
 - 2. Reinforce members to receive fastener threads.
 - 3. Do not use exposed fasteners, except for hardware application. For hardware application, use exposed fasteners with countersunk Phillips screw heads, stainless steel, finished to match framing system or hardware being fastened, unless otherwise noted.
- B. Anchors: Three-way adjustable anchors with minimum adjustment of 1 inch that accommodate fabrication and installation tolerances in material and finish compatible with adjoining materials and recommended by manufacturer.
 - 1. Concrete and Masonry Inserts: Hot-dip galvanized cast-iron, malleable-iron, or steel inserts complying with ASTM A 123/A 123M or ASTM A 153/A 153M requirements.
- C. Concealed Flashing: Manufacturer's standard corrosion-resistant, nonstaining, nonbleeding flashing compatible with adjacent materials.
- D. Bituminous Paint: Cold-applied asphalt-mastic paint complying with SSPC-Paint 12 requirements except containing no asbestos, formulated for 30-mil thickness per coat.

- E. Aluminum Brake Metal: Form exposed flashing from sheet aluminum finished to match framing and of sufficient thickness, not less than 0.063-inch thick, to maintain a flat appearance without visible deflection.
- F. Insulation Foam Sealant: On-site foam-in-place, single polyurethane component foam insulation sealant; Class 1 foam.
 - 1. Products:
 - a. GREAT STUFF PRO Gaps & Cracks Insulating Foam Sealant; Dow Chemical Company (The).
 - b. Insulating Foam Sealant Gaps & Cracks; Owens Corning Foam Insulation, LLC.

2.8 FABRICATION

- A. General: Fabricate glazed aluminum storefront and entrances systems assemblies according to approved Shop Drawings. Fabricate components that, when assembled, will have accurately fitted joints with ends coped or mitered to produce hairline joints free of burrs and distortion. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.
- B. Form or extrude aluminum shapes before finishing.
- C. Weld in concealed locations to greatest extent possible to minimize distortion or discoloration of finish. Remove weld spatter and welding oxides from exposed surfaces by descaling or grinding.
- D. Fabricate components that, when assembled, have the following characteristics:
 - 1. Profiles that are sharp, straight, and free of defects or deformations.
 - 2. Accurately fitted joints with ends coped or mitered.
 - 3. Physical and thermal isolation of glazing from framing members.
 - 4. Means to drain water passing joints, condensation within framing members, and moisture migrating within the system to exterior.
 - 5. Accommodations for thermal and mechanical movements of glazing and framing to maintain required glazing edge clearances.
 - 6. Provisions for field replacement of glazing from exterior.
 - 7. Fasteners, anchors, and connection devices that are concealed from view to greatest extent possible.
- E. Mechanically Glazed Framing Members: Fabricate for flush glazing without projecting stops.
 - 1. Glazing for exterior and vestibule storefront assemblies and entrances, except transoms, shall be wet seal glazed with silicone structural glazing sealant on the protected side (interior side) to retain glass during physical attack.
 - 2. Glazing for interior storefront sidelights and borrow lights receiving laminated glass (LAM) and receiving butt glazing shall be wet seal glazed with silicone structural glazing sealant on the protected side (interior side) to retain glass during physical attack.
 - 3. Glazing for storefront assemblies in exterior transoms and vestibule transoms and other storefront locations shall be standard glazing.
- F. Structural-Sealant-Glazed Framing Members: Include accommodations for using temporary support device to retain glazing in place while structural sealant cures.
- G. Storefront Framing: Fabricate components for assembly using screw-spline system.

- H. Entrance Door Frames: Reinforce as required to support loads imposed by door operation and for installing entrance door hardware.
 - 1. At exterior doors, provide compression weather stripping at fixed stops.
 - 2. At interior doors, provide silencers at stops to prevent metal-to-metal contact. Install three silencers on strike jamb of single-door frames and two silencers on head of frames for pairs of doors.
- I. Entrance Doors: Reinforce doors as required to support loads imposed by door operation and for installing entrance door hardware.
 - 1. At pairs of exterior doors, provide sliding-type weather stripping retained in adjustable strip and mortised into door edge.
 - 2. At exterior doors, provide weather sweeps applied to door bottoms.
 - 3. Glazing stops for doors shall be stops from hurricane-resistant door assemblies.
 - 4. Protected side (interior side) of glazing shall be wet seal glazed with silicone structural glazing sealant.
- J. Door Hardware Installation: Factory install entrance door hardware to the greatest extent possible. Cut, drill, and tap for factory-installed entrance door hardware before applying finishes.
 - 1. Install hardware for aluminum entrances furnished in Division 08 Section "Door Hardware."
- K. After fabrication, clearly mark components to identify their locations in Project according to Shop Drawings.

2.9 ALUMINUM FINISHES

- A. Clear Anodic Finish, Interior Storefront: AAMA 611, AA-M12C22A31, Class II, 0.010 mm or thicker.
- B. High-Performance Organic Finish, Exterior Storefront: Two-coat fluoropolymer finish complying with AAMA 2604 and containing not less than 50 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 - 1. Color and Gloss: Kawneer Permadized Hardcoat Finish, Sterling Gray.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
 - 1. Confirm that wood blocking, where used, has been sufficiently fastened to transfer storefront wind loads back to structure.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Prior to setting storefront, seal gaps between the ends of the brick returns and wood blocking and between back of lintel angles and wood blocking with foam sealant to seal joint, preventing cold air from entering that will short circuit the thermal break in aluminum storefront.

3.3 INSTALLATION

- A. General:
 - 1. Comply with manufacturer's written instructions.
 - 2. Do not install damaged components.
 - 3. Fit joints to produce hairline joints free of burrs and distortion.
 - 4. Rigidly secure nonmovement joints.
 - 5. Install anchors with separators and isolators to prevent metal corrosion and electrolytic deterioration and to prevent impeding movement of moving joints.
 - 6. Seal perimeter and other joints watertight unless otherwise indicated.
- B. Metal Protection:
 - 1. Where aluminum is in contact with dissimilar metals, protect against galvanic action by painting contact surfaces with materials recommended by manufacturer for this purpose or by installing nonconductive spacers.
 - 2. Where aluminum is in contact with concrete or masonry, protect against corrosion by painting contact surfaces with bituminous paint.
- C. Install components to drain water passing joints, condensation occurring within framing members, and moisture migrating within the system to exterior.
- D. Set continuous sill members and flashing in full sealant bed as specified in Division 07 Section "Joint Sealants" to produce weathertight installation. Install sills in one piece, full width of opening except where opening exceeds manufactured lengths. Provide sealed metal end dams at ends of sills. Sills shall turn up on backside to form pan, directing water to the exterior.
- E. Install components plumb and true in alignment with established lines and grades.
- F. Install operable units level and plumb, securely anchored, and without distortion. Adjust weather-stripping contact and hardware movement to produce proper operation.
- G. Install glazing as specified in Division 08 Section "Glazing."
 - 1. At storefront frames and doors, mask frame and glass to provide smooth, uniform tooling of structural sealant, with straight edges.
- H. Install weatherseal sealant according to installation requirements in Division 07 Section "Joint Sealants" and according to sealant manufacturer's written instructions to produce weatherproof joints. Install joint filler behind sealant as recommended by sealant manufacturer. Color of sealant to match Architect selection. Provide sealants around storefront perimeter on interior sides between frame and air/vapor barrier and exterior sides between frame and exterior finishes.
- I. Entrance Doors: Install doors and windows to produce smooth operation and tight fit at contact points.

1. Exterior Doors: Install to produce weathertight enclosure and tight fit at weather stripping.
2. Field-Installed Entrance Door Hardware: Install surface-mounted entrance door hardware according to hardware manufacturers' written instructions using concealed fasteners to greatest extent possible.
3. Install door hardware furnished in Division 08 Section "Door Hardware," including continuous hinges, power assist door operators, closers, pulls, exit devices, removable mullions, electric strikes, magnetic switches, overhead stops, trims and miscellaneous hardware as scheduled.
4. Coordinate with access control and intrusion contractor and electrical contractor to provide access for conduits, concealed low voltage wiring within entrance and storefront frames for door operators, electrified mag switches and miscellaneous equipment and accessories installed in conjunction with aluminum framed entrances and storefronts.

3.4 ERECTION TOLERANCES

- A. Erection Tolerances: Install aluminum-framed entrances and storefronts to comply with the following maximum tolerances:
 1. Plumb: 1/8 inch in 10 feet; 1/4 inch in 40 feet.
 2. Level: 1/8 inch in 20 feet; 1/4 inch in 40 feet.
 3. Alignment:
 - a. Where surfaces abut in line or are separated by reveal or protruding element up to 1/2 inch wide, limit offset from true alignment to 1/16 inch.
 - b. Where surfaces are separated by reveal or protruding element from 1/2 to 1 inch wide, limit offset from true alignment to 1/8 inch.
 - c. Where surfaces are separated by reveal or protruding element of 1 inch wide or more, limit offset from true alignment to 1/4 inch.
 4. Location: Limit variation from plane to 1/8 inch in 12 feet; 1/2 inch over total length.

3.5 FIELD QUALITY CONTROL

- A. Commissioning Agent: The Owner has hired a commissioning agent to perform tests and inspections, and to prepare test reports. Allow inspectors access to scaffolding and work areas, as needed to perform inspections and tests.
 1. Aluminum-framed entrances and storefronts will be considered defective if they do not pass tests and inspections.
 2. Commissioning agent shall prepare test and inspection reports.
 3. Repair or remove work where test results and inspections indicate that it does not comply with specified requirements.
 4. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
- B. Aluminum-framed entrances, storefronts and windows will be considered defective if they do not pass tests and inspections.
- C. Commissioning agent shall prepare test and inspection reports.
- D. Repair or remove work where test results and inspections indicate that it does not comply with specified requirements.

- E. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.
- F. Egress Door Inspections:
 - 1. Inspection Agency: Owner will engage a qualified inspector to perform inspections and to furnish reports to Architect.
 - 2. Inspect each door equipped with panic hardware, each door located in an exit enclosure, each electrically controlled egress door, and each door equipped with special locking arrangements in accordance with NFPA 101, Section 7.2.1.15.
 - a. Repair or remove and replace installations where inspections indicate that they do not comply with specified requirements.
 - b. Reinspect repaired or replaced installations to determine if replaced or repaired door assembly installations comply with specified requirements.
 - c. Inspection agency shall prepare inspection reports.

END OF SECTION 084113

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SECTION 087100 - DOOR HARDWARE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes commercial door hardware for the following:
 - 1. Swinging doors.
 - 2. Other doors to the extent indicated.
- B. Door hardware includes, but is not necessarily limited to, the following:
 - 1. Mechanical door hardware.
 - 2. Electromechanical door hardware.
 - 3. Automatic operators.
 - 4. Cylinders specified for doors in other sections.
- C. Related Sections:
 - 1. Division 08 Section "Door Hardware Schedule".
 - 2. Division 08 Section "Hollow Metal Doors and Frames".
 - 3. Division 08 Section "Aluminum-Framed Entrances and Storefronts".
- D. Codes and References: Comply with the version year adopted by the Authority Having Jurisdiction.
 - 1. ANSI A117.1 - Accessible and Usable Buildings and Facilities.
 - 2. ICC/IBC - International Building Code.
 - 3. NFPA 70 - National Electrical Code.
 - 4. NFPA 80 - Fire Doors and Windows.
 - 5. NFPA 101 - Life Safety Code.
 - 6. NFPA 105 - Installation of Smoke Door Assemblies.
 - 7. UL/ULC and CSA C22.2 - Standards for Automatic Door Operators Used on Fire and Smoke Barrier Doors and Systems of Doors.
 - 8. State Building Codes, Local Amendments.
- E. Standards: All hardware specified herein shall comply with the following industry standards as applicable. Any undated reference to a standard shall be interpreted as referring to the latest edition of that standard:

1. ANSI/BHMA Certified Product Standards - A156 Series.
2. UL10C - Positive Pressure Fire Tests of Door Assemblies.
3. ANSI/UL 294 - Access Control System Units.
4. UL 305 - Panic Hardware.
5. ANSI/UL 437- Key Locks.

1.3 SUBMITTALS

- A. Product Data: Manufacturer's product data sheets including installation details, material descriptions, dimensions of individual components and profiles, operational descriptions and finishes.
- B. Door Hardware Schedule: Prepared by or under the supervision of supplier, detailing fabrication and assembly of door hardware, as well as procedures and diagrams. Coordinate the final Door Hardware Schedule with doors, frames, and related work to ensure proper size, thickness, hand, function, and finish of door hardware.
 1. Format: Comply with scheduling sequence and vertical format in DHI's "Sequence and Format for the Hardware Schedule."
 2. Organization: Organize the Door Hardware Schedule into door hardware sets indicating complete designations of every item required for each door or opening. Organize door hardware sets in same order as in the Door Hardware Sets at the end of Part 3. Submittals that do not follow the same format and order as the Door Hardware Sets will be rejected and subject to resubmission.
 3. Content: Include the following information:
 - a. Type, style, function, size, label, hand, and finish of each door hardware item.
 - b. Manufacturer of each item.
 - c. Fastenings and other pertinent information.
 - d. Location of door hardware set, cross-referenced to Drawings, both on floor plans and in door and frame schedule.
 - e. Explanation of abbreviations, symbols, and codes contained in schedule.
 - f. Mounting locations for door hardware.
 - g. Door and frame sizes and materials.
 - h. Warranty information for each product.
 4. Submittal Sequence: Submit the final Door Hardware Schedule at earliest possible date, particularly where approval of the Door Hardware Schedule must precede fabrication of other work that is critical in the Project construction schedule. Include Product Data, Samples, Shop Drawings of other work affected by door hardware, and other information essential to the coordinated review of the Door Hardware Schedule.
- C. Shop Drawings: Details of electrified access control hardware indicating the following:
 1. Wiring Diagrams: Upon receipt of approved schedules, submit detailed system wiring diagrams for power, signaling, monitoring, communication, and control of the access

control system electrified hardware. Differentiate between manufacturer-installed and field-installed wiring. Include the following:

- a. Elevation diagram of each unique access controlled opening showing location and interconnection of major system components with respect to their placement in the respective door openings.
 - b. Complete (risers, point-to-point) access control system block wiring diagrams.
 - c. Wiring instructions for each electronic component scheduled herein.
2. Electrical Coordination: Coordinate with related sections the voltages and wiring details required at electrically controlled and operated hardware openings.
- D. Keying Schedule: After a keying meeting with the owner has taken place prepare a separate keying schedule detailing final instructions. Submit the keying schedule in electronic format. Include keying system explanation, door numbers, key set symbols, hardware set numbers and special instructions. Owner must approve submitted keying schedule prior to the ordering of permanent cylinders/cores.
- E. Informational Submittals:
1. Product Test Reports: Indicating compliance with cycle testing requirements, based on evaluation of comprehensive tests performed by manufacturer and witnessed by a qualified independent testing agency.
- F. Operating and Maintenance Manuals: Provide manufacturers operating and maintenance manuals for each item comprising the complete door hardware installation in quantity as required in Division 01, Closeout Procedures.

1.4 QUALITY ASSURANCE

- A. Manufacturers Qualifications: Engage qualified manufacturers with a minimum 5 years of documented experience in producing hardware and equipment similar to that indicated for this Project and that have a proven record of successful in-service performance.
- B. Certified Products: Where specified, products must maintain a current listing in the Builders Hardware Manufacturers Association (BHMA) Certified Products Directory (CPD).
- C. Installer Qualifications: A minimum 3 years documented experience installing both standard and electrified door hardware similar in material, design, and extent to that indicated for this Project and whose work has resulted in construction with a record of successful in-service performance.
- D. Door Hardware Supplier Qualifications: Experienced commercial door hardware distributors with a minimum 5 years documented experience supplying both mechanical and electromechanical hardware installations comparable in material, design, and extent to that indicated for this Project. Supplier recognized as a factory direct distributor by the manufacturers of the primary materials with a warehousing facility in Project's vicinity. Supplier to have on staff a certified Architectural Hardware Consultant (AHC) available during

the course of the Work to consult with Contractor, Architect, and Owner concerning both standard and electromechanical door hardware and keying.

- E. Source Limitations: Obtain each type and variety of door hardware specified in this section from a single source unless otherwise indicated.
 - 1. Electrified modifications or enhancements made to a source manufacturer's product line by a secondary or third party source will not be accepted.
 - 2. Provide electromechanical door hardware from the same manufacturer as mechanical door hardware, unless otherwise indicated.
- F. Each unit to bear third party permanent label demonstrating compliance with the referenced standards.
- G. Keying Conference: Conduct conference to comply with requirements in Division 01 Section "Project Meetings." Keying conference to incorporate the following criteria into the final keying schedule document:
 - 1. Function of building, purpose of each area and degree of security required.
 - 2. Plans for existing and future key system expansion.
 - 3. Requirements for key control storage and software.
 - 4. Installation of permanent keys, cylinder cores and software.
 - 5. Address and requirements for delivery of keys.
- H. Pre-Submittal Conference: Conduct coordination conference in compliance with requirements in Division 01 Section "Project Meetings" with attendance by representatives of Supplier(s), Installer(s), and Contractor(s) to review proper methods and the procedures for receiving, handling, and installing door hardware.
 - 1. Prior to installation of door hardware, conduct a project specific training meeting to instruct the installing contractors' personnel on the proper installation and adjustment of their respective products. Product training to be attended by installers of door hardware (including electromechanical hardware) for aluminum, hollow metal and wood doors. Training will include the use of installation manuals, hardware schedules, templates and physical product samples as required.
 - 2. Inspect and discuss electrical roughing-in, power supply connections, and other preparatory work performed by other trades.
 - 3. Review sequence of operation narratives for each unique access controlled opening.
 - 4. Review and finalize construction schedule and verify availability of materials.
 - 5. Review the required inspecting, testing, commissioning, and demonstration procedures
- I. At completion of installation, provide written documentation that components were applied to manufacturer's instructions and recommendations and according to approved schedule.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Inventory door hardware on receipt and provide secure lock-up and shelving for door hardware delivered to Project site. Do not store electronic access control hardware, software or accessories at Project site without prior authorization.
- B. Tag each item or package separately with identification related to the final Door Hardware Schedule, and include basic installation instructions with each item or package.
- C. Deliver, as applicable, permanent keys, cylinders, cores, access control credentials, software and related accessories directly to Owner via registered mail or overnight package service. Instructions for delivery to the Owner shall be established at the "Keying Conference".

1.6 COORDINATION

- A. Templates: Obtain and distribute to the parties involved templates for doors, frames, and other work specified to be factory prepared for installing standard and electrified hardware. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing hardware to comply with indicated requirements.
- B. Door and Frame Preparation: Doors and corresponding frames are to be prepared, reinforced and pre-wired (if applicable) to receive the installation of the specified electrified, monitoring, signaling and access control system hardware without additional in-field modifications.

1.7 WARRANTY

- A. General Warranty: Reference Division 01, General Requirements. Special warranties specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.
- B. Warranty Period: Written warranty, executed by manufacturer(s), agreeing to repair or replace components of standard and electrified door hardware that fails in materials or workmanship within specified warranty period after final acceptance by the Owner. Failures include, but are not limited to, the following:
 - 1. Structural failures including excessive deflection, cracking, or breakage.
 - 2. Faulty operation of the hardware.
 - 3. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
 - 4. Electrical component defects and failures within the systems operation.
- C. Standard Warranty Period: One year from date of Substantial Completion, unless otherwise indicated.
- D. Special Warranty Periods:
 - 1. Ten years for mortise locks and latches.
 - 2. Five years for exit hardware.

3. Twenty five years for manual overhead door closer bodies.
4. Five years for motorized electric latch retraction exit devices.
5. Two years for electromechanical door hardware.

1.8 MAINTENANCE SERVICE

- A. Maintenance Tools and Instructions: Furnish a complete set of specialized tools and maintenance instructions as needed for Owner's continued adjustment, maintenance, and removal and replacement of door hardware.

PART 2 - PRODUCTS

2.1 SCHEDULED DOOR HARDWARE

- A. General: Provide door hardware for each door to comply with requirements in Door Hardware Sets and each referenced section that products are to be supplied under.
- B. Designations: Requirements for quantity, item, size, finish or color, grade, function, and other distinctive qualities of each type of door hardware are indicated in the Door Hardware Sets at the end of Part 3. Products are identified by using door hardware designations, as follows:
 1. Named Manufacturer's Products: Product designation and manufacturer are listed for each door hardware type required for the purpose of establishing requirements. Manufacturers' names are abbreviated in the Door Hardware Schedule.
- C. Substitutions: Requests for substitution and product approval for inclusive mechanical and electromechanical door hardware in compliance with the specifications must be submitted in writing and in accordance with the procedures and time frames outlined in Division 01, Substitution Procedures. Approval of requests is at the discretion of the architect, owner, and their designated consultants.

2.2 HANGING DEVICES

- A. Hinges: ANSI/BHMA A156.1 certified butt hinges with number of hinge knuckles and other options as specified in the Door Hardware Sets.
 1. Quantity: Provide the following hinge quantity:
 - a. Two Hinges: For doors with heights up to 60 inches.
 - b. Three Hinges: For doors with heights 61 to 90 inches.
 - c. Four Hinges: For doors with heights 91 to 120 inches.
 - d. For doors with heights more than 120 inches, provide 4 hinges, plus 1 hinge for every 30 inches of door height greater than 120 inches.
 2. Hinge Size: Provide the following, unless otherwise indicated, with hinge widths sized for door thickness and clearances required:

- a. Widths up to 3'0": 4-1/2" standard or heavy weight as specified.
 - b. Sizes from 3'1" to 4'0": 5" standard or heavy weight as specified.
 - 3. Hinge Weight and Base Material: Unless otherwise indicated, provide the following:
 - a. Exterior Doors: Heavy weight, non-ferrous, ball bearing or oil impregnated bearing hinges unless Hardware Sets indicate standard weight.
 - b. Interior Doors: Standard weight, steel, ball bearing or oil impregnated bearing hinges unless Hardware Sets indicate heavy weight.
 - 4. Hinge Options: Comply with the following:
 - a. Non-removable Pins: Provide set screw in hinge barrel that, when tightened into a groove in hinge pin, prevents removal of pin while door is closed; for the all out-swinging lockable doors.
 - 5. Manufacturers:
 - a. Bommer Industries (BO).
 - b. Hager Companies (HA).
 - c. McKinney Products; ASSA ABLOY Architectural Door Accessories (MK).
- B. Continuous Geared Hinges: ANSI/BHMA A156.26 Grade 1-600 certified continuous geared hinge. with minimum 0.120-inch thick extruded 6060 T6 aluminum alloy hinge leaves and a minimum overall width of 4 inches. Hinges are non-handed, reversible and fabricated to template screw locations. Factory trim hinges to suit door height and prepare for electrical cut-outs.
- 1. Manufacturers:
 - a. Bommer Industries (BO).
 - b. Hager Companies (HA).
 - c. Pemko Products; ASSA ABLOY Architectural Door Accessories (PE).
- C. Electric Door Wire Harnesses: Provide electric/data transfer wiring harnesses with standardized plug connectors to accommodate up to twelve (12) wires. Connectors plug directly to through-door wiring harnesses for connection to electric locking devices and power supplies. Provide sufficient number and type of concealed wires to accommodate electric function of specified hardware. Provide a connector for through-door electronic locking devices and from hinge to junction box above the opening. Wire nut connections are not acceptable. Determine the length required for each electrified hardware component for the door type, size and construction, minimum of two per electrified opening.
- 1. Provide one each of the following tools as part of the base bid contract:
 - a. McKinney Products; ASSA ABLOY Architectural Door Accessories (MK) - Electrical Connecting Kit: QC-R001.
 - b. McKinney Products; ASSA ABLOY Architectural Door Accessories (MK) - Connector Hand Tool: QC-R003.

2. Manufacturers:

- a. Hager Companies (HA) - Quick Connect.
- b. McKinney Products; ASSA ABLOY Architectural Door Accessories (MK) - QC-C Series.

2.3 DOOR OPERATING TRIM

A. Flush Bolts and Surface Bolts: ANSI/BHMA A156.3 and A156.16, Grade 1, certified.

- 1. Flush bolts to be furnished with top rod of sufficient length to allow bolt retraction device location approximately six feet from the floor.
- 2. Furnish dust proof strikes for bottom bolts.
- 3. Surface bolts to be minimum 8" in length and U.L. listed for labeled fire doors and U.L. listed for windstorm components where applicable.
- 4. Provide related accessories (mounting brackets, strikes, coordinators, etc.) as required for appropriate installation and operation.
- 5. Manufacturers:
 - a. Door Controls International (DC).
 - b. Rockwood Products; ASSA ABLOY Architectural Door Accessories (RO).
 - c. Trimco (TC).

B. Door Push Plates and Pulls: ANSI/BHMA A156.6 certified door pushes and pulls of type and design specified in the Hardware Sets. Coordinate and provide proper width and height as required where conflicting hardware dictates.

- 1. Push/Pull Plates: Minimum .050 inch thick, size as indicated in hardware sets, with beveled edges, secured with exposed screws unless otherwise indicated.
- 2. Door Pull and Push Bar Design: Size, shape, and material as indicated in the hardware sets. Minimum clearance of 2 1/2-inches from face of door unless otherwise indicated.
- 3. Offset Pull Design: Size, shape, and material as indicated in the hardware sets. Minimum clearance of 2 1/2-inches from face of door and offset of 90 degrees unless otherwise indicated.
- 4. Fasteners: Provide manufacturer's designated fastener type as indicated in Hardware Sets.
- 5. Manufacturers:
 - a. Hiawatha, Inc. (HI).
 - b. Rockwood Products; ASSA ABLOY Architectural Door Accessories (RO).
 - c. Trimco (TC).

2.4 CYLINDERS AND KEYING

A. General: Cylinder manufacturer to have minimum (10) years experience designing secured master key systems and have on record a published security keying system policy.

- B. Source Limitations: Obtain each type of keyed cylinder and keys from the same source manufacturer as locksets and exit devices, unless otherwise indicated.
- C. Cylinder Types: Original manufacturer cylinders able to supply the following cylinder formats and types:
 - 1. Threaded mortise cylinders with rings and cams to suit hardware application.
 - 2. Rim cylinders with back plate, flat-type vertical or horizontal tailpiece, and raised trim ring.
 - 3. Bored or cylindrical lock cylinders with tailpieces as required to suit locks.
 - 4. Tubular deadlocks and other auxiliary locks.
 - 5. Mortise and rim cylinder collars to be solid and recessed to allow the cylinder face to be flush and be free spinning with matching finishes.
 - 6. Keyway: Manufacturer's Standard.
- D. Removable Cores: Provide removable cores as specified, core insert, removable by use of a special key, and for use with only the core manufacturer's cylinder and door hardware.
- E. Keying System: Each type of lock and cylinders to be factory keyed.
 - 1. Supplier shall conduct a "Keying Conference" to define and document keying system instructions and requirements.
 - 2. Furnish factory cut, nickel-silver large bow permanently inscribed with a visual key control number as directed by Owner.
 - 3. New System: Key locks to a new key system as directed by the Owner.
- F. Key Quantity: Provide the following minimum number of keys:
 - 1. Change Keys per Cylinder: Three (3).
 - 2. Master Keys (per Master Key Level/Group): Five (5).
 - 3. Construction Keys (where required): Ten (10).
 - 4. Construction Control Keys (where required): Two (2).
 - 5. Permanent Control Keys (where required): Two (2).
- G. Construction Keying: Provide temporary keyed construction cores.
- H. Key Registration List (Bitting List):
 - 1. Provide keying transcript list to Owner's representative in the proper format for importing into key control software.
 - 2. Provide transcript list in writing or electronic file as directed by the Owner.

2.5 KEY CONTROL

- A. Key Control Cabinet: Provide a key control system including envelopes, labels, and tags with self-locking key clips, receipt forms, 3-way visible card index, temporary markers, permanent markers, and standard metal cabinet. Key control cabinet shall have expansion capacity of 150% of the number of locks required for the project.

1. Manufacturers:
 - a. Lund Equipment (LU).
 - b. MMF Industries (MM).
 - c. Telkee (TK).

2.6 MECHANICAL LOCKS AND LATCHING DEVICES

- A. Mortise Locksets, Grade 1 (Heavy Duty): ANSI/BHMA A156.13, Series 1000, Operational Grade 1 Certified Products Directory (CPD) listed. Locksets are to be manufactured with a corrosion resistant steel case and be field-reversible for handing without disassembly of the lock body.
 1. Where specified, provide status indicators with highly reflective color and wording for “locked/unlocked” or “vacant/occupied” with custom wording options if required. Indicator to be located above the cylinder with the inside thumb-turn not blocking the visibility of the indicator status. Indicator window size to be a minimum of 2.1” x 0.6” with a curved design allowing a 180 degree viewing angle with protective covering to prevent tampering.
 2. Manufacturers:
 - a. Corbin Russwin Hardware (RU) - ML2000 Series.
 - b. Sargent Manufacturing (SA) - 8200 Series.
 - c. Schlage (SC) - L9000 Series.

2.7 AUXILIARY LOCKS

- A. Mortise Deadlocks, Small Case: ANSI/BHMA A156.36, Grade 1, small case mortise type deadlocks constructed of heavy gauge wrought corrosion resistant steel. Steel or stainless steel bolts with a 1" throw and hardened steel roller pins. Deadlocks to be products of the same source manufacturer and keyway as other specified locksets.
 1. Manufacturers:
 - a. Corbin Russwin Hardware (RU) - DL4000 Series.
 - b. Sargent Manufacturing (SA) - 4870 Series.
 - c. Schlage (SC) - L460 Series.

2.8 LOCK AND LATCH STRIKES

- A. Strikes: Provide manufacturer's standard strike with strike box for each latch or lock bolt, with curved lip extended to protect frame, finished to match door hardware set, unless otherwise indicated, and as follows:
 1. Flat-Lip Strikes: For locks with three-piece antifriction latchbolts, as recommended by manufacturer.

2. Extra-Long-Lip Strikes: For locks used on frames with applied wood casing trim.
3. Aluminum-Frame Strike Box: Provide manufacturer's special strike box fabricated for aluminum framing.
4. Double-lipped strikes: For locks at double acting doors. Furnish with retractable stop for rescue hardware applications.

B. Standards: Comply with the following:

1. Strikes for Mortise Locks and Latches: BHMA A156.13.
2. Strikes for Bored Locks and Latches: BHMA A156.2.
3. Strikes for Auxiliary Deadlocks: BHMA A156.36.
4. Dustproof Strikes: BHMA A156.16.

2.9 CONVENTIONAL EXIT DEVICES

A. General Requirements: All exit devices specified herein shall meet or exceed the following criteria:

1. At doors not requiring a fire rating, provide devices complying with NFPA 101 and listed and labeled for "Panic Hardware" according to UL305. Provide proper fasteners as required by manufacturer including sex nuts and bolts at openings specified in the Hardware Sets.
2. Where exit devices are required on fire rated doors, provide devices complying with NFPA 80 and with UL labeling indicating "Fire Exit Hardware". Provide devices with the proper fasteners for installation as tested and listed by UL. Consult manufacturer's catalog and template book for specific requirements.
3. Except on fire rated doors, provide exit devices with hex key dogging device to hold the pushbar and latch in a retracted position. Provide optional keyed cylinder dogging on devices where specified in Hardware Sets.
4. Devices must fit flat against the door face with no gap that permits unauthorized dogging of the push bar. The addition of filler strips is required in any case where the door light extends behind the device as in a full glass configuration.
5. Lever Operating Trim: Where exit devices require lever trim, furnish manufacturer's heavy duty escutcheon trim with threaded studs for thru-bolts.
 - a. Lock Trim Design: As indicated in Hardware Sets, provide finishes and designs to match that of the specified locksets.
 - b. Where function of exit device requires a cylinder, provide a cylinder (Rim or Mortise) as specified in Hardware Sets.
6. Vertical Rod Exit Devices: Where surface or concealed vertical rod exit devices are used at interior openings, provide as less bottom rod (LBR) unless otherwise indicated. Provide dust proof strikes where thermal pins are required to project into the floor.

7. Narrow Stile Applications: At doors constructed with narrow stiles, or as specified in Hardware Sets, provide devices designed for maximum 2" wide stiles.
 8. Dummy Push Bar: Nonfunctioning push bar matching functional push bar.
 9. Rail Sizing: Provide exit device rails factory sized for proper door width application.
 10. Through Bolt Installation: For exit devices and trim as indicated in Door Hardware Sets.
- B. Conventional Push Rail Exit Devices (Heavy Duty): ANSI/BHMA A156.3, Grade 1 Certified Products Directory (CPD) listed panic and fire exit hardware devices furnished in the functions specified in the Hardware Sets. Exit device latch to be stainless steel, pullman type, with deadlock feature.
1. Manufacturers:
 - a. Corbin Russwin Hardware (RU) - ED4000 / ED5000 Series.
 - b. Sargent Manufacturing (SA) - 80 Series.
 - c. dormakaba Precision (PR) - Apex 2000 Series.

2.10 ELECTROMECHANICAL EXIT DEVICES

- A. Electromechanical Push Rail Exit Devices (Heavy Duty): ANSI/BHMA A156.3, Grade 1 Certified Products Directory (CPD) listed panic and fire exit hardware devices subject to same compliance standards and requirements as mechanical exit devices. Electrified exit devices to be of type and design as specified below and in the hardware sets.
1. Energy Efficient Design: Provide devices which have a holding current draw of 15mA maximum, and can operate on either 12 or 24 volts. Locks are to be field configurable for fail safe or fail secure operation.
 2. Where conventional power supplies are not sufficient, include any specific controllers required to provide the proper inrush current.
 3. Motorized Electric Latch Retraction: Devices with an electric latch retraction feature must use motors which have a maximum current draw of 600mA. Solenoid driven latch retraction is not acceptable.
 4. Manufacturers:
 - a. Corbin Russwin Hardware (RU) - ED5000 Series.
 - b. dormakaba Precision (PR) - Apex 2000 Series.
 - c. Sargent Manufacturing (SA) - 80 Series.

2.11 DOOR CLOSERS

- A. All door closers specified herein shall meet or exceed the following criteria:

1. General: Door closers to be from one manufacturer, matching in design and style, with the same type door preparations and templates regardless of application or spring size. Closers to be non-handed with full sized covers.
 2. Standards: Closers to comply with UL-10C for Positive Pressure Fire Test and be U.L. listed for use of fire rated doors.
 3. Size of Units: Comply with manufacturer's written recommendations for sizing of door closers depending on size of door, exposure to weather, and anticipated frequency of use. Where closers are indicated for doors required to be accessible to the Americans with Disabilities Act, provide units complying with ANSI ICC/A117.1.
 4. Closer Arms: Provide heavy duty, forged steel closer arms unless otherwise indicated in Hardware Sets.
 5. Closers shall not be installed on exterior or corridor side of doors; where possible install closers on door for optimum aesthetics.
 6. Closer Accessories: Provide door closer accessories including custom templates, special mounting brackets, spacers and drop plates as required for proper installation. Provide through-bolt and security type fasteners as specified in the hardware sets.
- B. Door Closers, Surface Mounted (Large Body Cast Iron): ANSI/BHMA A156.4, Grade 1 Certified Products Directory (CPD) listed surface mounted, heavy duty door closers with complete spring power adjustment, sizes 1 thru 6; and fully operational adjustable according to door size, frequency of use, and opening force. Closers to be rack and pinion type, one piece cast iron body construction, with adjustable backcheck and separate non-critical valves for closing sweep and latch speed control.
1. Manufacturers:
 - a. Corbin Russwin Hardware (RU) - DC8000 Series.
 - b. LCN Closers (LC) - 4040XP Series.
 - c. Sargent Manufacturing (SA) - 281 Series.

2.12 ELECTROHYDRAULIC DOOR OPERATORS

- A. General: Provide low energy operators of size recommended by manufacturer for door size, weight, and movement; for condition of exposure; and for compliance with UL 325. Coordinate operator mechanisms with door operation, hinges, and activation devices.
1. Fire-Rated Doors: Provide door operators for fire-rated door assemblies that comply with NFPA 80 for fire-rated door components and are listed and labeled by a qualified testing agency.
- B. Standard: Certified ANSI/BHMA A156.19.
- C. Performance Requirements:

1. Opening Force if Power Fails: Not more than 15 lbf required to release a latch if provided, not more than 30 lbf required to manually set door in motion, and not more than 15 lbf required to fully open door.
 2. Entrapment Protection: Not more than 15 lbf required to prevent stopped door from closing or opening.
- D. Configuration: Surface mounted or in-ground as required. Door operators to control single swinging and pair of swinging doors.
- E. Operation: Power opening and spring closing operation capable of meeting ANSI A117.1 accessibility guideline. Provide time delay for door to remain open before initiating closing cycle as required by ANSI/BHMA A156.19. When not in automatic mode, door operator to function as manual door closer with fully adjustable opening and closing forces, with or without electrical power.
- F. Features: Operator units to have full feature adjustments for door opening and closing force and speed, backcheck, motor assist acceleration from 0 to 30 seconds, time delay, vestibule interface delay, obstruction recycle, and hold open time from 0 up to 30 seconds.
- G. Provide outputs and relays on board the operator to allow for coordination of exit device latch retraction, electric strikes, magnetic locks, card readers, safety and motion sensors and specified auxiliary contacts.
- H. Brackets and Reinforcements: Manufacturer's standard, fabricated from aluminum with nonferrous shims for aligning system components.
- I. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Norton Door Controls (NO) - 6000 Series.
 2. Stanley Security Solutions (ST) - D-4990 Series.

2.13 SURFACE MOUNTED CLOSER HOLDERS

- A. Electromagnetic Door Holders: Certified ANSI A156.15 electromagnetic door holder/releases with a minimum 20 to 40 pounds holding power and single coil construction able to accommodate 12VDC, 24VAC, 24VDC and 120VAC. Coils to be independently wound, employing an integral fuse and armatures to include a positive release button.
1. Manufacturers:
 - a. Rixson (RF) - 980/990 Series.
 - b. Sargent Manufacturing (SA) - 1560 Series.

2.14 ARCHITECTURAL TRIM

- A. Door Protective Trim

1. General: Door protective trim units to be of type and design as specified below or in the Hardware Sets.
2. Size: Fabricate protection plates (kick, armor, or mop) not more than 2" less than door width (LDW) on stop side of single doors and 1" LDW on stop side of pairs of doors, and not more than 1" less than door width on pull side. Coordinate and provide proper width and height as required where conflicting hardware dictates. Height to be as specified in the Hardware Sets.
3. Where plates are applied to fire rated doors with the top of the plate more than 16" above the bottom of the door, provide plates complying with NFPA 80. Consult manufacturer's catalog and template book for specific requirements for size and applications.
4. Protection Plates: ANSI/BHMA A156.6 certified protection plates (kick, armor, or mop), fabricated from the following:
 - a. Stainless Steel: 300 grade, 050-inch thick.
5. Options and fasteners: Provide manufacturer's designated fastener type as specified in the Hardware Sets. Provide countersunk screw holes.
6. Manufacturers:
 - a. Hiawatha, Inc. (HI).
 - b. Rockwood Products; ASSA ABLOY Architectural Door Accessories (RO).
 - c. Trimco (TC).

2.15 DOOR STOPS AND HOLDERS

- A. General: Door stops and holders to be of type and design as specified below or in the Hardware Sets.
- B. Door Stops and Bumpers: ANSI/BHMA A156.16, Grade 1 certified door stops and wall bumpers. Provide wall bumpers, either convex or concave types with anchorage as indicated, unless floor or other types of door stops are specified in Hardware Sets. Do not mount floor stops where they will impede traffic. Where floor or wall bumpers are not appropriate, provide overhead type stops and holders.
 1. Manufacturers:
 - a. Hiawatha, Inc. (HI).
 - b. Rockwood Products; ASSA ABLOY Architectural Door Accessories (RO).
 - c. Trimco (TC).
- C. Overhead Door Stops and Holders: ANSI/BHMA A156.8, Grade 1 Certified Products Directory (CPD) listed overhead stops and holders to be surface or concealed types as indicated in Hardware Sets. Track, slide, arm and jamb bracket to be constructed of extruded bronze and shock absorber spring of heavy tempered steel. Provide non-handed design with mounting brackets as required for proper operation and function.

1. Manufacturers:

- a. Rixson Door Controls (RF).
- b. Rockwood Products; ASSA ABLOY Architectural Door Accessories (RO).
- c. Sargent Manufacturing (SA).

2.16 ARCHITECTURAL SEALS

- A. General: Thresholds, weatherstripping, and gasket seals to be of type and design as specified below or in the Hardware Sets. Provide continuous weatherstrip gasketing on exterior doors and provide smoke, light, or sound gasketing on interior doors where indicated. At exterior applications provide non-corrosive fasteners and elsewhere where indicated.
- B. Smoke Labeled Gasketing: Assemblies complying with NFPA 105 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for smoke control ratings indicated, based on testing according to UL 1784.
 1. Provide smoke labeled perimeter gasketing at all smoke labeled openings.
- C. Fire Labeled Gasketing: Assemblies complying with NFPA 80 that are listed and labeled by a testing and inspecting agency acceptable to authorities having jurisdiction, for fire ratings indicated, based on testing according to UL-10C.
 1. Provide intumescent seals as indicated to meet UL10C Standard for Positive Pressure Fire Tests of Door Assemblies, and NFPA 252, Standard Methods of Fire Tests of Door Assemblies.
- D. Sound-Rated Gasketing: Assemblies that are listed and labeled by a testing and inspecting agency, for sound ratings indicated.
- E. Replaceable Seal Strips: Provide only those units where resilient or flexible seal strips are easily replaceable and readily available from stocks maintained by manufacturer.
- F. Manufacturers:
 1. National Guard Products (NG).
 2. Pemko Products; ASSA ABLOY Architectural Door Accessories (PE).
 3. Reese Enterprises, Inc. (RE).

2.17 FABRICATION

- A. Fasteners: Provide door hardware manufactured to comply with published templates generally prepared for machine, wood, and sheet metal screws. Provide screws according to manufacturers recognized installation standards for application intended.

2.18 FINISHES

- A. Standard: Designations used in the Hardware Sets and elsewhere indicate hardware finishes complying with ANSI/BHMA A156.18, including coordination with traditional U.S. finishes indicated by certain manufacturers for their products.
- B. Provide quality of finish, including thickness of plating or coating (if any), composition, hardness, and other qualities complying with manufacturer's standards, but in no case less than specified by referenced standards for the applicable units of hardware
- C. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine scheduled openings, with Installer present, for compliance with requirements for installation tolerances, labeled fire door assembly construction, wall and floor construction, and other conditions affecting performance.
- B. Notify architect of any discrepancies or conflicts between the door schedule, door types, drawings and scheduled hardware. Proceed only after such discrepancies or conflicts have been resolved in writing.

3.2 PREPARATION

- A. Hollow Metal Doors and Frames: Comply with ANSI/DHI A115 series.
- B. Wood Doors: Comply with ANSI/DHI A115-W series.

3.3 INSTALLATION

- A. Install each item of mechanical and electromechanical hardware and access control equipment to comply with manufacturer's written instructions and according to specifications.
 - 1. Installers are to be trained and certified by the manufacturer on the proper installation and adjustment of fire, life safety, and security products including: hanging devices; locking devices; closing devices; and seals.
- B. Mounting Heights: Mount door hardware units at heights indicated in following applicable publications, unless specifically indicated or required to comply with governing regulations:
 - 1. Standard Steel Doors and Frames: DHI's "Recommended Locations for Architectural Hardware for Standard Steel Doors and Frames."

2. Wood Doors: DHI WDHS.3, "Recommended Locations for Architectural Hardware for Wood Flush Doors."
 3. Where indicated to comply with accessibility requirements, comply with ANSI A117.1 "Accessibility Guidelines for Buildings and Facilities."
 4. Provide blocking in drywall partitions where wall stops or other wall mounted hardware is located.
- C. Retrofitting: Install door hardware to comply with manufacturer's published templates and written instructions. Where cutting and fitting are required to install door hardware onto or into surfaces that are later to be painted or finished in another way, coordinate removal, storage, and reinstallation of surface protective trim units with finishing work specified in Division 9 Sections. Do not install surface-mounted items until finishes have been completed on substrates involved.
- D. Thresholds: Set thresholds for exterior and acoustical doors in full bed of sealant complying with requirements specified in Division 7 Section "Joint Sealants."
- E. Storage: Provide a secure lock up for hardware delivered to the project but not yet installed. Control the handling and installation of hardware items so that the completion of the work will not be delayed by hardware losses before and after installation.

3.4 FIELD QUALITY CONTROL

- A. Field Inspection (Punch Report): Reference Division 01 Sections "Closeout Procedures". Produce project punch report for each installed door opening indicating compliance with approved submittals and verification hardware is properly installed, operating and adjusted. Include list of items to be completed and corrected, indicating the reasons or deficiencies causing the Work to be incomplete or rejected.
1. Organization of List: Include separate Door Opening and Deficiencies and Corrective Action Lists organized by Mark, Opening Remarks and Comments, and related Opening Images and Video Recordings.
 2. Submit documentation of incomplete items in the following formats:
 - a. PDF electronic file.
 - b. Electronic formatted file integrated with the Openings Studio™ door opening management software platform.

3.5 ADJUSTING

- A. Initial Adjustment: Adjust and check each operating item of door hardware and each door to ensure proper operation or function of every unit. Replace units that cannot be adjusted to operate as intended. Adjust door control devices to compensate for final operation of heating and ventilating equipment and to comply with referenced accessibility requirements.

3.6 CLEANING AND PROTECTION

- A. Protect all hardware stored on construction site in a covered and dry place. Protect exposed hardware installed on doors during the construction phase. Install any and all hardware at the latest possible time frame.
- B. Clean adjacent surfaces soiled by door hardware installation.
- C. Clean operating items as necessary to restore proper finish. Provide final protection and maintain conditions that ensure door hardware is without damage or deterioration at time of owner occupancy.

3.7 DEMONSTRATION

- A. Instruct Owner's maintenance personnel to adjust, operate, and maintain mechanical and electromechanical door hardware.

3.8 DOOR HARDWARE SETS

- A. The hardware sets represent the design intent and direction of the owner and architect. They are a guideline only and should not be considered a detailed hardware schedule. Discrepancies, conflicting hardware and missing items should be brought to the attention of the architect with corrections made prior to the bidding process. Omitted items not included in a hardware set should be scheduled with the appropriate additional hardware required for proper application and functionality.
 - 1. Quantities listed are for each pair of doors, or for each single door.
 - 2. The supplier is responsible for handling and sizing all products.
 - 3. Where multiple options for a piece of hardware are given in a single line item, the supplier shall provide the appropriate application for the opening.
 - 4. At existing openings with new hardware the supplier shall field inspect existing conditions prior to the submittal stage to verify the specified hardware will work as required. Provide alternate solutions and proposals as needed.
- B. Refer to Section 080671, Door Hardware Sets, for hardware sets.

END OF SECTION 087100

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SECTION 088000 - GLAZING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes glazing for the following products and applications, including those specified in other Sections where glazing requirements are specified by reference to this Section:
 - 1. Doors.
 - 2. Storefront framing.
 - 3. Interior borrowed lites.
- B. Related Sections:
 - 1. Division 08 Section "Hollow Metal Doors and Frames" for glazing of hollow metal doors and interior borrowed lites.

1.3 DEFINITIONS

- A. Glass Thicknesses: Indicated by thickness designations in millimeters according to ASTM C 1036.
- B. Interspace: Space between lites of an insulating-glass unit.

1.4 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. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on glass framing members and glazing components.
 - 1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

1.5 ACTION SUBMITTALS

- A. Product Data: For each glass product and glazing material indicated.
- B. Glazing Schedule: List glass types and thicknesses for each size opening and location. Use same designations indicated on Drawings.

1.6 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For glass and glazing products, from manufacturer.

- B. Warranties: Sample of special warranties.

1.7 QUALITY ASSURANCE

- A. Source Limitations for Glass: Obtain coated float glass, laminated glass, fire-rated glazing, and insulating glass 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.
- C. Glazing Publications: Comply with published recommendations of glass product manufacturers and organizations below, unless more stringent requirements are indicated. Refer to these publications for glazing terms not otherwise defined in this Section or in referenced standards.
 - 1. GANA Publications: GANA's "Laminated Glazing Reference Manual" and GANA's "Glazing Manual."
 - 2. IGMA Publication for Insulating Glass: SIGMA TM-3000, "North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial and Residential Use."
- D. Safety Glazing Labeling: Where safety glazing labeling is indicated, permanently mark glazing with certification label of the SGCC. Label shall indicate manufacturer's name, type of glass, thickness, and safety glazing standard with which glass complies.
- E. 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 for use in fire doors or other openings, whether or not glazing passes hose-stream test, whether or not glazing has a temperature rise rating of 450 deg F, and the fire-resistance rating in minutes.
- F. Insulating-Glass Certification Program: Permanently marked either on spacers or on at least one component lite of units with appropriate certification label of IGCC.

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. Protect fire-resistive glazing from ultraviolet light.

1.9 PROJECT 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 below 40 deg F.

1.10 WARRANTY

- A. Manufacturer's Special Warranty on Insulating Glass: Manufacturer's standard form in which insulating-glass manufacturer agrees to replace insulating-glass units that deteriorate within specified warranty period. Deterioration of insulating glass is defined as failure of hermetic seal

under normal use that is not attributed to glass breakage or to maintaining and cleaning insulating glass contrary to manufacturer's written instructions. Evidence of failure is the obstruction of vision by dust, moisture, or film on interior surfaces of glass.

1. Warranty Period: 10 years from date of Substantial Completion.

- B. Manufacturer's Special Warranty on Fire-Rated Glass: Manufacturer's standard form in which fire rated glass manufacturer agrees to replace fire rated glass units that deteriorate within specified warranty period. Deterioration of fire rated glass is defined as failure defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning fire rated glass contrary to manufacturer's written instructions. Defects include obstruction of glass area, delamination, or edge separation and/or changes in properties of the interlayer.

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

PART 2 - PRODUCTS

2.1 GLASS PRODUCTS, GENERAL

- A. Thickness: Where glass thickness is indicated, it is a minimum. Provide glass lites in thicknesses as needed to comply with requirements indicated.
1. Minimum Glass Thickness for Exterior Lites: Not less than 6.0 mm.
- B. Strength: Where float glass is indicated, provide annealed float glass. Where fully tempered glass or safety glazing is indicated or required by code, provide Kind FT heat-treated float glass.

2.2 GLASS PRODUCTS

- A. Float Glass: ASTM C 1036, Type I, Quality-Q3, Class I (clear) unless otherwise indicated.
- B. Safety Glass (Fully Tempered): ASTM C 1048; Kind FT (fully tempered), Condition A (uncoated), Type I (transparent flat glass); Class 1(clear); Quality q3 (glazing select); conforming to ANZI A97.1.
- C. Clear, Sputter-Coated Float Glass: ASTM C 1376, float glass with metallic-oxide or -nitride coating deposited by vacuum deposition process after manufacture and heat treatment (if any), and complying with other requirements specified.
1. Basis-of-Design: Subject to compliance with requirements, provide LoE-366 Glass by Cardinal Glass Industries or a comparable product from one of the following manufacturers:
- a. Guardian Industries Corporation.
 - b. Pilkington North America, Inc.
 - c. PPG Industries, Inc.

2.3 INSULATING GLASS

- A. Insulating-Glass Units: Factory-assembled units consisting of sealed lites of glass separated by a dehydrated interspace, qualified according to ASTM E 2190, and complying with other requirements specified.
1. Sealing System: Dual seal, with manufacturer's standard primary and secondary.
2. Spacer: Manufacturer's standard warm edge spacer material and construction.

3. Desiccant: Molecular sieve or silica gel, or blend of both.
- B. Glass: Comply with applicable requirements in "Glass Products" Article as indicated by designations in "Insulating-Glass Types" Article.
- C. Low-E, Clear, Insulated Glass Units:
 1. Overall Unit Thickness:
 - a. For Exterior Locations Other Than Doors: Inner and outer panes of 6.0 mm glass; total unit thickness of 1 inch minimum.
 - b. For Exterior Doors: Inner and outer panes of 3/16 clear glass; total unit thickness of 5/8 inch minimum.
 2. Outdoor Lite: Class 1 (clear) float glass, except as noted.
 - a. Kind FT (fully tempered) where indicated or required by code.
 3. Interspace Content: Argon.
 4. Indoor Lite: Class 1 (clear) float glass, except as noted.
 - a. Kind FT (fully tempered) where indicated or required by code.
 5. Low-E Coating: Sputtered on second surface.
 6. Visible Light Transmittance: 65 percent minimum.
 7. Winter Nighttime U-Factor: 0.24 maximum.
 8. Shading Coefficient: 0.27 maximum.
 9. Solar Heat Gain Coefficient: 0.27 maximum.
 10. Provide safety glazing labeling on fully tempered glass.

2.4 FIRE-PROTECTION-RATED GLAZING

- A. Fire-Protection-Rated Glazing, General: Listed and labeled by Underwriters Laboratories (UL) a testing agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing according to NFPA 252 for door assemblies.

2.5 GLAZING GASKETS

- A. Dense Compression Gaskets: Molded or extruded gaskets of profile and hardness required to maintain watertight seal, made from one of the following:
 1. EPDM complying with ASTM C 864.
 2. Silicone complying with ASTM C 1115.
 3. Thermoplastic polyolefin rubber complying with ASTM C 1115.

2.6 GLAZING SEALANTS

- A. General:
 1. Compatibility: Provide glazing sealants that are compatible with one another and with other materials they will contact, including glass products, seals of insulating-glass units, and glazing channel substrates, under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.
 2. Suitability: Comply with sealant and glass manufacturers' written instructions for selecting glazing sealants suitable for applications indicated and for conditions existing at time of installation.
 3. Sealants used inside the weatherproofing system shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

4. 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 50, Use NT.
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Dow Corning Corporation; 791 or 795.
 - b. GE Advanced Materials - Silicones; SilPruf NB SCS9000 or UltraPruf II SCS2900.
 - c. Pecora Corporation; 895.
 - d. Tremco Incorporated; Spectrem 2 or Spectrem 3.
- C. Glazing Sealants for Fire-Rated Glazing Products: Products that are approved by testing agencies that listed and labeled fire-resistant glazing products with which they are used for applications and fire-protection ratings indicated.

2.7 GLAZING TAPES

- A. 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 806.3 tape, for glazing applications in which tape is subject to continuous pressure.
 2. AAMA 807.3 tape, for glazing applications in which tape is not subject to continuous pressure.
- B. Expanded Cellular Glazing Tapes: Closed-cell, PVC foam tapes; factory coated with adhesive on both surfaces; and complying with AAMA 800 for the following types:
 1. AAMA 810.1, Type 2, for glazing applications in which tape is used in combination with a full bead of liquid sealant.

2.8 MISCELLANEOUS GLAZING MATERIALS

- A. General: Provide products of material, size, and shape complying with referenced glazing standard, requirements of manufacturers of glass and other glazing materials for application indicated, and with a proven record of compatibility with surfaces contacted in installation.
- B. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.
- C. Setting Blocks: Elastomeric material with a Shore, Type A durometer hardness of 85, plus or minus 5.
- D. Spacers: Elastomeric blocks or continuous extrusions 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.
- G. Perimeter Insulation for Fire-Resistive Glazing: Product that is approved by testing agency that listed and labeled fire-resistant glazing product with which it is used for application and fire-protection rating indicated.

2.9 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.
- B. 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 will 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. Adjust glazing channel dimensions as required by Project conditions during installation to provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances.

- 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. Protect glass edges as follows:
 - 1. Use a rolling block in rotating glass units to prevent damage to glass corners.
 - 2. Do not impact glass with metal framing.
 - 3. Use suction cups to shift glass units within openings. Do not raise or drift glass with a pry bar.
 - 4. Rotate glass lites with flares or bevels on bottom horizontal edges so edges are located at top of opening, unless otherwise indicated by manufacturer's label.
- D. Apply primers to joint surfaces where required for adhesion of sealants.
- 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 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.
- H. 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.
- I. Set glass lites in each series with uniform pattern, draw, bow, and similar characteristics.
- J. Set glass lites with proper orientation so that coatings face exterior or interior as specified.

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. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.
- D. Installation with Pressure-Glazing Stops: Center glass lites in openings on setting blocks and press firmly against soft compression gasket. Install dense compression gaskets and pressure-glazing stops, applying pressure uniformly to compression gaskets. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.
- E. 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 and to prevent sealant from extruding into glass channel and blocking weep systems until sealants cure. Secure spacers or spacers and backings in place and in position to control depth of installed sealant relative to edge clearance for optimum sealant performance.
- 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 wash away from glass.

3.7 CLEANING AND PROTECTION

- A. Protect exterior glass from damage immediately after installation by attaching crossed streamers to framing held away from glass. Do not apply markers to glass surface. Remove nonpermanent labels and clean surfaces.

- B. Protect glass from contact with contaminating substances resulting from construction operations. If, despite such protection, contaminating substances do come into contact with glass, remove substances immediately as recommended in writing by glass manufacturer.
- C. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for buildup of dirt, scum, alkaline deposits, or stains; remove as recommended in writing by glass manufacturer.
- D. Remove and replace glass that is broken, chipped, cracked, or abraded or that is damaged from natural causes, accidents, and vandalism, during construction period.
- E. 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.

END OF SECTION 088000

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SECTION 092110 - GYPSUM BOARD ASSEMBLIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 DESCRIPTION OF WORK

- A. Work Included: Provide labor, materials and equipment necessary to complete the work of this Section, including but not limited to the following:
 - 1. Interior gypsum wallboard.
 - 2. Tile backing panels.
 - 3. Acoustic insulation (sound attenuation batts) in gypsum wallboard assemblies.
 - 4. Installation of access panels.
 - 5. Marking and identification for fire- and smoke-partitions.
- B. Related Work: The following items are not included in this Section and are specified under the designated Sections:
 - 1. Section 061000 - ROUGH CARPENTRY for plywood backing panels.
 - 2. Section 061600 - SHEATHING for sheathing at exterior assemblies.
 - 3. Section 083110 - ACCESS DOORS AND FRAMES for installation in gypsum board assemblies.
 - 4. Section 093000 - TILING for joint compound at cementitious tile backing panels.

1.3 PERFORMANCE REQUIREMENTS

- A. Marking and Identification for Fire- and Smoke-Partitions: Fire walls, fire barriers, fire partitions, smoke barriers, smoke partitions and other walls required to have protected openings or penetrations shall be effectively and permanently identified with signs or stenciling. Such identification shall:
 - 1. Be located in accessible concealed floor, floor-ceiling or attic spaces; and
 - 2. Locate within 15 feet of end of each wall and repeat at intervals not exceeding 30 feet measured horizontally along the wall or partition; and
 - 3. Include lettering not less than 3 inches in height with a minimum 3/8 inch stroke in contrasting color, incorporating the suggested wording: "FIRE AND/OR SMOKE BARRIER - PROTECT ALL OPENINGS," or other wording.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: If materials and systems other than those specified and those indicated on the Drawings are proposed for use, submit shop drawings signed and sealed by a structural engineer licensed in the jurisdiction of the project certifying proposed systems meet code requirements, project requirements and the following deflection criteria:
 - 1. For gypsum board assemblies without applied rigid finishes L/240; for gypsum board assemblies with applied rigid finishes such as tile, stone, wood paneling L/360. Lateral load 5 psf except at shafts. Lateral load at shafts shall be required based on analysis of equipment and systems using shaft.
- C. Samples: Full-size Sample in 12-inch-long length for each trim accessory indicated.

1.5 QUALITY ASSURANCE

- 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.
- C. Mockups: Before beginning gypsum board installation, install mockups of at least 100 sq. ft. in surface area to demonstrate aesthetic effects and set quality standards for materials and execution.
 - 1. Install mockups for the following:
 - a. Each level of gypsum board finish indicated for use in exposed locations.
 - b. Each texture finish indicated.
 - 2. Apply or install final decoration indicated, including painting and wallcoverings, on exposed surfaces for review of mockups.
 - 3. Simulate finished lighting conditions for review of mockups.
 - 4. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.6 STORAGE AND HANDLING

- A. Store materials inside under cover and keep them dry and protected against damage from weather, condensation, direct sunlight, construction traffic, and other causes. Stack panels flat to prevent sagging.

1.7 PROJECT CONDITIONS

- A. Environmental Limitations: Comply with ASTM C 840 requirements or gypsum board manufacturer's written recommendations, whichever are more stringent.
- B. Do not install interior products until installation areas are enclosed and conditioned.

- C. Do not install panels that are wet, those that are moisture damaged, and those that are mold damaged.
 - 1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
 - 2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

PART 2 - PRODUCTS

2.1 SUSPENSION SYSTEM COMPONENTS

- A. Tie Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.0625-inch-diameter wire, or double strand of 0.0475-inch-diameter wire.
- B. Hanger Attachments to Concrete:
 - 1. Anchors: Fabricated from corrosion-resistant materials with holes or loops for attaching wire hangers and capable of sustaining, without failure, a load equal to 5 times that imposed by construction as determined by testing according to ASTM E 488 by an independent testing agency.
 - a. Type: Postinstalled, expansion anchor.
- C. Wire Hangers: ASTM A 641/A 641M, Class 1 zinc coating, soft temper, 0.162-inch diameter.
- D. Carrying Channels: Cold-rolled, commercial-steel sheet with a base-metal thickness of 0.0538 inch and minimum 1/2-inch-wide flanges with depth as required for span and loading and indicated on Drawings.
- E. Furring Channels (Furring Members): 0.0538-inch bare-steel thickness, with minimum 1/2-inch-wide flanges, 3/4 inch deep.
- F. Grid Suspension System for Ceilings: ASTM C 645, direct-hung system composed of main beams and cross-furring members that interlock.
 - 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Armstrong World Industries, Inc.; Drywall Grid Systems.
 - b. Chicago Metallic Corporation; Drywall Furring System.
 - c. USG Corporation; Drywall Suspension System.
 - 2. Performance Requirements: Ceiling support system shall support a live load of 6 psf minimum at L/240.

2.2 STEEL FRAMING FOR FRAMED ASSEMBLIES

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. California Expanded Metals Co. (CEMCO).
 - 2. Clarkwestern Dietrich Building Systems LLC.
 - 3. EB Metal U.S.
 - 4. Marino\WARE.
 - 5. Super Stud Building Products, Inc.
- B. Steel Studs and Runners: ASTM C 645.
 - 1. Minimum Base-Steel (Uncoated) Thickness: 0.0296 inches (20 gage)
- C. Steel framing for cantilevered partial wall systems that are unsupported at the top track:
 - 1. Clarkwestern Dietrich Building Systems LLC, Pony Wall Heavy, Basis of Design.
 - a. Plate Material: ASTM A 36, hot rolled steel, 1/2 inch thick.
 - b. Stud Material: Structural Grade 50 Type H, 50ksi, 12 gage, 0.0966 inch minimum thickness.
- D. Slip-Type Head Joints: Where indicated, provide one of the following:
 - 1. Single Long-Leg Runner System: ASTM C 645 top runner with 2-inch- deep flanges in thickness not less than indicated for studs, installed with studs friction fit into top runner and with continuous bridging located within 12 inches of the top of studs to provide lateral bracing.
 - 2. Double-Runner System: ASTM C 645 top runners, inside runner with 2-inch-deep flanges in thickness not less than indicated for studs and fastened to studs, and outer runner sized to friction fit inside runner.
 - 3. Deflection Track: Steel sheet top runner manufactured to prevent cracking of finishes applied to interior partition framing resulting from deflection of structure above; in thickness not less than indicated for studs and in width to accommodate depth of studs.
 - a. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 - 1) Brady Innovations; Sliptrack Systems.
 - 2) California Expanded Metals Co. (CEMCO); CST Slotted Tracks.
 - 3) Clark Dietrich Building Systems; MaxTrak Slotted Deflection Track.
 - 4) Steel Network Inc. (The); VertiTrack VT Series.
- E. Fire Stop Tracks: Top runner manufactured to allow partition heads to expand and contract with movement of the structure while maintaining continuity of fire-resistance-rated assembly indicated; in thickness compatible with studs and in width to accommodate depth of studs.
 - 1. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
 - a. California Expanded Metals Co. (CEMCO); FAS-TRK 1000 Slotted Tracks.
 - b. Clark Dietrich Building Systems; BlazeFrame Fire Stop Deflection Track.
 - c. Fire Trak Corp.; Fire Trak attached to studs with Fire Trak Slip Clip.
- F. Flat Strap and Backing Plate: Steel sheet for blocking and bracing in length and width indicated.
 - 1. Minimum Base-Metal Thickness: 0.0312 inch (20 gauge).

- G. Cold-Rolled Channel Bridging: 0.0538-inch bare-steel thickness, with minimum 1/2-inch- wide flanges.
 - 1. Depth: 1-1/2 inches.
 - 2. Clip Angle: Not less than 1-1/2 by 1-1/2 inches, 0.068-inch-thick, galvanized steel.
- H. Hat-Shaped, Rigid Furring Channels: ASTM C 645.
 - 1. Minimum Base-Metal Thickness: 0.0312 inch (20 gauge).
 - 2. Depth: 1-1/2 inches.
- I. Resilient Furring Channels: 1/2-inch-deep, steel sheet members designed to reduce sound transmission. Strictly comply with manufacturer's installation instruction.
 - 1. Basis-of-Design: ClarkDietrich RC Deluxe, asymmetrical configuration.
- J. Resilient Sound Isolation Clips: Provide galvanized steel and resilient material sound-isolation clips, equal to the following:
 - 1. Kinetics Noise Control Co.; IsoMax.
 - 2. PAC International, Inc.; RSIC-1.
 - 3. Pliteq, Inc.; GenieClip.
 - 4. Studco Building Systems; Resilmount A237R.
- K. Spring Isolation Hangers: Provide galvanized and coated spring hanger system, equal to the following:
 - 1. Kinetics Noise Control Co.; ICW.
 - 2. PAC International, Inc.; RSIC--SI-CRC Pro Series.
- L. Z-Shaped Furring: With slotted or nonslotted web, face flange of 1-1/4 inches wall attachment flange of 7/8 inch, minimum bare-metal thickness of 0.0179 inch, and depth required to fit insulation thickness indicated.
- M. Beam Clips: Colum and beam single step clips, Claw International, The Claw, Basis of Design.
- N. Fasteners for Metal Framing: Of type, material, size, corrosion resistance, holding power, and other properties required to fasten steel members to substrates.
- O. Isolation Strip at Exterior Walls: Adhesive-backed, closed-cell foam strips that allow fastener penetration without foam displacement, 1/8 inch thick, in width to suit steel stud size.

2.3 INTERIOR GYPSUM BOARD

- 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. CertainTeed Gypsum, Inc.
 - 2. National Gypsum Company.
 - 3. United States Gypsum Company (USG).
- B. Gypsum Wallboard: ASTM C 1396.
 - 1. Basis of Design: USG; SHEETROCK EcoSmart Panels.
 - 2. Thickness: 1/2 inch and 5/8 inch as indicated.
 - 3. Long Edges: Tapered.
- C. Gypsum Wallboard, Fire-Resistant Type X: ASTM C 1396.

1. Basis of Design: USG; SHEETROCK EcoSmart Panels Firecode X.
2. Thickness: 5/8 inch.
3. Long Edges: Tapered.

D. Moisture- and Mold-Resistant Gypsum Board: ASTM C 1396. With moisture- and mold-resistant core and paper surfaces.

1. Basis of Design: USG; SHEETROCK EcoSmart Mold Tough Firecode X.
2. Core: 5/8 inch, Type X.
3. Long Edges: Tapered.
4. Mold Resistance: ASTM D 3273, score of 10 as rated according to ASTM D 3274.

2.4 TRIM ACCESSORIES

A. Interior Trim: ASTM C 1047.

1. Material: Galvanized or aluminum-coated steel sheet or rolled zinc.
2. Shapes:
 - a. LC-Bead: J-shaped; exposed long flange receives joint compound.
 - b. Expansion (control) joint.
 - c. Curved-Edge Cornerbead: With notched or flexible flanges.

2.5 JOINT TREATMENT MATERIALS

A. General: Comply with ASTM C 475/C 475M.

B. Joint Tape:

1. Interior Gypsum Wallboard: Paper.
2. Tile Backing Panels: As recommended by panel manufacturer.

C. Joint Compound for Interior Gypsum Wallboard: For each coat use formulation that is compatible with other compounds applied on previous or for successive coats.

1. Prefilling: At open joints, rounded or beveled panel edges, and damaged surface areas, use setting-type taping compound.
2. Embedding and First Coat: For embedding tape and first coat on joints, fasteners, and trim flanges, use setting-type taping compound.
3. Fill Coat: For second coat, use setting-type, sandable topping compound.
4. Finish Coat: For third coat, use setting-type, sandable topping compound.
5. Skim Coat: For final coat of Level 5 finish, use setting-type, sandable topping compound.

D. Joint Compound for Tile Backing Panels:

1. Cementitious Backing Units: Thinset, nonsag mortar, as recommended by backing unit manufacturer. Refer to Section 093000 - TILING.
2. Water-Resistant Gypsum Backing Board: Use setting-type taping compound and setting-type, sandable topping compound.

2.6 AUXILIARY MATERIALS

A. General: Provide auxiliary materials that comply with referenced installation standards and manufacturer's written recommendations.

- B. Laminating Adhesive: Adhesive or joint compound recommended for directly adhering gypsum panels to continuous substrate.
- C. 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 tile backing units, use screws of type and size recommended by panel manufacturer.
- D. Acoustic Insulation, Sound Attenuation (Batts) Blankets: ASTM C 665, Type I (blankets without membrane facing) produced by combining thermosetting resins with mineral fibers manufactured from glass, slag wool, or rock wool.
- E. Acoustical Sealant: Manufacturer's standard nondrying, nonhardening, nonskinning, nonstaining, gunnable, joint sealant, recommended for sealing interior concealed joints to reduce airborne sound transmission.
- F. Insulation Support Anchors: Continuous, galvanized metal support trip, 25 gage, with pre-punched tabs at 8 inches on center.
 - 1. Product: Insul-hold; Insul-Hold Co., Inc.; phone: (207) 465-9066.
- G. Firestopping: Provide firestopping where fire rated gypsum board assemblies butt masonry, steel deck, joists, beams, and structural members as part of gypsum board assembly work. See Division 07 section – FIRE RESISTIVE JOINT SYSTEMS.

2.7 IDENTIFICATION LABELS FOR FIRE- AND SMOKE-PARTITIONS

- A. Identification Labels: Self-adhesive signs, to comply with applicable local Code.
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Fire Wall Signs, Inc.
 - b. Marking & Identification Tape (mnitape.com).
 - c. My Safety Sign.
 - d. Safety Supply Warehouse.
 - 2. Text: "FIRE AND SMOKE BARRIER - PROTECT ALL OPENINGS".

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and substrates, with Installer present, and including welded hollow-metal frames and framing, for compliance with requirements and other conditions affecting performance.
- 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 PREPARATION

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

3.3 INSTALLATION, GENERAL

- A. Installation Standard: ASTM C 754. Also comply with requirements in ASTM C 840 that apply to framing installation.
- B. Install supplementary framing, and blocking to support fixtures, equipment services, heavy trim, grab bars, toilet accessories, furnishings, or similar construction.
- C. Install bracing at terminations in assemblies.
- D. Do not bridge building control and expansion joints with non-load-bearing steel framing members. Frame both sides of joints independently.

3.4 INSTALLING SUSPENSION SYSTEMS

- A. Install suspension system components in sizes and spacings indicated on Drawings, but not less than those required by referenced installation standards for assembly types and other assembly components indicated.
- B. Isolate suspension systems from building structure where they abut or are penetrated by building structure to prevent transfer of loading imposed by structural movement.
- C. Suspend hangers from building structure as follows:
 - 1. Install hangers plumb and free from contact with insulation or other objects within ceiling plenum that are not part of supporting structural or suspension system.
 - a. Splay hangers only where required to miss obstructions and offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
 - 2. Where width of ducts and other construction within ceiling plenum produces hanger spacings that interfere with locations of hangers required to support standard suspension system members, install supplemental suspension members and hangers in the form of trapezes or equivalent devices.
 - a. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced installation standards.
 - 3. Wire Hangers: Secure by looping and wire tying, either directly to structures or to inserts, eye screws, or other devices and fasteners that are secure and appropriate for substrate, and in a manner that will not cause hangers to deteriorate or otherwise fail.
 - 4. Flat Hangers: Secure to structure, including intermediate framing members, by attaching to inserts, eye screws, or other devices and fasteners that are secure and appropriate for structure and hanger, and in a manner that will not cause hangers to deteriorate or otherwise fail.
 - 5. Do not attach hangers to steel roof deck.
 - 6. Do not attach hangers to permanent metal forms. Furnish cast-in-place hanger inserts that extend through forms.
 - 7. Do not attach hangers to rolled-in hanger tabs of composite steel floor deck.

- 8. Do not connect or suspend steel framing from ducts, pipes, or conduit.
- D. Fire-Resistance-Rated Assemblies: Wire tie furring channels to supports.
- E. Seismic Bracing: Sway-brace suspension systems with hangers used for support.
- F. Grid Suspension Systems: Attach perimeter wall track or angle where grid suspension systems meet vertical surfaces. Mechanically join main beam and cross-furring members to each other and butt-cut to fit into wall track.
- G. Installation Tolerances: Install suspension systems that are level to within 1/8 inch in 12 feet measured lengthwise on each member that will receive finishes and transversely between parallel members that will receive finishes.

3.5 APPLYING AND FINISHING PANELS, GENERAL

- A. Comply with ASTM C 840.
- B. Install ceiling panels across framing to minimize the number of abutting end joints and to avoid abutting end joints in central area of each ceiling. Stagger abutting end joints of adjacent panels not less than one framing member.
- C. Install panels with face side out. Butt panels together for a light contact at edges and ends with not more than 1/16 inch of open space between panels. Do not force into place.
- D. Locate edge and end joints over supports, except in ceiling applications where intermediate supports or gypsum board back blocking is provided behind end joints. Do not place tapered edges against cut edges or ends. Stagger vertical joints on opposite sides of partitions. Do not make joints other than control joints at corners of framed openings.
- E. Form control and expansion joints with space between edges of adjoining gypsum panels.
- F. Cover both faces of support framing with gypsum panels in concealed spaces (above ceilings, etc.), except in chases braced internally.
 - 1. Unless concealed application is indicated or required for sound, fire, air, or smoke ratings, coverage may be accomplished with scraps of not less than 8 sq. ft. in area.
 - 2. Fit gypsum panels around ducts, pipes, and conduits.
 - 3. Where partitions intersect structural members projecting below underside of floor/roof slabs and decks, cut gypsum panels to fit profile formed by structural members; allow 1/4- to 3/8-inch- wide joints to install sealant.
- G. Isolate perimeter of gypsum board applied to non-load-bearing partitions at structural abutments, except floors. Provide 1/4- to 1/2-inch- wide spaces at these locations, and trim edges with edge trim where edges of panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.
- H. Attachment to Wood Framing: Attach panels so leading edge or end of each panel is attached to open (unsupported) edges of stud first.

3.6 APPLYING INTERIOR GYPSUM BOARD

- A. 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 to minimize end joints.
 - 3. Fastening Methods: Apply gypsum panels to supports with steel drill screws.
- B. Multilayer Application:
 - 1. On ceilings, apply gypsum board indicated for base layers before applying face layers on walls/partitions; apply face layers in same sequence. Apply base layers at right angles to framing members and offset face-layer joints 1 framing member, 16 inches minimum, from parallel base-layer joints, unless otherwise indicated or required by fire-resistance-rated assembly.
 - 2. On partitions/walls, apply gypsum board indicated for base layers and face layers vertically (parallel to framing) with joints of base layers located over stud or furring member and face-layer joints offset at least one stud or furring member with base-layer joints, unless otherwise indicated or required by fire-resistance-rated assembly. Stagger joints on opposite sides of partitions.
 - 3. Fastening Methods: Fasten base layers and face layers separately to supports with screws.
- C. Laminating to Substrate: Where gypsum panels are indicated as directly adhered to a substrate (other than studs, joists, furring members, or base layer of gypsum board), comply with gypsum board manufacturer's written recommendations and temporarily brace or fasten gypsum panels until fastening adhesive has set.

3.7 FINISHING GYPSUM BOARD

- A. General: Treat gypsum board joints, interior angles, edge trim, control joints, penetrations, fastener heads, surface defects, and elsewhere as required to prepare gypsum board surfaces for decoration. Promptly remove residual joint compound from adjacent surfaces.
- B. Prefill open joints, rounded or beveled edges, and damaged surface areas.
- C. Apply joint tape over gypsum board joints, except those with trim having flanges not intended for tape.
- D. Gypsum Board Finish Levels: Finish panels to levels indicated below:
 - 1. Level 1: Ceiling plenum areas and concealed areas not exposed to view.
 - 2. Level 2: Panels that are substrate for tile.
 - 3. Level 3: Not Used.
 - 4. Level 4: Panel surfaces that will be exposed to view (typical panels).
 - 5. Level 5: Where indicated on Drawings.
- E. Cementitious Tile Backing Units: Finish according to manufacturer's written instructions.

3.8 INSTALLING IDENTIFICATION FOR FIRE- AND SMOKE-PARTITIONS

- A. Marking and Identification for Fire- and Smoke-Partitions: Permanently install as required by Code.

3.9 PROTECTION

- A. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.
- B. Remove and replace panels that are wet, moisture damaged, or exhibit mold growth. Repair of damaged panels in place is not acceptable.
 - 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 092110

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SECTION 093100 - TILE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Ceramic tile.
 - 2. Stone thresholds installed as part of tile installations.
 - 3. Crack-suppression membrane for thin-set tile installations.
 - 4. Metal edge strips installed as part of tile installations.
- B. Related Sections include the following:
 - 1. Division 03 Section "Cast-In-Place Concrete" for monolithic slab finishes specified for tile substrates.
 - 2. Division 07 Section "Joint Sealants" for sealing of contraction, control, and isolation joints in tile surfaces on walls and floors.
 - 3. Division 09 Section "Gypsum Board Assemblies" for glass-mat, water-resistant tile backer board.
 - 4. Division 22 Sections for floor drains in floor tile.

1.3 SUBMITTALS

- A. General: Submit in accordance with Division 01 Section "Submittal Procedures."
- B. Product Data: For each type of product indicated.
 - 1. For adhesives, include a printed statement of VOC content.
- C. Shop Drawings: Show locations of each type of tile and tile pattern. Show widths, details, and locations of expansion, contraction and isolation joints in tile substrates and finished tile surfaces, both floors and walls.
- D. Samples for Initial Selection: For each type of grout indicated consisting of actual products showing full range of colors available. Include Samples of accessories involving color selection.
 - 1. Provide samples of marble thresholds for the range of colors available.

1.4 QUALITY ASSURANCE

- A. Source Limitations for Tile: Obtain all tile of same type and color or finish from one source or producer.
 - 1. Obtain tile from same production run and of consistent quality in appearance and physical properties for each contiguous area.

- B. Source Limitations for Setting and Grouting Materials: Obtain ingredients of a uniform quality for each mortar, adhesive, and grout component from a single manufacturer and each aggregate from one source or producer.
- C. Source Limitations for Other Products: Obtain each of the following products specified in this Section through one source from a single manufacturer for each product:
 - 1. Stone thresholds.
 - 2. Crack-suppression membrane.
 - 3. Metal edge strips.
- D. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."
 - 1. Review requirements in ANSI A108.01 for substrates and for preparation by other trades.
 - 2. Assemble all trades working at Project site to coordinate the work and to prevent workers from walking on newly installed tiles for required setting bed and grout cure times. Large tile will require additional time for the mortar bed to cure. Contractor to coordinate project schedule to complete work by other trades and vacate areas receiving floor coverings, stopping pedestrian traffic over newly installed flooring installation until curing and drying period is complete. Contractor shall conduct periodic coordination meetings with all trades to review schedule and procedures to prevent interference and damage during installation and curing and drying periods of floor coverings.
- E. Provide Mockup for the following tile at location directed by the Architect. Each mockup shall be approximately 100 square feet. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
 - 1. Porcelain Floor Tile:
 - 2. Porcelain Wall Tile:
 - 3. Ceramic Wall Tile:
 - 4. Mosaic Floor tile:

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store packaged materials in original containers with seals unbroken and labels intact until time of use. Comply with requirement in ANSI A137.1 for labeling sealed tile packages.
- B. Store tile and cementitious materials on elevated platforms, under cover, and in a dry location.
 - 1. Prevent damage or contamination to materials by water, freezing, foreign matter, and other causes.
- C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.
- D. Store liquid materials in unopened containers and protected from freezing.

1.6 PROJECT CONDITIONS

- A. Environmental Limitations: Do not install tile until construction in spaces is complete and ambient and substrate temperatures and humidity conditions are maintained at the levels indicated in referenced standards and manufacturer's written instructions.
 - 1. Maintain temperatures at 50 deg F or more in tiled areas during installation and for 7 days after completion, unless higher temperatures are required by referenced installation standard or manufacturer's instructions.

- B. Vent temporary heaters to exterior to prevent damage to tile work from carbon dioxide buildup.

1.7 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Tile and Trim Units: Furnish quantity of full-size units equal to 2 percent of amount installed, for each type, composition, color, pattern, and size indicated.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply for product selection:
 - 1. Products: Subject to compliance with requirements, provide one of the products specified.
 - 2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 PRODUCTS, GENERAL

- A. ANSI Ceramic Tile Standard: Provide tile that complies with ANSI A137.1, "Specifications for Ceramic Tile," for types, compositions, and other characteristics indicated.
 - 1. Provide tile complying with Standard grade requirements, unless otherwise indicated.
- B. ANSI Standards for Tile Installation Materials: Provide materials complying with ANSI A108.02, ANSI standards referenced in other Part 2 articles, ANSI standards referenced by TCA installation methods specified in tile installation schedules, and other requirements specified.
- C. Factory Blending: For tile exhibiting color variations within ranges, blend tile in factory and package so tile units taken from one package show same range in colors as those taken from other packages and match approved Samples.
- D. Mounting: For factory-mounted tile, provide back- or edge-mounted tile assemblies as standard with manufacturer, unless otherwise indicated.

2.3 TILE PRODUCTS

- A. Ceramic Wall Tile: Flat tile as follows:
 - 1. Module Size: 8 by 24 inches.
 - 2. Thickness: 3/8 inch.
 - 3. Grout Joint: 1/8 inch

4. Face: Plain with modified square edges.
5. Finish: Matte, opaque glaze.
6. Trim Units: Coordinated with sizes and coursing of adjoining flat tile where applicable and matching characteristics of adjoining flat tile. Provide shapes as follows, selected from manufacturer's standard shapes:
 - a. Base for Thin-Set Mortar Installations: Straight, module size 4-1/4 by 12-7/8 inches.
 - b. External Corners for Thin-Set Mortar Installations: Surface bullnose, same size as adjoining flat tile.
 - c. Internal Corners: Field-buttet square corners. For coved base use angle pieces designed to fit with stretcher shapes.
7. Products:
 - a. Linera Color Wheel Collection; Daltile, Div. of Dal-Tile International Inc.
 - b. Color: As indicated on Materials Legend.

2.4 THRESHOLDS

- A. General: Fabricate to sizes and profiles indicated or required to provide transition between adjacent floor finishes. Provide stone that is uniform in color and finish.
 1. Bevel edges at 1:2 slope, aligning lower edge of bevel with adjacent floor finish. Limit height of bevel to 1/2 inch or less, and finish bevel to match face of threshold.
- B. Marble Thresholds: ASTM C 503 with a minimum abrasion resistance of 12 per ASTM C 1353 or ASTM C 241 and with honed finish.
 1. Comply with MIA Group "A" for soundness.
 2. Size: 2 inches wide by full width of opening; one-piece length.
 3. Description: Uniform, fine- to medium-grained stone with veining. Color to be selected by the Architect from manufacturer's standard colors.

2.5 WATERPROOF MEMBRANE FOR THIN-SET TILE INSTALLATIONS

- A. General: Manufacturer's standard product that complies with ANSI A118.10 and is recommended by the manufacturer for the application indicated. Include reinforcement and accessories recommended by manufacturer.
- B. Fabric-Reinforced, Fluid-Applied Membrane: System consisting of liquid-latex rubber or elastomeric polymer and continuous fabric reinforcement; products shall be compatible for use with radiant heat.
 1. Products:
 - a. LATICRETE International Inc.; Laticrete 9235 Waterproof Membrane.
 - b. MAPEI Corporation; Mapelastic HPG with MAPEI Fiberglass Mesh.
- C. Fluid-Applied Membrane (Shower Walls): Liquid-latex rubber or elastomeric polymer.
 1. Products:
 - a. Laticrete International, Inc.; Laticrete Watertight Floor N' Wall Waterproofing.
 - b. MAPEI Corporation; Mapelastic HPG.

2.6 CRACK ISOLATION MEMBRANE FOR THIN-SET TILE INSTALLATIONS

- A. General: Manufacturer's standard product that complies with ANSI A118.12 for standard performance and is recommended by the manufacturer for the application indicated. Include reinforcement and accessories recommended by manufacturer.
- B. Fabric-Reinforced, Fluid-Applied Membrane: System consisting of a two-part, liquid rubber and fabric reinforcement.
 - 1. Products:
 - a. Laticrete International, Inc.; Laticrete Blue 92 Anti-Fracture Membrane.
 - b. MAPEI Corporation; Mapelastic AquaDefense with MAPEI Reinforcing Fabric.
 - c. Location: Use under porcelain floor tile, quarry tile and mosaic tile floors at all cracks and control joints.

2.7 SETTING AND GROUTING MATERIALS

- A. Portland Cement Mortar (Thickset) Installation Materials: ANSI A108.1A and as specified below:
 - 1. Portland Cement: ASTM C-150, Type 1.
 - 2. Sand: ASTM C-144, clean, washed, sharp, durable, uncoated aggregate free from all deleterious substances, uniformly graded from coarse to fine with 100 percent passing through a No. 4 mesh screen, and not more than 5 percent passing through a No. 100 mesh screen.
 - 3. Cleavage Membrane: Asphalt felt, ASTM D 226, Type I (No. 15); or polyethylene sheeting, ASTM D 4397, 4.0 mils thick.
 - 4. Reinforcing Wire Fabric: Galvanized, welded wire fabric, 2 by 2 inches by 0.062-inch diameter, 16 gage, minimum; comply with ASTM A 185 and ASTM A 82 except for minimum wire size.
 - 5. Latex Additive: Manufacturer's standard water emulsion, serving as replacement for part or all of gaging water, of type specifically recommended by latex-additive manufacturer for use with field-mixed portland cement and aggregate mortar bed.
- B. Latex-Portland Cement Mortar (Thin Set) and Grout: ANSI A118.4 and ANSI A118.7 respectively, consisting of the following:
 - 1. Prepackaged premium dry-mortar mix combined with acrylic resin liquid-latex additive.
 - a. For wall applications, provide nonsagging mortar that complies with Paragraph F-4.6.1 in addition to the other requirements in ANSI A118.4.
 - 1) Products:
 - a) LATICRETE; Laticrete 254 Platinum Mortar. Permacolor Select Grout.
 - b) MAPEI; Ultraflex 3 Mortar. Ultra Color Plus FA Grout.
 - 2. Grout Colors: As indicated on Materials Legend; in locations not indicated, as selected by Architect from manufacturer's full range of colors.
- C. Latex-Portland Cement Mortar for Large Format Tile, Thin Set on Floors: ANSI A118.4 and ANSI A118.7 respectively. Provide product that is approved by manufacturer for application thickness of up to 3/4 inch without shrinkage for tile with a dimension of 12-inches or larger.
 - 1. Some concrete slabs have radiant heat.
 - 2. Provide prepackaged, dry-mortar mix containing dry, redispersible, vinyl acetate or acrylic additive to which only water must be added at Project site.
 - a. Products:
 - 1) LATICRETE; Laticrete ~~255~~ MultiMax Lite Mortar. Permacolor Select Grout.

- 2) MAPEI; Ultraflex LFT Mortar. Ultra Color Plus FA Grout calcium aluminate 603-957-2001 Rick Lindsey.
 3. Grout Colors: As indicated on Materials Legend; in locations not indicated, as selected by Architect from manufacturer's full range of colors.
- D. Latex-Portland Cement Mortar for Large Format Tile and Stone, Thin Set on Walls: ANSI A118.4 and ANSI A118.7 respectively. Provide product that is approved by manufacturer for application thickness of up to 3/4 inch without shrinkage for tile with a dimension of 12-inches or larger.
1. Provide prepackaged, premium dry-mortar mix containing a polymer additive.
 - a. For wall applications, provide mortar that complies with Paragraph F-4.6.1 in addition to the requirements for nonsagging mortar in addition to the other requirements in ANSI A118.4.
 - b. Products:
 - 1) LATICRETE; Laticrete ~~255~~-MultiMax Lite Mortar . Permacolor Select Grout.
 - 2) MAPEI; Ultraflex LFT Mortar. Ultra Color Plus FA Grout .
 - c. Grout Colors: As indicated on Materials Legend; in locations not indicated, as selected by Architect from manufacturer's full range of colors.
- E. Chemical-Resistant, Water-Cleanable, Tile-Setting and -Grouting Epoxy: ANSI A118.3, with a VOC content of 65 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
1. Provide product capable of withstanding continuous and intermittent exposure to temperatures of up to 140 deg F and 212 deg F, respectively, and certified by manufacturer for intended use.
 2. Grout Color: As indicated on Materials Legend; in locations not indicated, as selected by Architect from manufacturer's full range of colors.
 3. Manufacturers: Provide products from one of the following manufacturers:
 - a. LATICRETE: Laticrete 254 Platinum mortar. Spectralock 2000 IG Grout.
 - b. MAPEI. Ultraflex 3. Kerapoxy IEG CQ Grout.

2.8 MISCELLANEOUS MATERIALS

- A. Trowelable Underlayments and Patching Compounds: Latex-modified, portland cement-based formulation provided or approved by manufacturer of tile-setting materials for installations indicated.
1. Product: Ardex; Forti Finish.
- B. Metal Edge Strips at Floor Tile: Stainless steel, L-shaped profile, 1/8-inch wide at top edge with integral provision for anchorage to mortar bed or substrate and integrated grout joint spacer.
1. Finish: As selected by Architect.
 2. Height: As required for 5/16-inch thick tile plus setting bed so strip is flush with top of tile.
 3. Locations: Transition between thin set tile to carpet tile like entry mat and other locations where indicated.
 4. Product: Schluter Systems; Schluter-SCHIENE.

- C. Metal Transition Strips for Wall Tile: Stainless steel with brushed finish, L-profile with 1/8-inch wide top section and vertical wall section; with integrated trapezoid-perforated anchoring leg; provide with matching end caps, and inside and outside corner trim.
 - 1. Locations: Outside vertical corners of tile, cap for tile wainscot and where indicated. Provide matching corner caps.
 - 2. Product: Schluter Systems; Schluter--SCHIENE.
- D. Metal Cove Strips at Floor to Wall Transitions: Stainless steel, cove-shaped profile with integral provision for anchorage to mortar bed or substrate and a soft, thermoplastic rubber movement zone attached to profile via rigid rubber grip bars; provide inside and outside corners and matching end caps; finish as selected by Architect.
 - 1. Product: Schluter Systems; Schluter-DILEX-HKS at locations with tile floors, and Schluter-DILEX-AHKA at locations with rubber tile floors.
- E. Tile Cleaner: A neutral cleaner capable of removing soil and residue without harming tile and grout surfaces, specifically approved for materials and installations indicated by tile and grout manufacturers.
- F. Grout Sealer: Manufacturer's standard silicone product for sealing grout joints that does not change color or appearance of grout.
 - 1. Products:
 - a. Laticrete StoneTech Heavy Duty Grout Sealer.
 - b. MAPEI UltraCare Grout Sealer.

2.9 MIXING MORTARS AND GROUT

- A. Mix mortars and grouts to comply with referenced standards and mortar and grout manufacturers' written instructions, including those for accurate proportioning of materials, water, or additive content; type of mixing equipment, selection of mixer speeds, mixing containers, mixing time, and other procedures needed to produce mortars and grouts of uniform quality with optimum performance characteristics for application indicated.
- B. Obtain and use type of mixing equipment, mixer speeds, mixing containers, mixing time, and other procedures to produce mortars and grouts of uniform quality with optimum performance characteristics for installations indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions where tile will be installed, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of installed tile.
 - 1. Check flatness of substrate by laser. Level floor to provide a base for thin set that allows for a smooth, flat floor without irregularities. Verify proper drainage to drains. Grinding high spots until substrate is acceptable to the flooring Installer is specified in Division 03 Section "Cast-in-Place Concrete."
 - 2. Verify that substrates for setting tile are firm; dry; clean; free of coatings that are incompatible with tile-setting materials including curing compounds and other

- substances that contain soap, wax, oil, or silicone; and within flatness tolerances required by referenced ANSI A108 Series of tile installation standards for installations indicated.
3. Verify that concrete substrates for tile floors installed with thin-set mortar comply with surface finish requirements in ANSI A108.01 for installations indicated.
 - a. Verify that surfaces that received a steel trowel finish have been mechanically scarified.
 - b. Verify that protrusions, bumps, and ridges have been removed by sanding or grinding.
 4. Verify that gypsum board substrates for wall tile comply with the surface finish requirements in ANSI A108.01 for installations indicated and the following:
 - a. For Tile with at Least One Edge 15 Inches or Greater: Flatness shall not vary more than 1/8-inch in 10 feet with no more than 1/16-inch variation in 24 inches when measured from the high points in the surface.
 - b. Verify that substrate is properly supported in corners.
 - c. Verify that fasteners are properly spaced and covered.
 - d. Verify that joint treatment is fully cured.
 5. Verify that adjacent edges of concrete masonry units do not exceed 1/32-inch difference in height.
 6. Verify that installation of grounds, anchors, recessed frames, electrical and mechanical units of work, and similar items located in or behind tile has been completed before installing tile.

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

3.2 PREPARATION

- A. Grind slab clean prior to setting tile. Use diamond-abrasive surface grinding (Diamabrush) with dust control to remove all adhesives, coatings, sealers, curing compound, joint compound and efflorescence. Do not shot blast or bead blast.
- B. Fill cracks, holes, and depressions in concrete substrates for tile floors installed with thin-set mortar with trowelable leveling and patching compound specifically recommended by tile-setting material manufacturer.
- C. Where indicated, prepare substrates to receive waterproofing by applying a reinforced mortar bed that complies with ANSI A108.1A and is sloped 1/4 inch per foot toward drains.
- D. Blending: For tile exhibiting color variations, verify that tile has been factory blended and packaged so tile units taken from one package show same range of colors as those taken from other packages and match approved Samples. If not factory blended, either return to manufacturer or blend tiles at Project site before installing.
- E. Where wall tile is to be applied to concrete masonry units apply leveling coat of thin set mortar to level surfaces and fill mortar joints before application of large format tile.

3.3 INSTALLATION, GENERAL

- A. ANSI Tile Installation Standards: Comply with parts of ANSI A108 Series "Specifications for Installation of Ceramic Tile" that apply to types of setting and grouting materials and to methods indicated in ceramic tile installation schedules.

- B. TCA Installation Guidelines: TCA's "Handbook for Ceramic Tile Installation." Comply with TCA installation methods indicated in ceramic tile installation schedules.
- C. Lay tile in patterns indicated. When field conditions conflict with indicated pattern, notify Architect in writing prior to installation for review and approval of revisions.
- D. Extend tile work into recesses and under or behind equipment and fixtures to form complete covering without interruptions, unless otherwise indicated. Terminate work neatly at obstructions, edges, and corners without disrupting pattern or joint alignments.
- E. Accurately form intersections and returns. Perform cutting and drilling of tile without marring visible surfaces. Carefully grind cut edges of tile abutting trim, finish, or built-in items for straight aligned joints. Fit tile closely to electrical outlets, piping, fixtures, and other penetrations so plates, collars, or covers overlap tile. Top setting of coved base is not permitted.
- F. Tile shall lay flat and each edge flush with adjacent tile, free of tilting and skewed tile. Provide additional setting material to shim accent tiles that are thinner than field tiles so face is in same plane.
- G. Jointing Pattern: Lay tile in grid pattern, unless otherwise indicated. Align joints when adjoining tiles on floor, base, walls, and trim are same size. Lay out tile work and center tile fields in both directions in each space or on each wall area, unless indicated otherwise. Adjust to minimize tile cutting. Provide uniform joint widths, unless otherwise indicated.
 - 1. For tile mounted in sheets, make joints between tile sheets same width as joints within tile sheets so joints between sheets are not apparent in finished work.
- H. Lay out tile wainscots to next full tile beyond dimensions indicated.
- I. Expansion Joints: Locate expansion joints and other sealant-filled joints, including control, contraction, and isolation joints, where indicated during installation of setting materials, mortar beds, and tile. Do not saw-cut joints after installing tiles.
 - 1. Locate expansion joints in accordance with the TCNA Handbook and as follows:
 - a. Interior Floors on Grade: 20 to 25 feet in each direction.
 - b. Interior Elevated Slabs: 8 to 12 feet in each direction.
 - c. Interior Walls: 20 to 25 feet in each direction.
 - d. In areas exposed to direct sunlight or moisture, space joints not greater than 8 to 12 feet in each direction.
 - 2. Locate sealant-filled joints in accordance with approved Shop Drawings.
 - 3. Prepare joints and apply sealants to comply with requirements in Division 07 Section "Joint Sealants."
- J. Grout tile to comply with requirements of the following tile installation standards:
 - 1. For porcelain and ceramic tile grouts (latex-portland cement grouts), comply with ANSI A108.10.

3.4 WATERPROOFING AND CRACK-SUPPRESSION MEMBRANE INSTALLATION

- A. Install waterproofing to comply with ANSI A108.13 and waterproofing manufacturer's written instructions to produce waterproof membrane of uniform thickness bonded securely to substrate.
 - 1. Install continuous fabric reinforcement over entire floor.

2. Turn membrane with fabric reinforcement up walls as follows to keep water from traveling under partitions:
 - a. Toilet Rooms with Tile Floors on Elevated Slabs and Slabs on Grade: 3 inches minimum at perimeter walls of rooms.
 - b. Shower Rooms: 4 inches minimum at perimeter walls of Shower Rooms.
 - c. Shower Stalls: Apply over entire floor of stall.
 - 1) Apply fluid-applied water proofing to shower stall walls.
- B. Install crack-suppression membrane to comply with ANSI A108.17 and manufacturer's written instructions to produce membrane of uniform thickness bonded securely to substrate.
 1. Install fabric reinforcement in crack-suppression membrane at all cracks, saw cuts and room perimeter sealing.
 2. At toilet rooms and toilet rooms with showers on slabs-on-grade with tile floors, seal perimeter of room by running membrane with reinforcement fabric up wall 3 inches minimum and out onto the floor 4 inches minimum.
- C. Do not install tile over waterproofing until waterproofing has cured.

3.5 FLOOR TILE INSTALLATION

- A. General: Install tile to comply with requirements in the Floor Tile Installation Schedule, including those referencing TCA installation methods and ANSI A108 Series of tile installation standards.
 1. For installations indicated below, follow procedures in ANSI A108 Series tile installation standards for providing 95 percent mortar coverage.
 - a. Tile floors composed of tiles 8 by 8 inches or larger.
- B. Joint Widths: Install tile on floors with the following joint widths:
 1. Ceramic Mosaic Tile: 1/16 inch.
 2. Porcelain Tile: 1/8 inch.
- C. Stone Thresholds: Install stone thresholds in same type of setting bed as abutting field tile, unless otherwise indicated.
 1. Do not extend waterproofing or crack isolation membrane under thresholds set in latex-portland cement mortar. Fill joints between such thresholds and adjoining tile set on waterproofing or crack isolation membrane with elastomeric sealant.
- D. Metal Edge Strips: Install at locations indicated or where exposed edge of tile flooring meets carpet, wood, or other flooring that finishes flush with or below top of tile and no threshold is indicated. Metal edge strips shall be installed in accordance with manufacturer's written installation instructions.
- E. Grout Sealer: Apply grout sealer to grout joints according to grout-sealer manufacturer's written instructions. As soon as grout sealer has penetrated grout joints, remove excess sealer and sealer that has gotten on tile faces by wiping with soft cloth.

3.6 WALL TILE INSTALLATION

- A. Install types of tile designated for wall installations to comply with requirements in the Wall Tile Installation Schedule, including those referencing TCA installation methods and ANSI setting-bed standards.

- B. Joint Widths: Install tile on walls with the following joint widths:
 - 1. Ceramic Mosaic Tile: 1/16 inch.
 - 2. Porcelain and Ceramic Tile: 1/8 inch.

3.7 CLEANING AND PROTECTING

- A. Remove and replace material that is stained or otherwise damaged or that does not match adjoining tile. Provide new matching units, installed as specified and in a manner to eliminate evidence of replacement.
- B. Cleaning: On completion of placement and grouting, clean all ceramic tile surfaces so they are free of foreign matter.
 - 1. Remove latex-portland cement grout residue from tile as soon as possible.
 - 2. Clean grout smears and haze from tile according to tile and grout manufacturer's written instructions, but no sooner than 10 days after installation. Use only cleaners recommended by tile and grout manufacturers and only after determining that cleaners are safe to use by testing on samples of tile and other surfaces to be cleaned. Protect metal surfaces and plumbing fixtures from effects of cleaning. Flush surfaces with clean water before and after cleaning.
- C. When recommended by tile manufacturer, apply coat of neutral protective cleaner to completed tile walls and floors. Protect installed tile work with kraft paper or other heavy covering during construction period to prevent staining, damage, and wear.
- D. Prohibit foot and wheel traffic from tiled floors for at least seven days after grouting is completed.
- E. Before final inspection, remove protective coverings and rinse neutral cleaner from tile surfaces.

3.8 TILE INSTALLATION SCHEDULE

- A. Porcelain and Ceramic Tile over Concrete Floors on Grade, General Areas: Thin-set latex portland cement mortar over crack suppression membrane at saw cuts and random cracks, TCA F125 - Partial.
 - 1. At toilet rooms and toilet rooms with a shower on grade, seal perimeter of room by running membrane up wall 3 inches minimum and out on the floor 4 inches.
- B. Porcelain and Ceramic Tile over Concrete Floors with Occupied Rooms Below: Latex portland cement mortar, waterproof membrane, TCA F122.
 - 1. At toilets, seal perimeter of room by running waterproof membrane up wall 3 inches minimum.
- C. Quarry Tile over Concrete Floor, Thin Set: Thin-set epoxy mortar with epoxy grout. Treat all saw cut joints and random cracks with anti-fracture membrane, TCA F131 modified.
- D. Ceramic and Porcelain Wall Tile on Glass-Mat, Water Resistant Backer Board, Thin Set: Latex portland cement mortar tile setting bed, TCA W245.
- E. Ceramic and Porcelain Wall Tile on CMU, Thin Set: Latex portland cement mortar over leveling coat, TCA W201.

F. Tile in Showers: As follows:

1. Ceramic Tile over Concrete Floors in Shower Receptor, Thick Set: Reinforced cement mortar over waterproof membrane, turn waterproof membrane up wall, TCA B420. Apply joint sealer to tile joints.
2. Porcelain Wall Tile on CMU in Showers over Waterproof Membrane: Thin set latex portland cement mortar tile setting bed over leveling coat and waterproof membrane, lap waterproof membrane over receptor waterproof membrane, TCA 2021. Apply joint sealer to tile joints.

END OF SECTION 093100

SECTION 095113 - ACOUSTICAL PANEL CEILINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Acoustical panels.
 - 2. Exposed suspension systems.
- B. Related Sections include the following:
 - 1. Division 09 Section "Gypsum Board Assemblies" for suspension systems provided for gypsum board ceilings.
 - 2. Division 21, 22, 23, 26, and 27 Sections for coordination of air handling devices, fire protection devices, and electrical devices installed in ceiling systems.

1.3 DEFINITIONS

- A. CAC: Ceiling Attenuation Class.
- B. NRC: Noise Reduction Coefficient.

1.4 SUBMITTALS

- A. General: Submit in accordance with Division 01 Section "Submittal Procedures."
- B. Product Data: For each type of product indicated.
- C. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for each acoustical panel ceiling.
- D. Research/Evaluation Reports: For each acoustical panel ceiling suspension system, from ICC-ES.
- E. Maintenance Data: For finishes to include in maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Source Limitations:
 - 1. Acoustical Ceiling Panel: Obtain each type through one source from a single manufacturer.
 - 2. Suspension System: Obtain all suspension systems through one source from a single manufacturer.
- B. Fire-Test-Response Characteristics: Provide acoustical panel ceilings that comply with the following requirements:

1. Fire-Resistance Characteristics: Where indicated, provide acoustical panel ceilings identical to those of assemblies tested for fire resistance per ASTM E 119 by UL or another testing and inspecting agency acceptable to authorities having jurisdiction.
 - a. Identify materials with appropriate markings of applicable testing and inspecting agency.
2. Surface-Burning Characteristics: Provide acoustical panels with the following surface-burning characteristics complying with ASTM E 1264 for Class A materials as determined by testing identical products per ASTM E 84:
 - a. Smoke-Developed Index: 450 or less.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver acoustical panels, suspension system components, and accessories to Project site in original, unopened packages and store them in a fully enclosed, conditioned space where they will be protected against damage from moisture, humidity, temperature extremes, direct sunlight, surface contamination, and other causes. Store materials flat.
- B. Before installing acoustical panels, permit them to reach room temperature and a stabilized moisture content.
- C. Handle acoustical panels carefully to avoid chipping edges or damaging units in any way.

1.7 PROJECT CONDITIONS

- A. Environmental Limitations: Do not install acoustical panel ceilings until spaces are enclosed and weatherproof, 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.
- B. Mechanical, electrical, and other utility service installations above the ceiling plane shall have been completed prior to the installation of the ceilings.

1.8 COORDINATION

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

1.9 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Acoustical Ceiling Panels: Full-size panels equal to 2.0 percent of quantity installed, but not less than 4 full cartons of tile ACT-1 and ACT-2.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply for product selection:
 - 1. Products: Subject to compliance with requirements, provide one of the products specified.

2.2 ACOUSTICAL PANELS, GENERAL

- A. Acoustical Panel Standard: Provide manufacturer's standard panels of configuration indicated that comply with ASTM E 1264 classifications as designated by types, patterns, acoustical ratings, and light reflectances, unless otherwise indicated.
 - 1. Mounting Method for Measuring NRC: Type E-400; plenum mounting in which face of test specimen is 15-3/4 inches away from test surface per ASTM E 795.
 - 2. Test Method for Ceiling Attenuation Class (CAC). Where acoustical panel ceilings are specified to have a CAC, provide units identical to those tested per ASTM E 1414 by a qualified testing agency.
- B. Acoustical Panel Colors and Patterns: Match appearance characteristics indicated for each product type.
 - 1. Where appearance characteristics of acoustical panels are indicated by referencing pattern designations in ASTM E 1264 and not manufacturers' proprietary product designations, provide products selected by Architect from each manufacturer's full range that comply with requirements indicated for type, pattern, color, light reflectance, acoustical performance, edge detail, and size.
- C. Coating-Based Antimicrobial Treatment: Provide acoustical panels with face and back surfaces coated with antimicrobial treatment consisting of manufacturer's standard formulation with fungicide added to inhibit growth of mold and mildew and showing no mold or mildew growth when tested according to ASTM D 3273.

2.3 ACOUSTIC PANELS

- A. Acoustic Panel: ACT-1.
 - 1. Size: 24 inches x 24 inches.
 - 2. Thickness: Not less than 3/4-inch thick.
 - 3. Composition: Mineral wool fiber.
 - 4. Surface Finish: Factory-applied latex paint; white.
 - 5. Surface Texture: Fine texture.
 - 6. Edge: Beveled Tegular.
 - 7. NRC Range: Not less than 0.75.
 - 8. CAC Range: 35.
 - 9. Dimensional Stability: Sag resistant at high humidity.
 - 10. Antimicrobial Treatment: Coating based, front and back.
 - 11. Basis-of-Design: Subject to compliance with requirements, provide Ultima No. 1911 by Armstrong World Industries, Inc. or one of the following:
 - a. Certainteed Symphony m 1222BB-75-1.
 - 12. Suspension System Type: Type A.
 - 13.
- B. Acoustic Panel: ACT-2.
 - 1. Size: 24 inches x 48 inches.
 - 2. Thickness: Not less than 3/4-inch thick.

3. Composition: Mineral wool fiber.
4. Surface Finish: Factory-applied latex paint; white.
5. Surface Texture: Fine texture.
6. Edge: Beveled Tegal.
7. NRC Range: Not less than 0.75.
8. CAC Range: 35.
9. Dimensional Stability: Sag resistant at high humidity.
10. Antimicrobial Treatment: Coating based, front and back.
11. Basis-of-Design: Subject to compliance with requirements, provide Ultima No.1914 by Armstrong World Industries, Inc. or one of the following:
 - a. Certainteed Symphony m 1220BB-75-1.
12. Suspension System Type: Type A.

2.4 METAL SUSPENSION SYSTEMS, GENERAL

- A. Recycled Content: Provide products made from steel sheet with average recycled content such that postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 percent.
- B. Metal Suspension System Standard: Provide manufacturer's standard direct-hung metal suspension systems of types, structural classifications, and finishes indicated that comply with applicable requirements in ASTM C 635.
- C. Finishes and Colors, General: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes. Provide manufacturer's standard factory-applied finish for type of system indicated.
 1. High-Humidity Finish: Comply with ASTM C 635 requirements for "Coating Classification for Severe Environment Performance" where high-humidity finishes are indicated.
- D. Attachment Devices: Size for five times the design load indicated in ASTM C 635, 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 per ASTM E 1190, conducted by a qualified testing and inspecting agency.
- E. Wire Hangers, Braces, and Ties: Provide wires complying with the following requirements:
 1. Zinc-Coated Carbon-Steel Wire: ASTM A 641/A 641M, Class 1 zinc coating, soft temper.
 2. Size: Select wire diameter so its stress at three times hanger design load (ASTM C 635, Table 1, "Direct Hung") will be less than yield stress of wire, but provide not less than 0.106-inch- diameter wire.
- F. Hold-Down Clips: Where indicated, provide manufacturer's standard hold-down clips spaced 24 inches o.c. on all cross tees.
 1. Locations:
 - a. In Vestibules and for a distance of 10 feet inside exterior doors without Vestibules.
 - b. Where indicated.

2.5 METAL SUSPENSION SYSTEMS FOR ACOUSTICAL PANEL CEILINGS

- A. Type A: Wide-Face, Capped, Double-Web, Steel Suspension System: Main and cross runners roll formed from cold-rolled steel sheet, prepainted, electrolytically zinc coated, or hot-dip galvanized according to ASTM A 653/A 653M, not less than G30 coating designation, with prefinished 15/16-inch- wide metal caps on flanges.
1. Structural Classification: Intermediate-duty system.
 2. End Condition of Cross Runners: Override (stepped) or butt-edge type, as standard with manufacturer.
 3. Face Design: Flat, flush.
 4. Cap Material: Steel or aluminum cold-rolled sheet, as standard with manufacturer.
 5. Cap Finish: Painted white.
 6. Locations: For all suspended acoustical ceilings, except as otherwise noted.
 7. Products:
 - a. Armstrong World Industries, Inc.; Prelude XL Exposed Tee System, 7300 Series.
 - b. Chicago Metallic Corporation; 1200 System.
 - c. USG Interiors, Inc.; DX System.

2.6 DECORATIVE PERIMETER TRIM

- A. Extruded-Aluminum Edge Moldings and Trim: Where indicated, provide manufacturer's extruded-aluminum edge moldings and trim of profile indicated or referenced by manufacturer's designations, including splice plates, corner pieces, and attachment and other clips, complying with seismic design requirements and the following:
1. Aluminum Alloy: Alloy and temper recommended by aluminum producer and finisher for type of use and finish indicated, and with not less than the strength and durability properties of aluminum extrusions complying with ASTM B 221 for Alloy and Temper 6063-T5.
 2. Finish designations prefixed by AA comply with system established by the Aluminum Association for designating aluminum finishes.
 3. Baked-Enamel Finish: AA-C12C42R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: acid-chromate-fluoride-phosphate conversion coating; organic coating: as specified below). Apply baked enamel complying with paint manufacturer's written instructions for cleaning, conversion coating, and painting.
 - a. Organic Coating: Thermosetting, primer/topcoat system with a minimum dry film thickness of 0.8 to 1.2 mils.
- B. Decorative Perimeter Trim: Provide straight and curved decorative trim as follows:
1. Axiom Classic; Armstrong World Industries, Inc.
 - a. Size: As indicated.
 - b. Color: White.
 - c. Radius: As indicated.
 - d. Accessories: Manufactured inside and outside corners having factory mitered corners.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, including structural framing to which acoustical panel ceilings attach or abut, with Installer present, for compliance with requirements specified in this and other Sections that affect ceiling installation and anchorage and with requirements for installation tolerances and other conditions affecting performance of acoustical panel ceilings.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Measure each ceiling area and establish layout of acoustical panels to balance border widths at opposite edges of each ceiling. Avoid using less-than-half-width panels at borders, and comply with layout shown on reflected ceiling plans.

3.3 INSTALLATION, GENERAL

- A. General: Install acoustical panel ceilings to comply with ASTM C 636 and seismic requirements indicated, per manufacturer's written instructions and CISCA's "Ceiling Systems Handbook."
- B. Suspend ceiling hangers from building's structural members and as follows:
 - 1. Hangers shall be single lengths of wire without splices; coordinate lengths in deep ceiling cavities.
 - 2. 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.
 - 3. Splay hangers only where required to miss obstructions; offset resulting horizontal forces by bracing, countersplaying, or other equally effective means.
 - 4. 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. Size supplemental suspension members and hangers to support ceiling loads within performance limits established by referenced standards and publications.
 - 5. Secure wire hangers to ceiling suspension members and to supports above with a minimum of three tight turns. Connect hangers directly either to structures or to inserts, eye screws, or other devices that are secure and appropriate for substrate and that will not deteriorate or otherwise fail due to age, corrosion, or elevated temperatures.
 - 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. Do not attach hangers to steel deck tabs.
 - 8. Do not attach hangers to steel roof deck. Attach hangers to structural members.
 - 9. 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.
 - 10. Exposed pop rivets for grid alignment purposes shall not be permitted.
- C. Suspension system shall be reinforced to support diffusers, light fixtures and any additional members. Install hanger wires to grid at each corner of light fixtures. Coordinate location with electrical and other trades.

1. Each individual fixture and attachment with combined weight of 56 pounds or less shall have two 12-gage wire hangers attached at diagonal corners of the fixture. These wires shall be slack. Fixtures and attachments with a combined weight of greater than 56 pounds shall be independently supported from the structure at all four corners.
- D. Install edge moldings and trim of type indicated at perimeter of acoustical ceiling area and where necessary to conceal edges of acoustical panels.
 1. Screw attach moldings to substrate at intervals not more than 16 inches o.c. and not more than 3 inches from ends, leveling with ceiling suspension system to a tolerance of 1/8 inch in 12 feet. Miter corners accurately and connect securely.
 2. Do not use exposed fasteners, including pop rivets, on moldings and trim.
- E. Install suspension system runners so they are square and securely interlocked with one another. Remove and replace dented, bent, or kinked members.
- F. Install acoustical panels with undamaged edges and fit accurately into suspension system runners and edge moldings. Scribe and cut panels at borders and penetrations to provide a neat, precise fit.
 1. Arrange directionally patterned acoustical panels to run in the same direction.
 2. For square-edged panels, install panels with edges fully hidden from view by flanges of suspension system runners and moldings.
 3. For reveal-edged panels on suspension system runners, install panels with bottom of reveal in firm contact with top surface of runner flanges.
 4. Paint cut edges of panel remaining exposed after installation; match color of exposed panel surfaces using coating recommended in writing for this purpose by acoustical panel manufacturer.
 5. Install hold-down clips in Vestibules and at areas indicated, in areas required by authorities having jurisdiction, and for fire-resistance ratings; space as recommended by panel manufacturer's written instructions, unless otherwise indicated.

3.4 CLEANING

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

END OF SECTION 095113

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SECTION 099000 – PAINTING AND COATING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Exposed exterior items and surfaces with low VOC coatings complying with ME DEP regulations (OTC regulations).
 - 2. Exposed interior items and surfaces with low VOC coatings complying with ME DEP regulations (OTC regulations).
 - 3. Surface preparation, priming, and finish coats specified in this Section are in addition to shop priming and surface treatment specified in other Sections.
- B. Related Sections include the following:
 - 1. Section 081110 - HOLLOW METAL DOORS AND FRAMES for factory priming steel doors and frames.
 - 2. Section 092110 - GYPSUM BOARD ASSEMBLIES for surface preparation of gypsum board.
 - 3. Review all sections for shop primed items requiring field painting.

1.3 DEFINITIONS

- A. General: Standard coating terms defined in ASTM D 16 apply to this Section.
 - 1. Flat refers to a lusterless or matte finish with a gloss range below 15 when measured at an 85-degree meter.
 - 2. Eggshell refers to low-sheen finish with a gloss range between 20 and 35 when measured at a 60-degree meter.
 - 3. Satin refers to low-sheen finish with a gloss range between 15 and 35 when measured at a 60-degree meter.
 - 4. Semigloss refers to medium-sheen finish with a gloss range between 35 and 70 when measured at a 60-degree meter.
 - 5. Full gloss refers to high-sheen finish with a gloss range more than 70 when measured at a 60-degree meter.

1.4 SUBMITTALS

- A. General: Submit in accordance with Division 01 Section "Submittal Procedures."
- B. Product Data: For each paint system indicated. Include block fillers and primers.
 - 1. Material List: An inclusive list of required coating materials. Indicate each material and cross-reference specific coating, finish system, and application. Identify each material by manufacturer's catalog number and general classification.
 - 2. Manufacturer's Information: Manufacturer's technical information, including label analysis and instructions for handling, storing, and applying each coating material proposed for use.

3. Include printed statement of VOC content for each product.
- C. Schedule: Provide schedule of all surfaces to be coated, with prime and finish coat material listed, and manufacturer's recommended wet film thickness.
- D. Samples: For each type of exposed finish required, submit color chips, 3- by 5-inches, matching colors indicated on Materials Legend.
- E. Manufacturer Certificates: Signed by manufacturers certifying that products with limit VOC amounts specified comply with requirements.
- F. Qualification Data: For Applicator.
- G. Color Mix Code: For all colors used for Project to include in Owner's Manual.

1.5 QUALITY ASSURANCE

- A. Applicator Qualifications: Engage an experienced Applicator who has completed painting system applications similar in material, design, and extent to those indicated for this Project, whose work has resulted in applications with a record of successful in-service performance.
- B. Source Limitations: Obtain block fillers, primers and undercoat materials for each coating system from the same manufacturer as the finish coats.
- C. Benchmark Samples (Mockups): Provide a full-coat benchmark finish sample for each type of coating and substrate required. Duplicate finish of approved sample Submittals.
 1. Architect will select one room or surface to represent surfaces and conditions for each type of coating and substrate to be painted.
 - a. Wall Surfaces: Provide samples of at least 100 sq. ft.
 - b. Small Areas and Items: Architect will designate items or areas required.
 2. After permanent lighting and other environmental services have been activated, apply benchmark samples, according to requirements for the completed Work. Provide required sheen, color, and texture on each surface.
 - a. After finishes are accepted, Architect will use the room or surface to evaluate coating systems of a similar nature.
 3. Final approval of colors will be from benchmark samples.
 4. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver materials to the Project Site in manufacturer's original, unopened packages and containers bearing manufacturer's name and label, and the following information:
 1. Product name or title of material.
 2. Product description (generic classification or binder type).
 3. Manufacturer's stock number and date of manufacture.
 4. Contents by volume, for pigment and vehicle constituents.
 5. Thinning instructions.
 6. Application instructions.
 7. Color name and number.
 8. VOC content.

- B. Store materials not in use in tightly covered containers in a well-ventilated area at a minimum ambient temperature of 45 deg F. Maintain containers used in storage in a clean condition, free of foreign materials and residue.
 - 1. Protect from freezing. Keep storage area neat and orderly.
 - 2. Remove oily rags and waste daily.
 - 3. Take necessary measures to ensure that workers and work areas are protected from fire and health hazards resulting from handling, mixing, and application.

1.7 PROJECT CONDITIONS

- A. Apply finishes only when temperatures of surfaces to be finished and ambient air temperatures are between 50 and 95 deg F.
 - 1. At exterior applications, temperature shall be continuous for 48 hours prior to application, during application and for 48 hours after to application.
- B. Exterior Finishes: Do not apply paint in snow, rain, fog, or mist; or when relative humidity exceeds 85 percent; or at temperatures less than 5 deg F above the dew point; or to damp or wet surfaces.
 - 1. Painting may continue during inclement weather if surfaces and areas to be painted are enclosed and heated within temperature limits specified by manufacturer during application and drying periods.
 - 2. Allow wet surfaces to dry thoroughly and attain temperature and conditions specified before proceeding with or continuing coating operation.

1.8 EXTRA MATERIALS

- A. Furnish extra paint materials from the same production run as the materials applied and in the quantities described below. Package with protective covering for storage and identify with labels describing contents. Deliver extra materials to Owner.
 - 1. Quantity: Furnish Owner with not less than 1 gal., of each material and color applied for Owner's use during move in.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products: Subject to compliance with requirements, provide one of the products listed in other Part 2 articles.
- B. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:
 - 1. Benjamin Moore & Company (Moore).
 - 2. Samuel Cabot, Inc. (Cabot).
 - 3. Great Lakes Laboratories (GLL).
 - 4. PPG Architectural Finishes, Inc. (PPG).
 - 5. Sherwin-Williams Co. (S-W).
 - 6. Tnemec Company, Inc. (Tnemec).
 - 7. Flame Control Coatings, LLC (Flame Control); phone: (716) 282-1399; available through Sherwin-Williams.

2.2 COATINGS MATERIALS, GENERAL

- A. Material Compatibility: Provide block fillers, primers, undercoats, and finish-coat materials that are compatible with one another and with the substrates indicated under conditions of service and application, as demonstrated by manufacturer based on testing and field experience.
- B. Material Quality: Provide manufacturer's best quality coating material of the various coating types specified that are factory formulated and recommended by manufacturer for application indicated. Paint-material containers not displaying manufacturer's product identification will not be acceptable.
 - 1. Proprietary Names: Use of manufacturer's proprietary product names to designate colors or materials is not intended to imply that products named are required to be used to the exclusion of equivalent products of other manufacturers listed in the specification schedule. Furnish manufacturer's material data and certificates of performance for proposed substitutions.
 - 2. Where schedule says no substitution, use proprietary product only. Do not propose substitution, as the products from the other manufacturers have been considered, and are not acceptable.
- C. VOC Compliance for Exterior and Interior Paints and Coatings: Provide the manufacturer's formulation for the products specified below that are VOC compliant with the State of Maine Department of Environmental Protection Regulation, "Chapter 151: Architectural and Industrial Maintenance (AIM) Coatings" and the following chemical restrictions from the Ozone Transport Commission (OTC) expressed in grams per liter:
 - 1. Flat Paints and Coatings: VOC content of not more than 100 g/L.
 - 2. Non-Flat Paints and Coatings: VOC content of not more than 150 g/L.
 - 3. Non-Flat Paints and Coatings - High Gloss: VOC content of not more than 250 g/L.
 - 4. Anticorrosive (Rust Preventative) Coatings: VOC content of not more than 400 g/L.
 - 5. Clear Wood Coatings:
 - a. Varnishes: VOC content of not more than 350 g/L.
 - 6. Fire Retardant Coatings:
 - a. Clear: VOC content of not more than 650 g/L.

- b. Opaque: VOC content of not more than 350 g/L.
 - 7. Industrial Maintenance Coatings (IMC): VOC content of not more than 340 g/L.
 - 8. Primers, Sealers, and Undercoaters: VOC content of not more than 200 g/L.
 - 9. Quick-Dry Enamels: VOC content of not more than 250 g/L.
 - 10. Quick-Dry Primers, Sealers, and Undercoaters: VOC content of not more than 200 g/L.
 - 11. Specialty Primers, Sealers, and Undercoaters: VOC content of not more than 350 g/L.
 - 12. Stains: VOC content of not more than 500 g/L.
 - 13. Wood Preservatives: VOC content of not more than 350 g/L.
- D. Colors: Provide colors as indicated in Materials Legend; if color is not indicated, color shall be as selected by the Architect from the manufacturer's full range of options.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Applicator and drywall subcontractor present, under which painting will be performed for compliance with paint application requirements.
 - 1. Inspect walls for dents and imperfections prior to painting. Inspect walls again after primer and first coat of paint applied, with Applicator and drywall subcontractor present. Drywall subcontractor shall touch-up as follows:
 - a. Touch-up visible gypsum board imperfections before priming of walls.
 - b. Touch-up imperfections found in field of boards and joints made visible from painting after first finish coat applied.
 - 2. If unacceptable conditions are encountered, prepare written report, endorsed by Applicator, listing conditions detrimental to performance of work.
 - 3. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
 - 4. Application of coating indicates Applicator's acceptance of surfaces and conditions within a particular area.
 - 5. Begin coating application only after unsatisfactory conditions have been corrected and surfaces are dry.
- B. Coordination of Work: Review other Sections in which primers are provided to ensure compatibility of the total system for various substrates. On request, furnish information on characteristics of specified finish materials to ensure use of compatible primers.
 - 1. Notify Architect about anticipated problems when using the materials specified over substrates primed by others.

3.2 PREPARATION

- A. General: Remove hardware and hardware accessories, plates, machined surfaces, lighting fixtures, and similar items already installed that are not to be painted. If removal is impractical or impossible because of size or weight of the item, provide surface-applied protection before surface preparation and painting.
 - 1. After completing painting operations in each space or area, reinstall items removed using workers skilled in the trades involved.
- B. Cleaning: Before applying paint or other surface treatments, clean substrates of substances that could impair bond of the various coatings. Remove oil and grease before cleaning.

1. Schedule cleaning and painting so dust and other contaminants from the cleaning process will not fall on wet, newly painted surfaces.
- C. Surface Preparation: Clean and prepare surfaces to be painted according to manufacturer's written instructions for each particular substrate condition and as specified.
1. Provide barrier coats over incompatible primers or remove and reprime.
 2. Cementitious Materials: Prepare concrete unit masonry surfaces to be painted. Remove efflorescence, chalk, dust, dirt, grease, oils, and release agents. Roughen as required to remove glaze.
 - a. Determine alkalinity and moisture content of surfaces by performing appropriate tests. If surfaces are sufficiently alkaline to cause the finish paint to blister and burn, correct this condition before application. Do not paint surfaces if moisture content exceeds that permitted in manufacturer's written instructions.
 3. Exterior Wood: Clean and prepare surfaces to be finished according to manufacturer's written instructions for each substrate condition and as specified.
 - a. Pressure-preservative treated wood shall weather at least 30 days prior to application of finishes and shall have a maximum moisture content of 15 percent, when measured with an electronic moisture meter.
 - b. Remove dust, dirt, oil, grease and mildew by washing with a commercial wash solution; rinse thoroughly with clean water and allow to dry for at least three days and until moisture content is less than 15 percent. Remove grade stamps and pencil marks by sanding lightly. Remove loose wood fibers by brushing.
 4. Interior Wood: Clean surfaces of dirt, oil, and other foreign substances with scrapers, mineral spirits, and sandpaper, as required. Sand surfaces exposed to view smooth and dust off.
 - a. Scrape and clean small, dry, seasoned knots, and apply a thin coat of white shellac or other recommended knot sealer before applying primer.
 - b. Prime, stain, or seal wood to be painted immediately on delivery. Prime edges, ends, faces, undersides, and back sides of wood, including counters and paneling.
 - c. After priming, fill holes and imperfections in finish surfaces with putty or plastic wood filler. Sand smooth when dried.
 - d. If transparent finish is required, backprime with spar varnish.
 5. Ferrous Metals: Clean ungalvanized ferrous-metal surfaces that have not been shop coated; remove oil, grease, dirt, loose mill scale, and other foreign substances. Use solvent or mechanical cleaning methods that comply with SSPC's standards.
 - a. Treat bare and sandblasted or pickled clean metal with a metal treatment wash coat before priming.
 - b. Touch up bare areas and shop-applied prime coats that have been damaged. Clean with solvents recommended by paint manufacturer and SSPC SP2; and touch up with same primer as the shop coat.
 6. Galvanized Surfaces: Uniformly abrade galvanized surfaces with a palm sander and 60 grit aluminum oxide so surface is free of oil and surface contaminants. Remove pretreatment from galvanized sheet metal fabricated from coil stock by mechanical methods to produce clean, lightly etched surfaces that promote adhesion of subsequently applied paints.
 - a. Clean field welds with nonpetroleum-based solvents complying with SSPC's standards so surface is free of oil and surface contaminants.
 - b. Coating shall be applied within 8 hours of sanding and wipe down.
 7. Metal Doors and Frames: Wipe down to remove oils and surface contaminants from shipping and installation.
 - a. Coating shall be applied within 8 hours of sanding and wipe down.

8. PVC Trim: Clean surfaces of dirt, oil, and other foreign substances with mixture of water and mild detergent as recommended by manufacturer. Remove blemishes on surfaces exposed to view by sanding smooth and dust off.
- D. Material Preparation: Mix and prepare paint materials according to manufacturer's written instructions.
1. Maintain containers used in mixing and applying paint in a clean condition, free of foreign materials and residue.
 2. Stir material before application to produce a mixture of uniform density. Stir as required during application. Do not stir surface film into material. If necessary, remove surface film and strain material before using.
 3. Use only thinners approved by paint manufacturer and only within recommended limits.

3.3 APPLICATION

- A. General: Apply paint according to manufacturer's written instructions. Use applicators and techniques best suited for substrate and type of material being applied.
1. Paint colors, surface treatments, and finishes are indicated in the paint schedules.
 2. Do not paint over dirt, rust, scale, grease, moisture, scuffed surfaces, or conditions detrimental to formation of a durable paint film.
 3. Provide finish coats that are compatible with primers used.
 4. The term "exposed surfaces" includes areas visible when permanent or built-in fixtures, grilles, convector covers, covers for finned-tube radiation, vertical displacement diffusers, and similar components are in place. Extend coatings in these areas, as required, to maintain system integrity and provide desired protection.
 5. Paint surfaces behind movable equipment and furniture the same as similar exposed surfaces. Before final installation of equipment, paint surfaces behind permanently fixed equipment or furniture with prime coat only.
 6. Paint interior surfaces of ducts with a flat, nonspecular black paint where visible through registers or grilles.
 7. Paint back sides of access panels and removable or hinged covers to match exposed surfaces.
 8. Finish exterior doors on tops, bottoms, and side edges the same as exterior faces, unless indicated otherwise.
 9. Sand lightly between each succeeding enamel or varnish coat.
- B. Scheduling Painting: Apply first coat to surfaces that have been cleaned, pretreated, or otherwise prepared for painting as soon as practicable after preparation and before subsequent surface deterioration.
1. The number of coats and film thickness required are the same regardless of application method. Do not apply succeeding coats until previous coat has cured as recommended by manufacturer. If sanding is required to produce a smooth, even surface according to manufacturer's written instructions, sand between applications.
 2. Omit primer over metal surfaces that have been shop primed and touchup painted, unless otherwise indicated.
 3. If undercoats, stains, or other conditions show through final coat of paint, apply additional coats until paint film is of uniform finish, color, and appearance. Give special attention to ensure that edges, corners, crevices, welds, and exposed fasteners receive a dry film thickness equivalent to that of flat surfaces.
 4. Allow sufficient time between successive coats to permit proper drying. Do not recoat surfaces until paint has dried to where it feels firm, and does not deform or feel sticky.

under moderate thumb pressure, and until application of another coat of paint does not cause undercoat to lift or lose adhesion.

- C. Paint all exposed surfaces, except where the paint schedules indicate that a surface or material is not to be painted or is to remain natural. If the paint schedules do not specifically mention an item or a surface, paint the item or surface the same as similar adjacent materials or surfaces whether or not schedules indicate colors. If the schedules do not indicate color or finish, the Architect will select from standard colors and finishes available.
 - 1. Painting includes field painting of exposed bare and covered pipes and ducts (including color-coding), hangers, exposed steel and iron work, and primed metal surfaces of mechanical and electrical equipment at all locations, except mechanical and electrical rooms.
- D. Do not paint prefinished items, concealed surfaces, finished metal surfaces, operating parts, and labels.
 - 1. Labels: Do not paint over Underwriters Laboratories (UL), Factory Mutual (FM), or other code-required labels or equipment name, identification, performance rating, or nomenclature plates.
- E. Application Procedures: Apply paints and coatings by brush, roller, spray, or other applicators according to manufacturer's written instructions. Walls shall have roller finish.
 - 1. Brushes: Use brushes best suited for type of material applied. Use brush of appropriate size for surface or item being painted.
 - 2. Rollers: Use rollers of carpet, velvet-back, or high-pile sheep's wool as recommended by manufacturer for material and texture required.
 - 3. Spray Equipment: Use airless spray equipment with orifice size as recommended by manufacturer for material and texture required.
- F. Minimum Coating Thickness: Apply paint materials no thinner than manufacturer's recommended spreading rate to achieve dry film thickness indicated. Provide total dry film thickness of the entire system as recommended by manufacturer.
- G. Mechanical and Electrical Work: Painting of mechanical, plumbing, fire protection, and electrical work is limited to items exposed in occupied spaces (outside mechanical and electrical rooms).
- H. Mechanical, plumbing, and fire protection items to be painted include, but are not limited to, the following:
 - 1. Piping, pipe hangers and supports.
 - 2. Heat exchangers.
 - 3. Tanks.
 - 4. Ductwork, including interior of ductwork visible through air devices.
 - 5. Insulation.
 - 6. Accessory items.
- I. Electrical items to be painted include, but are not limited to, the following:
 - 1. Conduit and fittings.
 - 2. Switchgear.
 - 3. Panelboards.

- J. Block Fillers: Apply block fillers to concrete masonry units at a rate to ensure complete coverage with pores filled.
- K. Prime Coats: Before applying finish coats, apply a prime coat, as recommended by manufacturer, to material that is required to be painted or finished and that has not been prime coated by others. Recoat primed and sealed surfaces where evidence of suction spots or unsealed areas in first coat appears, to ensure a finish coat with no burn-through or other defects due to insufficient sealing.
- L. Pigmented (Opaque) Finishes: Completely cover surfaces as necessary to provide a smooth, opaque surface of uniform finish, color, appearance, and coverage. Cloudiness, spotting, holidays, laps, brush marks, runs, sags, ropiness, or other surface imperfections will not be acceptable.
- M. Transparent (Clear or Stained) Finishes: Use multiple coats to produce a glass-smooth surface film of even luster. Provide a finish free of laps, runs, cloudiness, color irregularity, brush marks, orange peel, nail holes, or other surface imperfections.
 - 1. Provide satin finish for final coats, unless otherwise noted.
- N. Stipple Enamel Finish: Roll and redistribute paint to an even and fine texture. Leave no evidence of rolling, such as laps, irregularity in texture, skid marks, or other surface imperfections.
- O. Completed Work: Match approved samples for color, texture, and coverage. Remove, refinish, or repaint work not complying with requirements.
- P. Exterior Ferrous Metal Items to Be Painted Include, but Are Not Limited To, the Following:
 - 1. Exposed structural steel and lintel plates.
 - a. Galvanized single angle lintels do not require painting.
 - 2. Steel doors and frames.
 - 3. Bollards.
 - 4. Metal fabrications; see Division 05 Section "Metal Fabrications."
 - 5. Miscellaneous metal items, including galvanized steel.
- Q. Interior Ferrous Metal Items to Be Painted Include, but Are Not Limited To, the Following:
 - 1. Steel doors and frames.
 - 2. Steel stairs, including risers and stringers.
 - 3. Handrails and guardrails.
 - 4. Lintel plates and angles.
 - 5. Exposed construction, including metal deck.
 - 6. Access panels (both sides).
 - 7. Metal fabrications; see Division 05 Section "Metal Fabrications."
 - 8. Miscellaneous metal items.

3.4 CLEANING

- A. Cleanup: At the end of each workday, remove empty cans, rags, rubbish, and other discarded paint materials from the Project site.
 - 1. After completing painting, clean glass and paint-spattered surfaces. Remove spattered paint by washing and scraping. Be careful not to scratch or damage adjacent finished surfaces.

3.5 PROTECTION

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

3.6 EXTERIOR PAINT SCHEDULE

- A. VOC Compliance, General: Provide the manufacturers' formulations for the products specified below that comply with the VOC requirements for the State of Maine Department of Environmental Protection in paragraph 2.2.C of this Section.
- B. Concrete Unit Masonry: Provide the following finish systems over exterior concrete unit masonry:
 - 1. Low-Luster Acrylic Finish: 2 finish coats over a block filler.
 - a. Block Filler: High-performance, latex block filler applied at spreading rate recommended by the manufacturer to achieve a dry mill thickness of not less than indicated for product.
 - 1) Moore: Super Spec Masonry Interio/Exterior Hi-Build Block Filler No. 206; 10.0 mils DFT.
 - 2) PPG: Speedhide 6-15 Interior/Exterior Masonry Hi Fill Latex Block Filler; 7.0 mils DFT.
 - 3) S-W: PrepRite Block Filler Interior/Exterior Latex B25W25; 8.0 mils DFT.
 - b. First and Second Coats: Low-luster (eggshell or satin), exterior, acrylic-latex paint applied at spreading rate recommended by the manufacturer to achieve a dry film thickness per coat of not less than indicated for product.
 - 1) Moore: Ben 100% Acrylic Exterior Low Lustre Finish No. 542; 1.3 mils DFT per coat.
 - 2) PPG: Speedhide Exterior 100% Acrylic Latex Satin, 6-2045XI Series; 1.4 mils DFT per coat.
 - 3) S-W: SuperPaint Exterior Latex Satin A89 Series; 1.5 mils DFT per coat.
- C. Exposed Wood Framing and Sheathing, Opaque Finish: Provide the following finish systems over exterior wood surfaces, including pressure-preservative surfaces:
 - 1. Acrylic Solid Body Stain: 2 finish coats over a cleaner.
 - a. Cleaner: Biodegradable cleaning solution Formulated to remove dirt, mildew stains and other foreign matter.
 - 1) Cabot: Problem Solver Wood Cleaner No. 8002.
 - b. First and Second Coats: Water repellant and fade resistant, exterior, 100 percent acrylic solid body stain applied at spreading rate recommended by the manufacturer to achieve a dry film thickness per coat of not less than indicated for product.
 - 1) Cabot: Cabot Solid Color Acrylic Siding Stain No. 800 Series; 2.1 mils DTF per coat.

- D. Wood Decking, Opaque Finish: Opaque Finish: Provide the following finish systems over exterior pressure-preservative decking (dugout brnches):
1. Acrylic Solid Body Deck Stain: 2 finish coats over a cleaner.
 - a. Cleaner: Biodegradable cleaning solution Formulated to remove dirt, mildew stains and other foreign matter.
 - 1) Cabot: Problem Solver Wood Cleaner No. 8002.
 - b. First and Second Coats: Water repellent, fade resistant, scuff resistant, 100 percent acrylic, solid body deck stain applied at spreading rate recommended by the manufacturer to achieve a dry film thickness per coat of not less than indicated for product.
 - 1) Cabot: Cabot Solid Acrylic Deck Stain No. 1800 Series; 3.0 mils DTF per coat.
- E. PVC Trim: Provide the following finish systems over exterior PVC substrates:
1. Low-Luster Acrylic Finish: 2 finish coats over a prime coat.
 - a. Prime Coat: Exterior, latex primer/sealer applied at spreading rate recommended by the manufacturer to achieve a dry film thickness of not less than indicated for product.
 - 1) Moore: Fresh Start Multi-Purpose Latex Primer N023; 1.2 mils DFT.
 - 2) PPG: Speedhide 6-609 Exterior Latex Wood Primer; 1.6 mils DFT.
 - 3) SW: Multi-Purpose Interior/Exterior Latex Primer/Sealer B51-450 Series; 1.4 mils DFT.
 - b. First and Second Coats: Low-sheen (satin), exterior, acrylic-latex paint, tinted with vinyl safe colorants, paint applied at spreading rate recommended by the manufacturer to achieve a dry film thickness per coat of not less than indicated for product.
 - 1) Moore: Aura Waterborne Exterior Paint Satin Finish No. 631 with Gennex colorant system; 2.4 mils DFT per coat.
 - 2) PPG: Speedhide 6-2045XI Exterior 100% Acrylic Latex Satin with SidingSafe Color Technology colorants; 1.4 mils DFT per coat.
 - 3) S-W: Duration Exterior Latex Satin K33-200 Series with vinyl safe colorants; 2.5 mils DFT per coat.
- F. Exposed Structural Steel: Provide the following finish systems over exposed exterior structural steel shop-coated with a zinc-rich urethane primer.
1. Primer: Zinc-rich urethane primer applied by fabrication shop.
 2. Semigloss, Thermoset Solution Fluoropolymer: 1 top coat over intermediate coat.
 - a. Intermediate Coat: High-solids, low VOC, polyamide epoxy applied at spreading rate recommended by the manufacturer to achieve a dry film thickness of not less than indicated for product.
 - 1) Tnemec: Series 66HS, Hi-Build Epoxoline; 5.0 mils DFT.
 - b. Top Coat: Semigloss, high-solid fluoropolymer coating applied at spreading rate recommended by the manufacturer to achieve a dry film thickness of not less than indicated for product.
 - 1) Tnemec: Series 1071, Fluoronar; 2.5 mils DFT.
- G. Ferrous Metal and Zinc-Coated Metal: Provide the following finish systems over exterior ferrous metal and zinc-coated (galvanized) metal surfaces. Primer is not required on shop-primed items, except zinc-coated (galvanized) steel doors and frames, which require a primer under this specification.

1. Semigloss, Waterborne Alkyd or Waterbased Alkyd Urethane Finish: 2 finish coats over a primer.
 - a. Primer: Quick-drying, corrosion resistant, single component, acrylic-modified alkyd or acrylic metal primer applied to ferrous metals not previously shop-primed applied at spreading rate recommended by the manufacturer to achieve a dry film thickness of not less than indicated for product.
 - 1) Moore:Corotech Acrylic Metal Primer V110; 1.7 mils DFT.
 - 2) PPG: Speedhide 6-208 Interior/Exterior Rust Inhibitive Steel Primer; 2.3 mils DFT.
 - 3) S-W: Pro Industrial Pro-Cryl Universal Primer B66W01300 Series; 2.7 mils DFT.
 - b. First and Second Coats: Semigloss, exterior, single component, waterborne alkyd or single component, urethane-modified alkyd resin system applied at spreading rate recommended by the manufacturer to achieve a dry film thickness per coat of not less than indicated for product.
 - 1) Moore:Corotech Alkyd Urethane Enamel Semi-Gloss CV201; 22.5 mils DFT per coat.
 - 2) PPG: Speedhide Interior/Exterior WB Alkyd Semi-Gloss 6-1510 Series; 1.5 mils DFT per coat.
 - 3) S-W: Pro Industrial Waterbased Alkyd Urethane B53W1150, 1.6 mils DFT per coat.
- H. Thermal Break Coating: Provide the following finish system on stainless steel and steel components where indicated:
 1. Primer: Low odor, low VOC, corrosion-resistant, water-based epoxy applied at spreading rate recommended by the manufacturer to achieve the dry film thickness of not less than indicated for product (prepare surface to SP3 - Power Tool Clean).
 - a. Tnemec: Epoxoline WB Series 1224; 6 mils DFT. No substitution.
 2. First and Second Coats: Fluid-applied, thermal coating utilizing aerogel particles to impart insulative properties to substrate.
 - a. Tnemec: Aerolon Series 971; 40 mils DFT per coat. No substitutions.

3.7 LOW VOC INTERIOR COATINGS

- A. VOC Compliance, General: Provide the manufacturers' formulations for the products specified below that comply with the VOC requirements for the State of Maine Department of Environmental Protection in as defined in paragraph 2.2.C of this Section.
- B. Concrete Masonry Units: Provide the following finish systems over interior concrete masonry block units:
 1. Semigloss, Acrylic-Latex Finish, Walls, Except Where Indicated Otherwise: 2 finish coats over a block filler.
 - a. Block Filler: High-build, latex-based, block filler applied at spreading rate recommended by the manufacturer to achieve a dry film thickness of not less than indicated for product.
 - 1) Moore: Super Spec Masonry Interior/Exterior Hi-Build Block Filler No. 206; 10.0 mils DFT.
 - 2) PPG: Speedhide 6-15 Interior/Exterior Masonry Hi Fill Latex Block Filler; 7.0 mils DFT.
 - 3) S-W: PrepRite Block Filler Interior/Exterior Latex B25W25; 8.0 mils DFT.

- b. First and Second Coats: Low odor, low or Zero VOC, semigloss, acrylic-latex, interior finish applied at spreading rate recommended by the manufacturer to achieve a dry film thickness per coat of not less than indicated for product.
 - 1) Moore: Ultra Spec 500 Semi-Gloss Finish No. N539; 1.8 mils DFT per coat.
 - 2) PPG: Speedhide Interior Enamel Latex Semi-Gloss, 6-500 Series; 1.4 mils DFT per coat.
 - 3) S-W: ProMar 200 Zero VOC Interior Latex Semi-Gloss B31-2600 Series; 1.6 mils DFT per coat.
- 2. Semigloss, Waterborne Alkyd or Waterborne Alkyd Urethane Finish, Walls of Gyms, Stairwells, Kitchen, Kitchen Support Areas and Interiors of Concession Buildings: 2 finish coats over a block filler.
 - a. Block Filler: High-performance, latex-based, block filler applied at spreading rate recommended by the manufacturer to achieve a total dry film thickness of not less than indicated for product.
 - 1) Moore: Super Spec Masonry Interio/Exterio Hi-Build Block Filler No. 206; 10.0 mils DFT.
 - 2) PPG: Speedhide 6-15 Interior/Exterior Masonry Hi Fill Latex Block Filler; 7.0 mils DFT.
 - 3) S-W: PrepRite Block Filler B25W25; 8.0 mils DFT.
 - b. First and Second Coats: Low VOC, semigloss, waterborne alkyd finish or waterborne alkyd urethane finish applied at spreading rate recommended by the manufacturer to achieve a dry film thickness per coat of not less than indicated for product.
 - 1) Moore: Advance Waterborne Interior Alkyd Semi-Gloss No. 793; 1.3 mils DFT per coat.
 - 2) PPG: Speedhide Interior/Exterior WB Alkyd Semi-Gloss No. 6-1510 Series; 1.5 mils DFT per coat.
 - 3) S-W: Pro Industrial Waterbased Alkyd Urethane Enamel B53-1150 Series; 1.5 mils DFT per coat.
- C. Gypsum Board and Tackable Wall Panels (Homosote): Provide the following finish systems over interior gypsum board and tackable wall surfaces:
 - 1. Flat Acrylic Finish, GPDW Soffits and Ceilings, Except Where Indicated Otherwise: 2 finish coats over a primer.
 - a. Primer: Low-odor, low or zero VOC, latex-based, interior primer applied at spreading rate recommended by the manufacturer to achieve a dry film thickness of not less than indicated for product.
 - 1) Moore: Ultra Spec 500 Interior Latex Primer No. N534; 1.8 mils DFT.
 - 2) PPG: Speedhide Interior MaxPrime Latex Primer/Surfacer 6-4; 1.0 mils DFT.
 - 3) S-W: ProMar 200 Zero VOC Interior Latex Primer B28W02600 Series; 1.0 mils DFT.
 - b. First and Second Coats: Low-odor, low or zero VOC, flat, acrylic-latex-based, interior paint applied at spreading rate recommended by the manufacturer to achieve a dry film thickness per coat of not less than indicated for product.
 - 1) Moore: Ultra Spec 500 Interior Flat Finish No. N536; 1.8 mils DFT per coat.
 - 2) PPG: Speedhide Interior Latex Flat 6-70 Series; 1.3 mils DFT per coat.
 - 3) S-W: ProMar 200 Zero VOC Interior Latex Flat, B30W2600 Series; 1.6 mils DFT per coat.

2. Low-Luster (Satin or Eggshell), Acrylic-Latex Finish; Walls, Except Where Indicated Otherwise, Toilet Room Ceilings and Tackable Wall Panels (Homosote): 2 finish coats over a primer.
 - a. Primer: Low odor, low or zero VOC, latex-based, interior primer applied at spreading rate recommended by the manufacturer to achieve a dry film thickness of not less than indicated for product.
 - 1) Moore: Ultra Spec 500 Interior Latex Primer No. N534; 1.8 mils DFT.
 - 2) PPG: Speedhide Interior MaxPrime Latex Primer/Surfacer 6-4; 1.0 mils DFT.
 - 3) S-W: ProMar 200 Zero VOC Interior Latex Primer, B28W02600 Series; 1.0 mils DFT.
 - b. First and Second Coats: Low odor, low or zero VOC, low-luster (eggshell or satin), acrylic-latex, interior finish applied at spreading rate recommended by the manufacturer to achieve a dry film thickness per coat of not less than indicated for product.
 - 1) Moore: Ultra Spec 500 Low Sheen Finish No. N537; 1.8 mils DFT per coat.
 - 2) PPG: Speedhide Interior Satin Acrylic Latex, Series 6-3511; 1.3 mils DFT per coat.
 - 3) S-W: ProMar 200 Zero VOC Interior Latex Eg-Shel, B20W2600 Series; 1.7 mils DFT per coat.
3. Semigloss, Acrylic-Latex Finish; Walls in Toilet Rooms: 2 finish coats over a primer.
 - a. Primer: Low odor, low or zero VOC, latex-based, interior primer applied at spreading rate recommended by the manufacturer to achieve a dry film thickness of not less than indicated for product.
 - 1) Moore: Ultra Spec 500 Interior Latex Primer No. N534; 1.8 mils DFT per coat.
 - 2) PPG: Speedhide Interior MaxPrime Latex Primer/Surfacer 6-4; 1.0 mils DFT per coat.
 - 3) S-W: ProMar 200 Zero VOC Interior Latex Primer, B28W02600 Series; 1.0 mils DFT per coat.
 - b. First and Second Coats: Low odor, low or zero VOC, semigloss, interior acrylic-latex, interior finish applied at spreading rate recommended by the manufacturer to achieve a dry film thickness per coat of not less than indicated for product.
 - 1) Moore: Ultra Spec 500 Semi-Gloss Finish No. N539; 1.8 mils DFT per coat.
 - 2) PPG: Speedhide zero 6-4510XI Interior Zero-VOC Latex Semi-Gloss; 1.3 mils DFT.
 - 3) S-W: ProMar 200 Zero VOC Interior Latex Semi-Gloss B31-2600 Series; 1.6 mils DFT per coat.
4. Magnetic Primer with Paint Finish: 2 low-luster (satin or eggshell), acrylic-latex finish coats over 4 coats magnetic primer, over a drywall primer. Mask perimeter of area to receive finish.
 - a. Primer: Latex-based, interior primer applied at spreading rate recommended by the manufacturer to achieve a dry film thickness of not less than indicated for product. Inspect level 5 gypsum board surface finish for irregularities.
 - 1) Moore: Ultra Spec 500 Interior Latex Primer No. N534; 1.8 mils DFT.
 - 2) PPG: Speedhide Interior MaxPrime Latex Primer/Surfacer 6-4; 1.0 mils DFT per coat.
 - 3) S-W: ProMar 200 Zero VOC Interior Latex Primer, B28W02600 Series; 1.0 mils DFT per coat.

- 4) Allow primers to cure and sand before magnetic primer application. Inspect for surface finish for irregularities. Correct surface as required and prime surface repairs.
 - b. Four Coats Magnetic Primer: Modified alkyd magnetite, applied with dense foam roller at spreading rate recommended by the manufacturer to achieve a dry film thickness of not less than indicated for product.
 - 1) Rust-Oleum Specialty Magnetic Primer; 4.0-5.0 mils DFT per coat, 8.5-11.0 mils WFT per coat. 39-48 sq.ft./quart (1 coat), 13-16 sq.ft./quart (3 coats).
 - 2) Apply uniformly without visible laps, marks, ridges, sags, ropiness, or other surface imperfections. Lightly sand surface between coats, minimizing amount of magnetic primer loss. Allow primer to fully dry before application of topcoats.
 - c. First and Second Finish Coats: Low odor, low or zero VOC, low-luster (eggshell or satin), acrylic-latex, interior finish applied at spreading rate recommended by the manufacturer to achieve a dry film thickness per coat of not less than indicated for product.
 - 1) Moore:Ultra Spec 500 Low Sheen Finish No. N537; 1.8 mils DFT per coat.
 - 2) PPG: Speedhide Interior Satin Acrylic Latex, Series 6-3511; 1.3 mils DFT per coat.
 - 3) S-W: ProMar 200 Zero VOC Interior Latex Eg-Shel, B20W2600 Series; 1.7 mils DFT per coat.
5. Magnetic Markerboard Paint Finish: 2 dry erase finish coats over 4 coats magnetic primer, over a drywall primer. Mask perimeter of area to receive finish.
- a. Primer: Latex-based, interior primer applied at spreading rate recommended by the manufacturer to achieve a dry film thickness of not less than indicated for product. Inspect level 5 gypsum board surface finish for irregularities.
 - 1) Moore:Ultra Spec 500 Interior Latex Primer No. N534; 1.8 mils DFT.
 - 2) PPG: Speedhide Interior MaxPrime Latex Primer/Surfacer 6-4; 1.0 mils DFT per coat.
 - 3) S-W: ProMar 200 Zero VOC Interior Latex Primer, B28W02600 Series; 1.0 mils DFT per coat.
 - 4) Allow primers to cure and sand before magnetic primer application. Inspect for surface finish for irregularities. Correct surface as required and prime surface repairs.
 - b. Four Coats Magnetic Primer: Modified alkyd magnetite, applied with dense foam roller at spreading rate recommended by the manufacturer to achieve a dry film thickness of not less than indicated for product.
 - 1) Rust-Oleum Specialty Magnetic Primer; 4.0-5.0 mils DFT per coat, 8.5-11.0 mils WFT per coat. 39-48 sq.ft./quart (1 coat), 13-16 sq.ft./quart (3 coats).
 - 2) Apply uniformly without visible laps, marks, ridges, sags, ropiness, or other surface imperfections. Lightly sand surface between coats, minimizing amount of magnetic primer loss. Allow primer to fully dry before application of topcoats.
 - c. Two Coats Dry Erase Paint: Polyamine epoxy blend, applied at spreading rate recommended by the manufacturer to achieve a dry film thickness of not less than indicated for product.
 - 1) Rust-Oleum Specialty Dry Erase Kit; 1.0-2.0 mils DFT per coat, 2.1-4.2 mils WFT per coat. Allow 24 hours before recoat, lightly sand between coats.
 - d. Allow full 4 day cure before use.

- D. Ferrous Metal: Provide the following finish systems over ferrous metal. Primer is not required on shop-primed items, except steel doors and frames, which require a primer under this specification. Prime bare spots and cracks on other ferrous metals.
1. Semigloss, Waterborne Alkyd Finish or Waterborne Alkyd Urethane Finish: 2 finish coats over a primer.
 - a. Primer: Quick-drying, corrosion resistant, single component, acrylic-modified alkyd primer or self cross-linking acrylic primer, as recommended by the manufacturer for this substrate, applied at spreading rate recommended by the manufacturer to achieve a dry film thickness of not less than indicated for product.
 - 1) Moore: Advance Waterborne Interior Alkyd Primer No. 790; 1.6 mils DFT.
 - 2) PPG: Pitt-Tech Plus 90-912 Interior/Exterior Industrial DTM Primer; 3.0 mils DFT.
 - 3) S-W: Pro Industrial Pro-Cryl Universal Primer B66-310 Series; 3.0 mils DFT.
 - b. First and Second Coats: Low VOC, semigloss, waterborne alkyd interior or waterborne alkyd urethane finish applied at spreading rate recommended by the manufacturer to achieve a dry film thickness per coat of not less than indicated for product.
 - 1) Moore: Advance Waterborne Interior Alkyd Semi-Gloss No. 793; 1.3 mils DFT per coat.
 - 2) PPG: Speedhide Interior/Exterior WBAlkyd Semi-Gloss No. 6-1510 Series; 1.5 mils DFT per coat.
 - 3) S-W: Pro Industrial Waterbased Alkyd Urethane Enamel B53-1150 Series; 1.5 mils DFT per coat.
 2. Gloss, Water Based Polyamine Epoxy or Polysioxane Finish, Handrails and Guardrails: 2 finish coats over a primer.
 - a. Primer: Low VOC, quick-drying, corrosion resistant, single component, acrylic-modified alkyd primer or self cross-linking acrylic primer, as recommended by the manufacturer for this substrate, applied at spreading rate recommended by the manufacturer to achieve a dry film thickness of not less than indicated for product.
 - 1) Moore: Corotech Acrylic Metal Primer V110; 1.7 mils DFT.
 - 2) PPG: Amercoat 185H; 2.5 mils DFT.
 - 3) S-W: Pro Industrial Pro-Cryl Universal Acrylic Primer B66W01310; 2.7 mils DFT per coat.
 - b. First and Second Coats: Gloss, low VOC, corrosion resistant, abrasion resistant, waterborne polyamine epoxy or polysioxane finish applied at spreading rate recommended by the manufacturer to achieve a dry mill thickness per coat of not less than indicated for product.
 - 1) Moore: Corotech Waterborne Amine Epoxy V440; 1.7 mils DFT per coat.
 - 2) PPG: PSX-One; 2.5 mils DFT per coat.
 - 3) S-W: Pro Industrial Water Based Catalyzed Epoxy B73-300 Series; 3.5 mils DFT per coat
- E. Zinc-Coated Metal: Provide the following finish systems over zinc-coated metal. Primer is not required on shop-primed items, except zinc-coated steel doors and frames, which require a primer under this specification. Prime bare spots and cracks on zinc-coated metals.
1. Semigloss, Waterborne Alkyd Finish or Waterborne Alkyd Urethane Finish: 2 finish coats over a primer.
 - a. Primer: Quick-drying, corrosion resistant, single component, acrylic-modified alkyd primer or self cross-linking acrylic primer, as recommended by the

manufacturer for this substrate, applied at spreading rate recommended by the manufacturer to achieve a dry film thickness of not less than indicated for product.

- 1) Moore: Advance Waterborne Interior Alkyd Primer No. 790; 1.6 mils DFT.
- 2) PPG: Speedhide 6-209 Interior/Exterior Galvanized Steel Primer; 3.6 mils DFT.
- 3) S-W: Pro Industrial Pro-Cryl Universal Primer B66-310 Series; 3.0 mils DFT.

- b. First and Second Coats: Low VOC, semigloss, waterborne alkyd interior or waterborne alkyd urethane finish applied at spreading rate recommended by the manufacturer to achieve a dry film thickness per coat of not less than indicated for product.

- 1) Moore: Advance Waterborne Interior Alkyd Gloss No. 794; 1.6 mils DFT per coat.
- 2) PPG: Speedhide Interior/Exterior WBAlkyd Semi-Gloss No. 6-1510 Series; 1.5 mils DFT per coat.
- 3) S-W: Pro Industrial Waterbased Alkyd Urethane Enamel B53-1150 Series; 1.5 mils DFT per coat.

- F. Overhead Exposed Construction, Including Metal Deck, Steel Joists, Galvanized Duct Work, Conduit and Piping: Provide the following finish system.

1. Flat, Modified Alkyd Rust-Inhibitive Primer/Finish: Quick-drying, corrosion resistant, primer/finish over prepaint surface cleaner.

- a. Prepaint Surface Cleaner: Concentrated alkaline detergent blend for cleaning overhead construction without needing to rinse prior to coating, applied at spreading rate recommended by the manufacturer.

- 1) GLL: No Rinse Prepaint Cleaner.

- b. Primer/Finish: Quick-drying, corrosion resistant, primer, as recommended by the manufacturer for this substrate, applied at spreading rate recommended by the manufacturer to achieve a dry film thickness of not less than indicated for product.

- 1) Tnemec: Series 115, Uni-Bond DF; 3.0 mils DFT. No substitution.

- G. Telecommunication, Data and Electrical Backboards: Provide the following finish over plywood:

1. Flat Intumescent Finish: Two finish coats over a primer.

- a. Primer: Latex-based, interior primer applied at spreading rate recommended by the manufacturer to achieve a dry film thickness of not less than indicated for product.

- 1) Moore: Fresh Start High-Hiding All-Purpose Primer No. 056; 1.4 mils DFT.

- 2) SW: Preprite Problock Interior/Exterior Latex Primer\Sealer; 1.4 mils DFT.

- b. First and Second Coats: Intumescent-type, fire-retardant paint applied at spreading rate recommended by manufacturer to achieve a total dry film thickness of not less than 4 mils; white color for telecommunication and black for electrical.

- 1) Moore: P59 220 Latex Fire-Retardant Coating.

- 2) FlameControl: 20-20A Flat Latex Intumescent Coating.

- H. Smoke and Fire-Rated Partition Identification: Identify all smoke partitions and all fire-rated walls and partitions by stenciling "X-HOUR FIRE WALL", where "X" is the hourly rating; provide on each side of rated walls above ceiling line with 4 inch high letters in red or orange semigloss paint; each rated wall shall be identified with fire rating of wall at least once and at a

spacing not greater than 12 feet o.c. and not more than 5 feet from each end of the wall. Identify all smoke barriers and partitions by stenciling "SMOKE" on each side of walls above ceiling line with 4 inch high letters in bright green semigloss paint; each rated wall shall be identified at least once and at a spacing not greater than 12 feet o.c. and not more than 5 feet from each end of wall.

1. First Coat: Low odor, low or zero VOC, semigloss, acrylic-latex, interior enamel applied at spreading rate recommended by the manufacturer to achieve a dry film thickness of not less than indicated for product.
 - a. Moore: Ultra Spec 500 Semi-Gloss No. N539; 1.8 mils DFT.
 - b. PPG: Speedhide Interior High Lustre Semi-Gloss Latex, 6-8510 Series; 1.2 mils DFT.
 - c. S-W: ProMar 200 Zero VOC Interior Latex Semi-Gloss, B31-2600 Series; 1.6 mils DFT.

END OF SECTION 099000

SECTION 102800 - TOILET AND BATH ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Toilet and bath accessories.
- B. Related Sections include the following:
 - 1. Division 06 Section "Rough Carpentry" for concealed wood blocking to support accessories.
 - 2. Division 08 Section "Glazing" for frameless mirrors.
 - 3. Division 09 Section "Tile" for ceramic toilet and bath accessories.
 - 4. Division 22 Sections for fiberglass shower units with integral grab bars, folding seats, and shower rods.
 - 5.

1.3 SUBMITTALS

- A. General: Submit in accordance with Division 01 Section "Submittal Procedures."
- B. Product Data: Include construction details, material descriptions and thicknesses, dimensions, profiles, fastening and mounting methods, specified options, and finishes for each type of accessory specified.
- C. Shop Drawings: Include blocking locations and mounting heights identified.
- D. Setting Drawings: For cutouts required in other work; include templates, substrate preparation instructions, and directions for preparing cutouts and installing anchoring devices.
- E. Product Schedule: Indicating types, quantities, sizes, and installation locations by room of each accessory required. Use room and accessory designations indicated in the Toilet and Bath Accessory Schedule in Part 3 and room and accessory designations indicated on Drawings.
- F. Maintenance Data: For accessories to include in maintenance manuals specified in Division 01. Provide lists of replacement parts and service recommendations.
- G. Warranties: Special warranties specified in this Section.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Provide products of same manufacturer for each type of accessory unit and for units exposed to view in same areas, unless otherwise approved by Architect.

- B. Insofar as possible, fitting, construction and fabrication of the work shall be executed at shop, ready for delivery and erection at building.
- C. Provide all holes, connections, and fastenings for and to work of other trades abutting, adjoining or intersecting work of this Section.
- D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.5 COORDINATION

- A. Coordinate accessory locations with other work to prevent interference with clearances required for access by disabled persons, proper installation, adjustment, operation, cleaning, and servicing of accessories.

1.6 WARRANTY

- A. General Warranty: Special warranty specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.
- B. Manufacturer's Hand Dryer Warranty: Written warranty, executed by hand dryer manufacturer agreeing to replace hand dryers that fail in materials or workmanship within specified warranty period.
 - 1. Minimum Warranty Period: 5 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Stainless Steel: ASTM A 666, Type 304, with No. 4 finish (satin), in 0.0312-inch minimum nominal thickness, unless otherwise indicated.
- B. Sheet Steel: ASTM A 366/A 366M, cold rolled, commercial quality, 0.0359-inch minimum nominal thickness; surface preparation and metal pretreatment as required for applied finish.
- C. Galvanized Steel Sheet: ASTM A 653/A 653M, G60.
- D. Chromium Plating: ASTM B 456, Service Condition Number SC 2 (moderate service), nickel plus chromium electrodeposited on base metal.
- E. ABS Plastic: Acrylonitrile-butadiene-styrene resin formulation.
- F. Galvanized Steel Mounting Devices: ASTM A 153/A 153M, hot-dip galvanized after fabrication.
- G. Fasteners: Screws, bolts, and other devices of same material as accessory unit, tamper and theft resistant when exposed, and of galvanized steel when concealed.

2.2 TOILET ACCESSORIES

- A. Grab Bars: Provide stainless-steel grab bar, concealed mounting with manufacturer's standard flanges and anchors, minimum nominal thickness 0.05 inch, 1-1/2 inches outside diameter for heavy-duty applications, in lengths and configurations indicated.
 - 1. Products:
 - a. Bobrick Washroom Equipment, Inc.; B-6806 Series.
 - b. Bradley Corporation; 800 Series.
- B. Channel-Framed Mirror: Fabricate frame from stainless-steel channels in manufacturer's standard polished finish with square corners mitered to hairline joints and mechanically interlocked; size as indicated on Drawings. Mirrors shall be first quality plate-glass conforming to U.S. Commercial Standard CS-27-36 with 2 coats of silver and copper clad. Mirror backs shall be zinc-coated steel.
 - 1. Size: As indicated.
 - 2. Products:
 - a. Bobrick Washroom Equipment, Inc.; Model B-165 Series.
 - b. Bradley Corporation; Model 781.
- C. Standard Toilet Tissue Dispenser, Surface Mounted (TTD): Provide concealed mounting, stainless-steel roll-in-reserve dispenser with hinged front secured with tumbler lockset with noncontrol delivery with manufacturer's standard theft-resistant spindle designed for 4-1/2- or 5-inch- diameter-core tissue rolls.
 - 1. Products:
 - a. Bobrick Washroom Equipment, Inc.; Model B-4288.
 - b. Bradley Corporation; Model 5A10.
- D. Liquid Soap Dispenser, Wall Mounted (SD): Horizontally- or vertically-mounted soap dispenser as standard by manufacturer, container body and back Type 304 stainless steel, satin finish. Shall dispense liquid soaps, including foam, 40 fl. oz. capacity, unbreakable refill window, concealed wall fastening, large locked hinged stainless steel filler top, vandal-resistant. Front of dispenser door shall have arced surface; and corners and returns shall be radiused.
 - 1. Products:
 - a. Bobrick Washroom Equipment, Inc.; Model B-4112.
 - b. Bradley Corporation; Model 6A00.
- E. Waste Receptacle, Recessed: Provide recessed stainless-steel type with projecting receptacle, designed for nominal 4-inch wall depth; with continuous, seamless wall flange.
 - 1. Products:
 - a. Bobrick Washroom Equipment, Inc.; Model B-43644.
 - b. Bradley Corporation; Model 2A05-10.
- F. Sanitary Napkin Disposal, Surface Mounted, SND2: Provide stainless steel sanitary napkin disposal unit with seamless exposed walls; self-closing top cover; locking bottom panel with stainless-steel, continuous hinge; and removable, reusable receptacle. Front of dispenser door shall have arced surface; and corners and returns shall be radiused.
 - 1. Products:
 - a. Bobrick Washroom Equipment, Inc.; Model B-270.
 - b. Bradley Corporation; Model 4A10-11.

- G. Sanitary Napkin/Tampon Vendor, Semirecessed, SND1: Type 304 stainless steel cabinet, satin finish, all-welded construction designed for nominal 4-inch wall depth; with seamless door with returned edges and secured by tumbler lockset. Vendor product selection and coin return pushbutton-operation shall be certified ADA-ABA, ICC/ANSI A117.1 compliant. Provide identification reading "Napkins" and "Tampons"; brand-name advertising is not allowed. Capacity not less than 20 napkins and 30 tampons. Single-coin operated; coinage denomination to be determined by Owner.
1. Products:
 - a. Bobrick Washroom Equipment, Inc.; Model B-370634 Series.
- H. Antibacterial Shower Curtain: Minimum 10-oz., nylon-reinforced vinyl or 0.008-inch- thick vinyl material with integral antibacterial agent and corrosion-resistant grommets at minimum 6 inches o.c. through top hem, length required for shower opening indicated. Provide white curtain.
1. Products:
 - a. Bobrick Washroom Equipment, Inc.; Model B-204-2.
 - b. Bradley Corporation; Model 9535.
- I. Mop and Broom Holder with Utility Shelf: 36-inch- long unit fabricated of minimum nominal 0.05-inch- thick stainless steel with shelf, 8 inches deep; support brackets for wall mounting; three hooks for wiping rags; four spring-loaded, rubber hat, cam-type, mop/broom holders. Provide at each janitor's sink.
1. Products:
 - a. Bobrick Washroom Equipment, Inc.; Model B-239.
 - b. Bradley Corporation; Model 9933.
- J. Towel Hooks: Satin stainless steel concealed mount towel pin with 1 inch projection.
1. Products: Bobrick Washroom Equipment, Inc. - Single Robe Hook Model B76717.
- K. Paper Towel Dispenser, Surface Mounted PTD: Type-304 stainless steel cabinet, satin finish, all-welded construction, front of paper towel dispenser door shall have same degree of arc as other Bobrick ConturaSeries accessories in the washroom. Radius on corners and edges of door and cabinet shall complement other Bobrick ConturaSeries washroom accessories. Unit equipped with TowelMate consisting of a 90° return towel guide bracket inside cabinet to prevent paper towels from falling forward out when door is opened for servicing and a Nylon Rod across the center of the towel tray to dispense paper towels one at a time. Door shall be drawn, one-piece, seamless construction; secured to cabinet with a full-length stainless steel piano-hinge; and equipped with a tumbler lock keyed like other Bobrick washroom accessories. Unit shall be capable of dispensing 400 C-fold or 525 multifold paper towels 2-1/2" to 3-13/16" (64-97 mm) deep without adjustment or use of adapters.
1. Products:
 - a. Bobrick Washroom Equipment, Inc.; Model B-4262.
- L. Waste Receptacle, Recessed, WR: Type-304 stainless steel, satin finish, all-welded construction, front of waste receptacle shall have same degree of arc and match other Bobrick ConturaSeries accessories in the washroom. Radius on corners and edges of flange and waste receptacle shall complement other Bobrick ConturaSeries washroom accessories. Flange shall be drawn, one-piece, seamless construction. Waste receptacle shall have formed, one-piece, seamless, removable front panel with top edge hemmed. Waste receptacle shall be equipped

with LinerMate to facilitate installation and trash liner holder is fabricated with a molded plastic bag holder sleeve and a 20-gauge (.091mm) stainless steel U-shaped support strap; riveted construction. Bag holder shall have an arc at front and same shape as inside of waste receptacle area. Capacity of waste receptacle shall be 12.8-gal. (48.3-L).

1. Products:

- a. Bobrick Washroom Equipment, Inc.; Model B-43644.

2.3 FABRICATION

- A. General: One, maximum 1-1/2-inch- diameter, unobtrusive stamped manufacturer logo, as approved by Architect, is permitted on exposed face of accessories. On interior surface not exposed to view or back surface of each accessory, provide printed, waterproof label or stamped nameplate indicating manufacturer's name and product model number.
- B. Sections and shapes shall be rolled, formed, drawn, or extruded as required for respective functions.
- C. Molded work shall have sharply defined profile and shall be clean and straight. Plain work shall be leveled, straight and surfaces true and smooth. Edges, angles, and corners shall be square, clean and sharp, unless otherwise detailed.
- D. Fastenings, exposed metal fastenings, and accessories, unless Underwriters prohibit for safety, shall be of same materials, texture, color and finish as the base metal to which applied.
- E. Molds, trim, frames and other metalwork shall be proper dimensions to receive masonry block and tile, plaster, ceramic tile, or other scheduled finishes.
- F. Surface-Mounted Toilet Accessories: Unless otherwise indicated, fabricate units with tight seams and joints, and exposed edges rolled. Hang doors and access panels with continuous stainless-steel hinge. Provide concealed anchorage where possible.
- G. Semi-Recessed Toilet Accessories: Unless otherwise indicated, fabricate units of all-welded construction, without mitered corners; exposed edges rolled. Hang doors and access panels with full-length, stainless-steel hinge. Provide anchorage that is fully concealed when unit is closed.
- H. Keys: Provide universal keys for internal access to accessories for servicing and resupplying. Provide minimum of six keys to Owner's representative.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install accessories according to manufacturers' written instructions, using fasteners appropriate to substrate indicated and recommended by unit manufacturer. Install units level, plumb, and firmly anchored in locations and at heights indicated.

- B. Grab bars shall be screwed to solid wood blocking in stud partitions. Install grab bars to withstand a downward load of at least 250 lbf, when tested according to method in ASTM F 446.
- C. Concealed Blocking: Provide concealed wood blocking, 3/4-inch thick plywood covering 32 inch by 32-inch area, in stud walls, including for Owner furnished accessories.

3.2 TOILET ACCESSORIES SCHEDULE

- A. Toilet Accessories in each Single Person Toilet Room (Rooms 106, 122, 136, 137, 142, 144, 146, 148) :
 - 1. Provide channel-framed mirror over lavatory - one channel-framed mirror over each lavatory in Rooms 142 and 144.
 - 2. Provide one soap dispenser (SD) - one soap dispenser for each lavatory in Rooms 142 and 144.
 - 3. Provide one paper towel dispenser (PTD).
 - 4. Provide one toilet tissue dispenser (TTD) - one toilet tissue dispenser for each water closet in Rooms 142 and 144.
 - 5. Provide grab bars in configurations shown as indicated. Grab bars mounted on steel framed walls shall be screwed to solid wood blocking in stud partitions.
 - 6. Provide diaper-changing station in Room 106.
- B. Toilet Accessories in Multi-Person Toilet Rooms (Rooms 105, 107):
 - 1. Provide one soap dispenser (SD) for each lavatory.
 - 2. Provide one toilet tissue dispenser (TTD) for each water closet.
 - 3. Provide one paper towel dispenser (PTD).
 - 4. Provide one waste receptacle (WR).
 - 5. Provide one warm-air hand dryer.
 - 6. Provide grab bars in configurations shown at designated water closets. Grab bars mounted on steel framed walls shall be screwed to solid wood blocking in stud partitions.
 - 7. Provide one sanitary napkin disposal unit (SND2) for each water closet in each Women's Toilet Rooms.
 - 8. Provide one sanitary napkin vendor (SND1) where indicated in each Women's Toilet Room.
 - 9. Mirrors provided in Division 08 Section "Glazing."
- C. Custodial Closets:
 - 1. Provide one mop/broom holder.

3.3 ADJUSTING AND CLEANING

- A. Adjust accessories for unencumbered, smooth operation and verify that mechanisms function properly. Replace damaged or defective items.
- B. Remove temporary labels and protective coatings.
- C. Clean and polish exposed surfaces according to manufacturer's written recommendations.

END OF SECTION 102800

SECTION 104400 - FIRE-PROTECTION SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Portable fire extinguishers.
 - 2. Fire-protection cabinets for portable fire extinguishers.
 - 3. Mounting brackets for fire extinguishers.
 - 4. Wall signage for extinguishers.
- B. Related Sections include the following:
 - 1. Division 07 Section "Penetration Firestopping" for firestopping sealants at fire-rated cabinets.

1.3 SUBMITTALS

- A. General: Submit in accordance with Division 01 Section "Submittal Procedures."
- B. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for fire extinguishers and fire-protection cabinets.
 - 1. Fire Extinguishers: Include rating and classification.
 - 2. Fire-Protection Cabinets: Include roughing-in dimensions, details showing mounting methods, relationships of box and trim to surrounding construction, door hardware, cabinet type, trim style, and panel style.
- C. Samples for Initial Selection: For fire-protection cabinets with factory-applied color finishes.
- D. Product Schedule: For fire protection cabinets. Coordinate final fire protection cabinet schedule with fire extinguisher schedule to ensure proper fit and function. Use same designations indicated on Drawings.
- E. Maintenance Data: For fire extinguishers and fire-protection cabinets to include in maintenance manuals.
- F. Warranty: Sample of special warranty.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain fire extinguishers and fire-protection cabinets through one source from a single manufacturer.
- B. NFPA Compliance: Fabricate and label fire extinguishers to comply with NFPA 10, "Portable Fire Extinguishers."

- C. Fire Extinguishers: Listed and labeled for type, rating, and classification by an independent testing agency acceptable to authorities having jurisdiction.
 - 1. Provide fire extinguishers approved, listed, and labeled by FMG.
- D. Fire-Rated, Fire-Protection Cabinets: Listed and labeled to comply with requirements of ASTM E 814 for fire-resistance rating of walls where they are installed.
- E. Fire Extinguisher Inspection: Prior to installation, professionally inspect all fire extinguishers in accordance with NFPA 10, "Portable Fire Extinguishers" and attach tag to the fire extinguisher verifying inspection and inspection date. Tag shall comply with the requirements of the local authority having jurisdiction. Tag with manufacturing date only is not acceptable.

1.5 COORDINATION

- A. Coordinate size of fire-protection cabinets to ensure that type and capacity of fire extinguishers indicated are accommodated.
- B. Coordinate sizes and locations of fire protection cabinets with wall depths.

1.6 WARRANTY

- A. Special Warranty for Fire Extinguishers: Manufacturer's standard form in which manufacturer agrees to repair or replace components of portable fire extinguishers that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Failure of hydrostatic test according to NFPA 10.
 - b. Faulty operation of valves or release levers.
 - 2. Warranty Period: Six years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers:
 - 1. JL Industries, Inc.
 - 2. Larsen's Manufacturing Company.
 - 3. Potter Roemer; Div. of Smith Industries, Inc.
- B. Fire extinguisher cabinets, fire extinguishers, and mounting brackets shall be from same manufacturer.

2.2 MATERIALS

- A. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B.
- B. Stainless-Steel Sheet: ASTM A 666, Type 304.
- C. Tempered Float Glass: ASTM C 1048, Kind FT, Condition A, Type I, Quality q3, 3 mm thick, Class 1 (clear).

2.3 PORTABLE FIRE EXTINGUISHERS

- A. General: Provide fire extinguishers of type, size, and capacity for each fire-protection cabinet and mounting bracket indicated.
 - 1. Handles and Levers: Manufacturer's standard.
 - 2. Instruction Labels: Include pictorial marking system complying with NFPA 10, Appendix B.
- B. Multipurpose Dry-Chemical Type in Steel Container: UL-rated 4-A:80-B:C, 10-lb nominal capacity, with monoammonium phosphate-based dry chemical in enameled-steel container.
 - 1. Provide for new fire extinguisher cabinets.
 - 2. Provide wall mounted units where indicated.

2.4 FIRE-PROTECTION CABINET

- A. Cabinet Type: Suitable for fire extinguisher.
 - 1. Products:
 - a. JL Industries, Inc.; Academy Series.
 - b. Larsen's Manufacturing Company; Architectural Series.
 - c. Potter Roemer; Div. of Smith Industries, Inc.; Alta Series.
- B. Cabinet Construction: Nonrated and rated as required for wall construction where cabinet is located.
- C. Cabinet Material: Enameled-steel sheet.
 - 1. Shelf: Same metal and finish as cabinet.
- D. Semirecessed Cabinet: Cabinet box partially recessed in walls of shallow depth to suit style of trim indicated; with one-piece combination trim and perimeter door frame overlapping surrounding wall surface with exposed trim face and wall return at outer edge (backbend).
 - 1. Rolled-Edge Trim: 2-1/2-inch backbend depth.
- E. Surface-Mounted Cabinet: Cabinet box fully exposed and mounted directly on wall; with no trim.
- F. Cabinet Trim Material: Same material and finish as door.
- G. Door Material: Steel sheet.
- H. Door Style: Horizontal duo panel with frame to match existing.
- I. Door Glazing: Tempered float glass (clear).
- J. Door Hardware: Manufacturer's standard door-operating hardware of proper type for cabinet type, trim style, and door material and style indicated.
 - 1. Provide projecting lever handle with cam-action latch.
 - 2. Provide continuous hinge, of same material and finish as trim, permitting door to open 180 degrees.
- K. Accessories:
 - 1. Mounting Bracket: Manufacturer's standard steel, designed to secure fire extinguisher to fire-protection cabinet, of sizes required for types and capacities of fire extinguishers indicated, with plated or baked-enamel finish.

2. Door Lock: Cam lock that allows door to be opened during emergency by pulling sharply on door handle.
3. Identification: Identify fire extinguisher in fire-protection cabinet with the words "FIRE EXTINGUISHER"; lettering complying with authorities having jurisdiction for letter style, size, spacing, and location; lettering orientation and color as selected by Architect. Locate as indicated by Architect.

L. Finishes:

1. Manufacturer's standard baked-enamel or powder coat finish for the following:
 - a. Exterior of cabinet, door, and trim, except for those surfaces indicated to receive another finish.
 - b. Interior of cabinet and door.
2. Steel: Baked enamel or powder coat.
 - a. Color and Texture: As selected by Architect from manufacturer's full range.

2.5 MOUNTING BRACKETS

- A. Mounting Brackets: Manufacturer's standard steel, designed to secure fire extinguisher to wall or structure, of sizes required for types and capacities of fire extinguishers indicated, with plated or baked-enamel finish; black.
- B. Identification: Lettering complying with authorities having jurisdiction for letter style, size, spacing, and location. Locate as indicated by Architect.
 1. Identify bracket-mounted fire extinguishers with the words "FIRE EXTINGUISHER" in red letter decals applied vertically to mounting surface.

2.6 FABRICATION

- A. Fire-Protection Cabinets: Provide manufacturer's standard box (tub), with trim, frame, door, and hardware to suit cabinet type, trim style, and door style indicated.
 1. Weld joints and grind smooth.
- B. Cabinet Doors: Fabricate doors according to manufacturer's standards, from materials indicated and coordinated with cabinet types and trim styles selected.
 1. Fabricate door frames with tubular stiles and rails and hollow-metal design, minimum 1/2 inch thick.
 2. Miter and weld perimeter door frames.
- C. Cabinet Trim: Fabricate cabinet trim in one piece with corners mitered, welded, and ground smooth.

2.7 FINISHES, GENERAL

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Finish fire-protection cabinets after assembly.

- D. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.8 STEEL FINISHES

- A. Surface Preparation: Clean surfaces of dirt, oil, grease, mill scale, rust, and other contaminants that could impair paint bond using manufacturer's standard methods.
- B. Baked-Enamel Finish or Powder-Coat Finish: Immediately after cleaning and pretreating, apply manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat. Comply with coating manufacturer's written instructions for applying and baking to achieve a minimum dry film thickness of 2 mils.

2.9 WALL SIGNAGE FOR EXTINGUISHERS

- A. Wall Signage for Extinguishers: Provide 3-dimensional, projecting, photoluminescent signage for wall mounting; sign shall have a graphic of a fire extinguisher and an arrow pointing to fire extinguisher on each face of sign; and shall be roughly 6 inches high and project from wall approximately 5 inches. Provide with mounting hardware.
 - 1. Product: Fire Extinguisher Signs, Model S-4663; website: www.fireextinguishersigns.com.
 - 2. Wall signage is in addition to the identification signage specified on the fire extinguisher in Articles 2.4.J.3 and 2.5.B.1 above.
 - 3. Provide at each fire extinguisher cabinet and at each bracket mounted fire extinguisher.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine walls and partitions for suitable framing depth and blocking where semirecessed cabinets will be installed.
- B. Examine fire extinguishers for proper charging and tagging.
 - 1. Remove and replace damaged, defective, or undercharged units.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Prepare recesses for semirecessed fire-protection cabinets as required by type and size of cabinet and trim style.

3.3 INSTALLATION

- A. General: Install fire-protection specialties in locations and at mounting heights indicated or, if not indicated, at heights indicated below:
 - 1. Fire-Protection Cabinets: 54 inches above finished floor to top of cabinet.

- 2. Mounting Brackets: 54 inches above finished floor to top of fire extinguisher.
 - B. Fire-Protection Cabinets: Fasten fire-protection cabinets to structure, square and plumb.
 - 1. Fasten mounting brackets to inside surface of fire-protection cabinets, square and plumb.
 - C. Mounting Brackets: Fasten mounting brackets to surfaces, square and plumb, at locations indicated.
 - D. Identification: Apply decals at locations indicated.
 - E. Wall Signage: Mount where indicated in accordance with manufacturer's instructions.
- 3.4 INSTALLATION OF FIRE-RATED CABINETS
- A. Install cabinet with not more than 1/16-inch tolerance between pipe OD and knockout OD. Center pipe within knockout.
 - B. Seal through penetrations with firestopping sealant as specified in Division 7 Section "Through-Penetration Firestop Systems."
- 3.5 ADJUSTING AND CLEANING
- A. Remove temporary protective coverings and strippable films, if any, as fire-protection specialties are installed, unless otherwise indicated in manufacturer's written installation instructions.
 - B. Adjust fire-protection cabinet doors to operate easily without binding. Verify that integral locking devices operate properly.
 - C. On completion of fire-protection cabinet installation, clean interior and exterior surfaces as recommended by manufacturer.
 - D. Touch up marred finishes, or replace fire-protection cabinets that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by fire-protection cabinet manufacturer.
 - E. Replace fire-protection cabinets that have been damaged or have deteriorated beyond successful repair by finish touchup or similar minor repair procedures.

END OF SECTION 104400

SECTION 105113 – PHENOLIC LOCKERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Phenolic lockers, double-tier, flat tops
 - 2. Locker benches.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of metal locker.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of locker and bench.
- B. Shop Drawings: For metal lockers.
 - 1. Include plans, elevations, sections, details, and attachments to other work.
 - 2. Show locker trim and accessories.
 - 3. Include locker identification system and numbering sequence. Coordinate numbering with Owner's requirements.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For adjusting, repairing, and replacing locker doors and latching mechanisms to include in maintenance manuals.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Do not deliver lockers until spaces to receive them are clean, dry, and ready for their installation.

1.6 FIELD CONDITIONS

- A. Field Measurements: Verify actual dimensions of recessed openings by field measurements before fabrication and indicate measurements on Shop Drawings.

1.7 COORDINATION

- A. Coordinate sizes and locations of concrete and wood bases for metal lockers.
- B. Coordinate sizes and locations of framing, blocking, furring, reinforcements, and other related units of work specified in other Sections to ensure that metal lockers can be supported and installed as indicated.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work including the following:
 - 1. ASI Storage Solutions
 - 2. Hollman Inc. Basis of Design
 - 3. Summit Lockers
- B. Panel Material for all Surfaces: Solid phenolic material with rounded corners, ASTM C 84 Class A fire-retardant treated.
 - 1. Doors: 3/4 in. thick solid phenolic materials.
 - 2. Tops, Bottoms, and Intermediate Shelves: 3/4 in. thick solid phenolic material with ventilation holes.
 - 3. Locker Backs: 3/4 in. thick solid phenolic material.
 - 4. Locker Sides: 3/4 in. thick solid phenolic material
- C. Locker Body: Fabricated from particle board-core panels covered on both sides with thermoset decorative overlays; curb-mounted.
- D. End Panels: Match style, material, construction, and finish of doors.
- E. Hinges: Self-closing; welded to door and attached to door frame with not less than 2 factory-installed rivets per hinge that are completely concealed and tamper resistant when door is closed; fabricated to swing 180 degrees.
- F. Recessed Door Handle and Latch: Stainless-steel cup with integral door pull, recessed so locking device does not protrude beyond face of door; pry resistant.
 - 1. Lock: Hasp for Owner provided padlocks.
- G. Accessories:
 - 1. Recess Trim and Filler Panels: Match Locker bodies
 - 2. Locker Hardware: Do not allow chrome-plated metals.
 - a. Hooks: Manufacturer's standard ball-pointed type, stainless steel.
 - b. Coat Rods: Fabricated from stainless steel.
 - 3. Identification Plates: Manufacturer's standard etched, embossed, or stamped aluminum plates; with numbers and letters.
 - a. Comply with Owner's Standards.

2.2 LOCKER BENCHES

- A. General: Provide locker benches fabricated by same manufacturer as lockers.
- B. Provide Locker room bench units with overall assembly height of 17-1/2 inches.
- C. Bench Tops: Manufacturer's standard one-piece units, with rounded corners and edges.
 - 1. Size: Minimum 9-1/2 inches wide by 1-1/4 inches thick except provide minimum 24-inch-wide tops where locker room ADA accessible benches are indicated.
 - 2. Material: Solid Phenolic.
 - 3. Provide standard and ADA locker room benches as indicated on the Drawings.

2.3 FABRICATION

- A. Fabricate lockers square, rigid, without warp, and with faces flat and free of dents or distortion. Make exposed edges safe to touch and free of sharp edges and burrs.
 - 1. Provide fasteners, filler plates, supports, clips, and closures as required for complete installation.
- B. Fabricate each metal locker with an individual door and frame; individual top, bottom, and back; and common intermediate uprights separating compartments.
- C. Accessible (ADA) Lockers: Fabricate as follows:
 - 1. Locate bottom shelf no lower than 15 inches above the floor.
 - 2. Where hooks, coat rods, or additional shelves are provided, locate no higher than 48 inches above the floor.
- D. Continuous Base: Fabricated in lengths as long as practicable to enclose base and base ends of lockers; finished to match lockers.
- E. Filler Panels: Fabricated from same material as lockers. Provide slip joint filler angle formed to receive filler panel.
- F. End Panels: Provide solid phenolic end panels designed for concealing fasteners and holes at exposed ends of nonrecessed lockers.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine walls, floors, and support bases, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. General: Install lockers level, plumb, and true; shim as required, using concealed shims.
 - 1. Anchor locker runs at ends and at intervals recommended by manufacturer, but not more than 36 inches o.c. Using concealed fasteners, install anchors through backup reinforcing plates, channels, or blocking as required to prevent metal distortion.
 - 2. Anchor single rows of metal lockers to walls near top and bottom of lockers.
 - 3. Anchor back-to-back metal lockers to floor.
- B. Equipment and Accessories: Fit exposed connections of trim, fillers, and closures accurately together to form tight, hairline joints, with concealed fasteners and splice plates.

3.3 ADJUSTING

- A. Clean, lubricate, and adjust hardware. Adjust doors and latches to operate easily without binding. Verify that integral locking devices operate properly.

3.4 PROTECTION

- A. Protect lockers from damage, abuse, dust, dirt, stain, or paint. Do not permit use during construction.
- B. Touch up marred finishes, or replace lockers that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by locker manufacturer.

END OF SECTION 105113

SECTION 122413 - ROLLER WINDOW SHADES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Manually operated chain-and-clutch roller shades with single rollers.
 - 2. Manually operated interior chain-and-clutch roller shades with single rollers privacy shades.
- B. Related Requirements:
 - 1. Division 06 Section "Rough Carpentry" for wood blocking for mounting roller shades and accessories.

1.3 ACTION SUBMITTALS

- A. General: Submit in accordance with Division 01 Section "Submittals Procedures."
- B. Product Data: For each type of product.
 - 1. Include styles, material descriptions, construction details, dimensions of individual components and profiles, features, finishes, and operating instructions for roller shades.
 - 2. Motorized Shade Operators: Include operating instructions.
- C. Shop Drawings: Show fabrication and installation details for roller shades, including shadeband materials, their orientation to rollers, and their seam and batten locations.
 - 1. Identify locations where blocking is required for attachment of support hardware for shades.
 - 2. Motor-Operated Shades: Include details of installation and diagrams for power, signal, and control wiring.
- D. Samples: For each exposed product and for each color and texture specified, 10 inches long.
- E. Samples for Initial Selection: For each type and color of shadeband material.
 - 1. Include Samples of accessories involving color selection.
- F. Roller-Shade Schedule: Use same room designations indicated on Drawings.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For roller shades to include in maintenance manuals. Include the following:
 - 1. Methods for maintaining roller shades and finishes.
 - 2. Precautions about cleaning materials and methods that could be detrimental to fabrics, finishes, and performance.
 - 3. Operating hardware.

1.5 QUALITY ASSURANCE

- A. Source Limitations: Obtain all roller shades through one source from a single manufacturer.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver roller shades in factory packages, marked with manufacturer, product name, and location of installation using same designations indicated on Drawings.

1.7 FIELD CONDITIONS

- A. Environmental Limitations: Do not install roller shades until construction and finish work in spaces, including painting, is complete and dry and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.
- B. Field Measurements: Where roller shades are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication and indicate measurements on Shop Drawings. Allow clearances for operating hardware of operable glazed units through entire operating range. Notify Architect of installation conditions that vary from Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

PART 2 - PRODUCTS

2.1 MANUALLY OPERATED CHAIN-AND-CLUTCH SHADES WITH SINGLE ROLLERS

- A. Products: Subject to compliance with requirements, provide one of the following:
 - 1. Draper Inc.; Manual Flex Shade.
 - 2. Mecho Shade Systems; Mecho/5 System.
- B. Chain-and-Clutch Operating Mechanisms: With continuous-loop bead chain and clutch that stops shade movement when bead chain is released; permanently adjusted and lubricated.
 - 1. Bead Chains: Stainless steel.
 - a. Loop Length: Full length of roller shade.
 - b. Limit Stops: Provide upper and lower ball stops.
 - c. Chain-Retainer Type: Chain tensioner, sill mounted.
- C. Rollers: Corrosion-resistant steel or extruded-aluminum tubes of diameters and wall thicknesses required to accommodate operating mechanisms and weights and widths of shadebands indicated without deflection. Provide with permanently lubricated drive-end assemblies and idle-end assemblies designed to facilitate removal of shadebands for service.
 - 1. Roller Drive-End Location: As indicated by Architect during Shop Drawing review.
 - 2. Direction of Shadeband Roll: Regular, from back of roller.
 - 3. Shadeband-to-Roller Attachment: Manufacturer's standard method.
- D. Mounting Hardware: Brackets or endcaps, corrosion resistant and compatible with roller assembly, operating mechanism, installation accessories, and mounting location and conditions indicated.
- E. Shadebands:

1. Shadeband Material:
 - a. Exterior Windows: Light-filtering fabric.
 - b. Interior Borrowed Lites and Side Lites: Light-blocking fabric.
2. Shadeband Bottom (Hem) Bar: Steel or extruded aluminum.
 - a. Type: Enclosed in sealed pocket of shadeband material.
 - b. Color and Finish: As selected by Architect from manufacturer's full range.

F. Installation Accessories:

1. Exposed Headbox: Rectangular, extruded-aluminum enclosure including front fascia, top and back covers, and removable bottom closure. Provide end caps for exposed ends for non-between jamb installations.
 - a. Height: Manufacturer's standard height required to enclose roller and shadeband when shade is fully open, but not more than 4 inches.
2. Installation Accessories Color and Finish: As selected from manufacturer's full range.

2.2 SHADEBAND MATERIALS

- A. Shadeband Material Flame-Resistance Rating: Comply with NFPA 701. Testing by a qualified, independent testing agency. Identify products with appropriate markings of applicable testing agency.
- B. Light-Filtering Fabric: Woven fabric, stain and fade resistant.
 1. Source: Roller-shade manufacturer.
 2. Type: PVC-coated polyester.
 3. Weave: Mesh.
 4. Weight: Manufacturer's standard, but not less than 18.5 oz./sq. yd.
 5. Orientation on Shadeband: Up the bolt.
 6. Openness Factor: 1 percent.
 7. Color: As selected by Architect from manufacturer's full range.
 8. Product: Draper Inc.; Phifer SheerWeave - PW4800 or equivalent from Mecho Shade Systems.
- C. Light-Blocking Fabric: Opaque fabric, stain and fade resistant.
 1. Source: Roller-shade manufacturer.
 2. Type: Opaque, close woven fiberglass base textile with sun-resistant vinyl film bonded to each side; fire retardant, washable and stain resistant.
 3. Products:
 - a. Draper Inc.; SunBloc Series SB9000.
 - b. Mecho Shade Systems; Equinox 0100 Series.
 4. Weight: 12 oz./sq. yd.
 5. Color: As selected by Architect from manufacturer's full range; same color both sides.

2.3 ROLLER-SHADE FABRICATION

- A. Product Safety Standard: Fabricate roller shades to comply with WCMA A 100.1, including requirements for flexible, chain-loop devices; lead content of components; and warning labels.
- B. Unit Sizes: Fabricate units in sizes to fill window and other openings as follows, measured at 74 deg F:
 1. Exterior Windows, between (Inside) Jamb of Window Opening Installation: Width equal to jamb-to-jamb dimension of opening in which shade is installed less 1/4 inch per side or

- 1/2-inch total, plus or minus 1/8 inch. Length equal to head-to-sill or -floor dimension of opening in which shade is installed less 1/4 inch, plus or minus 1/8 inch.
2. Borrowed Lites, Mounted to Frame Head: Width equal to outside of jamb-to-jamb dimension of opening where shade is installed plus 1/4 inch per side or 1/2-inch total, plus or minus 1/8 inch. Length equal to head-to-sill or -floor dimension of opening in which shade where is installed plus 1/4 inch, plus or minus 1/8 inch.
- C. Shadeband Fabrication: Fabricate shadebands without battens or seams to extent possible except as follows:
1. Vertical Shades: Where width-to-length ratio of shadeband is equal to or greater than 1:4, provide battens and seams at uniform spacings along shadeband length to ensure shadeband tracking and alignment through its full range of movement without distortion of the material.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, operational clearances, accurate locations of connections to building electrical system, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 ROLLER-SHADE INSTALLATION

- A. Install roller shades level, plumb, and aligned with adjacent units according to manufacturer's written instructions. Attach brackets to wood or cold formed metal framing substrates. Attachment to gypsum wallboard only is not permitted. Provide adequate screw length to securely fasten hardware to blocking and substrates. Field verify dimensions before fabricating.
 1. Shadebands at Exterior Windows: Located so shadeband is not closer than 2 inches to interior face of glass. Allow clearances for window operation hardware.
 2. Provide a single shade for full width of multi-unit mulled windows. Shades shall be full height of window, including transoms. Where window opening exceeds available shade width, provide multiple shades at opening of uniform width.
 3. Shadebands at Borrowed Lites: Mounting hardware shall extend sufficiently to allow proper operation of roller shades without interference with frame.

3.3 ADJUSTING

- A. Adjust and balance roller shades to operate smoothly, easily, safely, and free from binding or malfunction throughout entire operational range.

3.4 CLEANING AND PROTECTION

- A. Clean roller-shade surfaces after installation, according to manufacturer's written instructions.

- B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer, that ensure that roller shades are without damage or deterioration at time of Substantial Completion.
- C. Replace damaged roller shades that cannot be repaired, in a manner approved by Architect, before time of Substantial Completion.

3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain motor-operated roller shades.

3.6 WINDOW TREATMENT SCHEDULE

- A. Exterior Windows: Provide manual chain-and-clutch roller shades with light-filtering fabric for all exterior aluminum windows and for storefront windows.
- B. Interior Aluminum Storefronts: Provide chain-and-clutch roller shades with light-blocking fabric.

END OF SECTION 122413

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SECTION 124813 - ENTRANCE FLOOR MATS AND FRAMES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Carpet tile type entrance mats.
 - 2. Surface-mounted frames.

1.3 ACTION SUBMITTALS

- A. General: Submit in accordance with Division 01 Section "Submittal Procedures."
- B. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for floor mats and frames.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For floor mats and frames to include in maintenance manuals. Include the following:
 - 1. Precautions for cleaning materials and methods that could be detrimental to carpet tile type entrance mats.

PART 2 - PRODUCTS

2.1 ENTRANCE FLOOR MATS AND FRAMES, GENERAL

- A. Accessibility Standard: Comply with applicable provisions in the DOJ's "2010 ADA Standards for Accessible Design" and ICC A117.1.

2.2 RESILIENT-TILE ENTRANCE MATS

- A. Carpet-Type Tiles for Walk-Off Mat: Solution-dyed, UV stabilized polypropylene carpet bonded to bitumen backing to form mats 1/2 inch thick with nonraveling edges.
 - 1. Pile Weight: 52 oz./sq. yd.
 - 2. Tile Size: 19-11/16 inches by 19-11/16 inches.
 - 3. Thickness: 1/2 – inch.
 - 4. Installation Method: Direct glued.
 - 5. Tile Pattern: Quarter turn tiles.
 - 6. Product: Mats, Inc.; Super Nop 52 Tile.
 - a. Color: As indicated in Materials Legend.

2.3 FRAMES

- A. Surface-Mounted Frames: Extruded aluminum angle edge-frame with 1/8-inch wide exposed face; clear anodized finish. Provide with floor anchorage devices, mitered corners, and sizes recommended by manufacturer.
 - 1. Provide tapered ramp frame at side where frame meets resilient tile.

2.4 INSTALLATION MATERIALS

- A. Trowelable Leveling and Patching Compounds: Polymer-modified, portland cement based formulation provided or approved by manufacturer for applications indicated.
 - 1. Product: Ardex; Forti Finish.
- B. Adhesive: Low VOC, premium grade, water-resistant, pressure sensitive adhesive as recommended by manufacturer to suit products and subfloor conditions.
 - 1. Maximum Allowable RH: 95 percent RH as measured by ASTM F 2170.
 - 2. Product: Mats, Inc.; MI 1000 Adhesive.

2.5 FABRICATION

- A. Floor Mats: Shop fabricate units to greatest extent possible in sizes indicated. Unless otherwise indicated, provide single unit for each mat installation; do not exceed manufacturer's recommended maximum sizes for units that are removed for maintenance and cleaning. Where joints in mats are necessary, space symmetrically and away from normal traffic lanes. Miter corner joints in framing elements with hairline joints or provide prefabricated corner units without joints.
- B. Surface-Mounted Frames: As indicated for permanent surface-mounted installation, complete with corner connectors, splice plates or connecting pins, and post installed expansion anchors.
- C. Coat concealed surfaces of aluminum frames that contact cementitious material with manufacturer's standard protective coating.

2.6 ALUMINUM FINISHES

- A. Clear Anodic Finish: AAMA 611, AA-M12C22A31, Class II, 0.010 mm or thicker.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and floor conditions for compliance with requirements for location, sizes, and other conditions affecting installation of floor mats and frames.
- B. Concrete Slabs: Verify that concrete slabs comply with ASTM F 710 and the following:
 - 1. Verify that slab substrates are dry and free of curing compounds, sealers, hardeners, and other materials that may interfere with adhesive bond. Determine dryness characteristics by performing moisture tests required by walk-off mat manufacturer and with the specified requirements.

2. An independent testing agency shall perform relative humidity test. Field technician shall be certified per the International Concrete Repair Institute (ICRI) as a Tier 2 Certified Technician. Perform test using in situ probes, ASTM F 2170.
 - a. Perform tests on slabs to receive glue down carpet installation at rate of 1 test/1000 sq. ft. of floor area.
 - b. Maintain a minimum temperature of 70 deg F in spaces to be tested for not less than 72 hours prior to and during tests.
 3. Proceed with installation only after substrates have maximum relative humidity (RH) level of not more than 95 percent.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install surface-type frames to comply with manufacturer's written instructions; coordinate with entrance locations and traffic patterns.
1. Anchor fixed surface-type frame members to floor with devices spaced as recommended by manufacturer.
 2. Delay installing mats until construction traffic has ended.

3.3 PROTECTION

- A. After completing frame installation, provide temporary filler of plywood or fiberboard in recesses and cover frames with plywood protective flooring. Maintain protection until construction traffic has ended and Project is near Substantial Completion.

END OF SECTION 124813

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SECTION 210500 - COMMON WORK RESULTS FOR FIRE SUPPRESSION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. The fire protection system shall be installed in accordance with the 2016 edition of NFPA 13.
- B. This Section includes the following:
 - 1. Piping materials and installation instructions common to most piping systems.
 - 2. Sleeves.
 - 3. Escutcheons.
 - 4. Equipment installation requirements common to equipment sections.

1.3 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspace, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.
- D. The following are industry abbreviations for rubber materials:
 - 1. EPDM: Ethylene-propylene-diene terpolymer rubber.
 - 2. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS

- A. Product Data: For the following:
 - 1. Mechanical sleeve seals.
 - 2. Escutcheons.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

1.6 COORDINATION

- A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for fire-suppression installations.
- B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 PIPE, TUBE, AND FITTINGS

- A. Refer to individual Division 21 piping Sections for pipe, tube, and fitting materials and joining methods.
- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.3 JOINING MATERIALS

- A. Refer to individual Division 21 piping Sections for special joining materials not listed below.
- B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
 - 1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch (3.2-mm) maximum thickness unless thickness or specific material is indicated.
 - a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
 - b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
 - 2. AWWA C110, rubber, flat face, 1/8 inch (3.2 mm) thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.
- C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

2.4 ESCUTCHEONS

- A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.
- C. One-Piece, Cast-Brass Type: With set screw.
 - 1. Finish: Polished chrome-plated or white painted in finished spaces.

- D. One-Piece, Floor-Plate Type: Cast-iron floor plate.

PART 3 - EXECUTION

3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. Install piping according to the following requirements and Division 21 Sections specifying piping systems.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping to permit valve servicing.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Select system components with pressure rating equal to or greater than system operating pressure.
- J. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
 - 1. New Piping:
 - a. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
 - b. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
 - c. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with polished chrome-plated finish.
 - d. Bare Piping in Equipment Rooms: One-piece, cast-brass type.
 - e. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.
 - 2. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.
- K. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section "Penetration Firestopping" for materials.

- L. Verify final equipment locations for roughing-in.
- M. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.2 PIPING JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and Division 21 Sections specifying piping systems.
- B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- E. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.3 PAINTING

- A. Painting of fire-suppression systems, equipment, and components exposed in finished spaces is specified in Division 09 Section "Painting."
- B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.4 ERECTION OF METAL SUPPORTS AND ANCHORAGES

- A. Refer to Division 05 for structural steel.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor fire-suppression materials and equipment.
- C. Field Welding: Comply with AWS D1.1.

END OF SECTION 210500

SECTION 211313 - WET-PIPE SPRINKLER SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Pipes, fittings, and specialties.
 - 2. Fire-protection valves.
 - 3. Backflow Preventer.
 - 4. Fire-department connections.
 - 5. Sprinklers.
 - 6. Alarm devices.
 - 7. Pressure gages.

1.3 DEFINITIONS

- A. Standard-Pressure Sprinkler Piping: Wet-pipe sprinkler system piping designed to operate at working pressure of 175 psig (1200 kPa) maximum.

1.4 SYSTEM DESCRIPTIONS

- A. Wet-Pipe Sprinkler System: Automatic sprinklers are attached to piping containing water and that is connected to water supply through alarm valve. Water discharges immediately from sprinklers when they are opened. Sprinklers open when heat melts fusible link or destroys frangible device. Hose connections are included if indicated.

1.5 PERFORMANCE REQUIREMENTS

- A. Standard-Pressure Piping System Component: Listed for 175-psig (1200-kPa) minimum working pressure.
- B. Delegated Design: Design sprinkler system(s), including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- C. Sprinkler system design shall be approved by authorities having jurisdiction.
 - 1. Margin of Safety for Available Water Flow and Pressure: 10 percent, including losses through water-service piping, valves, and backflow preventer.
 - 2. Sprinkler Occupancy Hazard Classifications:
 - a. Building Service Areas: Ordinary Hazard, Group 1.
 - b. Electrical Equipment Rooms: Ordinary Hazard, Group 1.
 - c. Mechanical Equipment Rooms: Ordinary Hazard, Group 1.

- d. Classrooms, Offices and Public Areas: Light Hazard.
- 3. Minimum Density for Automatic-Sprinkler Piping Design:
 - a. Light-Hazard Occupancy: 0.10 gpm over 1500-sq. ft. (4.1 mm/min. over 139-sq. m.)
 - b. Ordinary-Hazard, Group 1 Occupancy: 0.15 gpm over 1500-sq. ft. area.
 - c. Combustible warm attic Areas with combustible sloped roof: Light-Hazard Occupancy: 0.10 gpm over 1950-sq. ft.
- 4. Maximum Protection Area per Sprinkler:
 - a. Classrooms, Offices and Public Areas: 225 sq. ft. (20.9 sq. m.)
 - b. Storage Areas: 130 sq. ft. (12.1 sq. m.)
 - c. Combustible attic Areas: 130 sq. ft. (12.1 sq. m.)
 - d. Mechanical Equipment Rooms: 130 sq. ft. (12.1 sq. m.)
 - e. Electrical Equipment Rooms: 130 sq. ft. (12.1 sq. m.)
 - f. Other Areas: According to NFPA 13 recommendations unless otherwise indicated.
- 5. Total Combined Hose-Stream Demand Requirement: 100 gpm.

1.6 SUBMITTALS

- A. Product Data: For each type of product indicated
- B. Shop Drawings: For wet-pipe sprinkler systems. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Wiring Diagrams: For power, signal, and control wiring.
- C. Delegated-Design Submittal: For sprinkler systems indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- D. Coordination Drawings: Sprinkler systems, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Domestic water piping.
 - 2. HVAC Ductwork.
 - 3. HVAC hydronic piping.
 - 4. Items penetrating finished ceiling include the following:
 - a. Lighting fixtures.
 - b. Air outlets and inlets
 - 5. Structural framing components.
- E. Qualification Data: For qualified Installer.
- F. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction, including hydraulic calculations if applicable.
- G. Field Test Reports and Certificates: Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13. Include "Contractor's Material and Test Certificate for Aboveground Piping."
- H. Field quality-control reports.

- I. Operation and Maintenance Data: For sprinkler specialties to include in emergency, operation, and maintenance manuals.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications:
 - 1. Installer's responsibilities include designing, fabricating, and installing sprinkler systems and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.
 - a. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified professional engineer.
- B. Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. NFPA Standards: Sprinkler system equipment, specialties, accessories, installation, and testing shall comply with the following:
 - 1. NFPA 13, "Installation of Sprinkler Systems."

1.8 COORDINATION

- A. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.

1.9 EXTRA MATERIALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Sprinkler Cabinets: Finished, wall-mounted, steel cabinet with hinged cover, and with space for minimum of six spare sprinklers plus sprinkler wrench. Include number of sprinklers required by NFPA 13 and sprinkler wrench. Include separate cabinet with sprinklers and wrench for each type of sprinkler used on Project.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

- A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, and fitting materials, and for joining methods for specific services, service locations, and pipe sizes.

2.2 STEEL PIPE AND FITTINGS

- A. Standard Weight, Black-Steel Pipe: ASTM A 53/A 53M, Pipe ends may be factory or field formed to match joining method.

- B. Thinwall Black-Steel Pipe: ASTM A 135 or ASTM A 795/A 795M, threadable, with wall thickness less than Schedule 30 and equal to or greater than Schedule 10. Pipe ends may be factory or field formed to match joining method.
- C. Schedule 10, Black-Steel Pipe: ASTM A 135 or ASTM A 795/A 795M, Schedule 10 in NPS 5 (DN 125) and smaller; and NFPA 13-specified wall thickness in NPS 6 to NPS 10 (DN 150 to DN 250), plain end.
- D. Cast-Iron Flanges: ASME 16.1, Class 125.
- E. Grooved-Joint, Steel-Pipe Appurtenances:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Victaulic Company.
 - 2. Pressure Rating: 175 psig (1200 kPa minimum).
 - 3. Grooved-End-Pipe Couplings for Steel Piping: AWWA C606 and UL 213, rigid pattern, unless otherwise indicated, for steel-pipe dimensions. Include ferrous housing sections, EPDM-rubber gasket, and bolts and nuts.

2.3 PIPING JOINING MATERIALS

- A. Pipe-Flange Gasket Materials: ASME B16.21, nonmetallic and asbestos free.
 - 1. Class 125, Cast-Iron Flanges and Class 150, Bronze Flat-Face Flanges: Full-face gaskets.
- B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.

2.4 LISTED FIRE-PROTECTION VALVES

- A. General Requirements:
 - 1. Valves shall be UL listed or FM approved.
 - 2. Minimum Pressure Rating for Standard-Pressure Piping: 175 psig (1200 kPa).
- B. Ball Valves:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 2. Basis-of-Design Product: Subject to compliance with requirements, provide product name or designation or comparable product by one of the following:
 - a. Victaulic Company.
 - 3. Standard: UL 1091 except with ball instead of disc.
 - 4. Valves NPS 1-1/2 (DN 40) and Smaller: Bronze body with threaded ends.
 - 5. Valves NPS 2 and NPS 2-1/2 (DN 50 and DN 65): Bronze body with threaded ends or ductile-iron body with grooved ends.
 - 6. Valves NPS 3 (DN 80): Ductile-iron body with grooved ends.

C. Check Valves:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Basis-of-Design Product: Subject to compliance with requirements, provide product name or designation or comparable product by one of the following:
 - a. American Cast Iron Pipe Company; Waterous Company Subsidiary.
 - b. Anvil International, Inc.
 - c. Crane Co.; Crane Valve Group; Crane Valves.
 - d. Crane Co.; Crane Valve Group; Jenkins Valves.
 - e. Crane Co.; Crane Valve Group; Stockham Division.
 - f. Globe Fire Sprinkler Corporation.
 - g. Kennedy Valve; a division of McWane, Inc.
 - h. Metraflex, Inc.
 - i. Milwaukee Valve Company.
 - j. Mueller Co.; Water Products Division.
 - k. NIBCO INC.
 - l. Potter Roemer.
 - m. Reliable Automatic Sprinkler Co., Inc.
 - n. Tyco Fire & Building Products LP.
 - o. United Brass Works, Inc.
 - p. Victaulic Company.
 - q. Viking Corporation.
 - r. Watts Water Technologies, Inc.
3. Standard: UL 312.
4. Pressure Rating: 250 psig (1725 kPa) minimum 300 psig (2070 kPa).
5. Type: Swing check.
6. Body Material: Cast iron.
7. End Connections: Flanged or grooved.

D. Iron OS&Y Gate Valves:

1. Manufacturers: Subject to compliance with requirements available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Basis-of-Design Product: Subject to compliance with requirements, provide product name or designation or comparable product by one of the following:
 - a. American Valve, Inc.
 - b. Crane Co.; Crane Valve Group; Crane Valves.
 - c. Crane Co.; Crane Valve Group; Jenkins Valves.
 - d. Crane Co.; Crane Valve Group; Stockham Division.
 - e. Hammond Valve.
 - f. Milwaukee Valve Company.
 - g. Mueller Co.; Water Products Division.
 - h. NIBCO INC.
 - i. Tyco Fire & Building Products LP.
 - j. United Brass Works, Inc.
 - k. Watts Water Technologies, Inc.
3. Standard: UL 262.
4. Pressure Rating: 250 psig (1725 kPa) minimum
5. Body Material: Cast or ductile iron.
6. End Connections: Flanged or grooved.

- E. Indicating-Type Butterfly Valves:
1. Basis-of-Design Product: Subject to compliance with requirements, provide product name or designation or comparable product by one of the following:
 - a. Anvil International, Inc.
 - b. Global Safety Products, Inc.
 - c. Kennedy Valve; a division of McWane, Inc.
 - d. Milwaukee Valve Company.
 - e. NIBCO INC.
 - f. Tyco Fire & Building Products LP.
 - g. Victaulic Company.
 2. Standard: UL 1091.
 3. Pressure Rating: 175 psig (1200 kPa) minimum.
 4. Valves NPS 2 (DN 50) and Smaller:
 - a. Valve Type: Ball or butterfly.
 - b. Body Material: Bronze.
 - c. End Connections: Threaded.
 5. Valves NPS 2-1/2 (DN 65) and Larger:
 - a. Valve Type: Butterfly.
 - b. Body Material: Cast or ductile iron.
 - c. End Connections: Flanged, grooved, or wafer.
 6. Valve Operation: Integral indicating device.

2.5 BACKFLOW PREVENTER

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Ames 20 or designation or comparable product by one of the following:
1. Watts.
 2. Ames.
 3. Deringer.
- B. Connection Size: 4"
- C. Assembly: Testable Double Check Valve with two shut-off valves and four test cocks.
- D. Material: 304 Schedule 40, Stainless Steel housing and components.
- E. Valves: OS&Y
- F. Seats: Replaceable check disc rubber.

2.6 TRIM AND DRAIN VALVES

- A. General Requirements:
1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
 2. Pressure Rating: 175 psig (1200 kPa) minimum.

- B. Angle Valves:
 - 1. Manufacturers: Subject to compliance with requirements available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Fire Protection Products, Inc.
 - b. United Brass Works, Inc.
- C. Ball Valves:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Anvil International, Inc.
 - b. Conbraco Industries, Inc.; Apollo Valves.
 - c. Fire Protection Products, Inc.
 - d. Kennedy Valve; a division of McWane, Inc.
 - e. Kitz Corporation.
 - f. Milwaukee Valve Company.
 - g. NIBCO INC.
 - h. Tyco Fire & Building Products LP.
 - i. Victaulic Company.
 - j. Watts Water Technologies, Inc.

2.7 SPECIALTY VALVES

- A. General Requirements:
 - 1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
 - 2. Body Material: Cast or ductile iron.
 - 3. Size: Same as connected piping.
 - 4. End Connections: Flanged or grooved.
- B. Riser Zone Valves:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 2. Basis-of-Design Product: Subject to compliance with requirements, provide product name or designation or comparable product by one of the following:
 - a. Globe Fire Sprinkler Corporation.
 - b. Reliable Automatic Sprinkler Co., Inc.
 - c. Tyco Fire & Building Products LP.
 - d. Victaulic Company.
 - 3. Standard: UL 193.
 - 4. Design: For horizontal or vertical installation.
 - 5. Include trim sets for bypass, drain, electrical sprinkler alarm switch, pressure gages and fill-line attachment with strainer.
 - 6. Drip Cup Assembly: Pipe drain with check valve to main drain piping.
- C. Automatic (Ball Drip) Drain Valves:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

2. Basis-of-Design Product: Subject to compliance with requirements, provide product name or designation or comparable product by one of the following:
 - a. AFAC Inc.
 - b. Reliable Automatic Sprinkler Co., Inc.
 - c. Tyco Fire & Building Products LP.
3. Standard: UL 1726.
4. Pressure Rating: 175 psig (1200 kPa) minimum.
5. Type: Automatic draining, ball check.
6. Size: NPS 3/4 (DN 20).
7. End Connections: Threaded.

2.8 FIRE-DEPARTMENT CONNECTIONS

- A. Exposed-Type, Fire-Department Connection:
 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:
 2. Basis-of-Design Product: Subject to compliance with requirements, provide product name or designation or comparable product by one of the following:
 - a. Elkhart Brass Mfg. Company, Inc.
 - b. Fire-End & Croker Corporation.
 - c. Fire Protection Products, Inc.
 - d. GMR International Equipment Corporation.
 - e. Guardian Fire Equipment, Inc.
 - f. Tyco Fire & Building Products LP.
 - g. Wilson & Cousins Inc.
 3. Standard: UL 405.
 4. Type: Storz, exposed, projecting, for wall mounting.
 5. Pressure Rating: 175 psig (1200 kPa) minimum.
 6. Body Material: Corrosion-resistant metal.
 7. Inlet: Brass with threads matching local fire-department sizes and threads. Include extension pipe nipples, brass lugged swivel connections, and check devices or clappers.
 8. Caps: Brass, lugged type, with gasket and chain.
 9. Escutcheon Plate: Round, brass, wall type.
 10. Outlet: Back, with pipe threads.
 11. Number of Inlets: One.
 12. Escutcheon Plate Marking for wet system: Similar to "AUTO SPKR"
 13. Finish: Rough chrome plated or Aluminum.
 14. Outlet Size: NPS 4 (DN 100).

2.9 SPRINKLER SPECIALTY PIPE FITTINGS

- A. Branch Outlet Fittings:
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Anvil International, Inc.
 - b. National Fittings, Inc.
 - c. Tyco Fire & Building Products LP.
 - d. Victaulic Company.

2. Standard: UL 213.
3. Pressure Rating: 175 psig (1200 kPa) minimum.
4. Body Material: Ductile-iron housing with EPDM seals and bolts and nuts.
5. Type: Mechanical-T and -cross fittings.
6. Configurations: Snap-on and strapless, ductile-iron housing with branch outlets.
7. Size: Of dimension to fit onto sprinkler main and with outlet connections as required to match connected branch piping.
8. Branch Outlets: Grooved, plain-end pipe, or threaded.

B. Flow Detection and Inspectors Test Assemblies:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. AGF Manufacturing Inc.
 - b. Reliable Automatic Sprinkler Co., Inc.
 - c. Tyco Fire & Building Products LP.
 - d. Victaulic Company.
2. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
3. Pressure Rating: 175 psig (1200 kPa) minimum.
4. Body Material: Cast- or ductile-iron housing with orifice, sight glass, and integral test valve.
5. Size: Same as connected piping.
6. Inlet and Outlet: Threaded.

2.10 SPRINKLERS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Reliable Automatic Sprinkler Co., Inc.
2. Tyco Fire & Building Products LP.
3. Victaulic Company.
4. Viking Corporation.

B. General Requirements:

1. Standard: UL's "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
2. Pressure Rating for Automatic Sprinklers: 175 psig (1200 kPa) minimum.

C. Automatic Sprinklers with Heat-Responsive Element:

1. Early-Suppression, Fast-Response Applications: UL 1767.
2. Nonresidential Applications: UL 199.
3. Residential Applications: UL 1626.
4. Characteristics: Nominal 1/2-inch (12.7-mm) orifice with Discharge Coefficient K of 5.6, and for "Ordinary" temperature classification rating unless otherwise indicated or required by application.

D. Sprinkler Finishes:

1. Acoustical Tile Ceilings: White Concealed Plate recessed sprinklers.
2. Bronze upright in all unfinished spaces such as mechanical rooms (provide red cages on sprinklers located under ducts and in Mechanical spaces).

3. Finished spaces without ceilings: White exposed upright type sprinklers.
 - a. Provide chrome plated cages on sprinklers located in the Gym, Workout Equipment Room and Track.
 4. .
 5. Finished spaces sidewall: White concealed plate.
- E. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers.
1. Acoustical Tile Ceiling Mounting: White Concealed Plate recessed sprinklers.
 2. Interior Sidewall Mounting: White painted steel, two piece, semi-recessed with 1-inch (25-mm) adjustment.
 3. Exterior Sidewall Mounting: Dry-sidewall, chrome plated, semi-recessed with 1-inch (25-mm) adjustment.
Sprinkler Guards: Red, tested in conjunction with the sprinkler type installed.
 4. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Reliable Automatic Sprinkler Co., Inc.
 - b. Tyco Fire & Building Products LP.
 - c. Victaulic Company.
 - d. Viking Corporation.
 5. Standard: UL 199.
 6. Type: Wire cage with fastening device for attaching to sprinkler.

2.11 ALARM DEVICES

- A. Alarm-device types shall match piping and equipment connections.
- B. Water-Flow Indicators:
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Potter Electric Signal Company.
 2. Standard: UL 346.
 3. Water-Flow Detector: Electrically supervised.
 4. Components: Two single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.
 5. Type: Paddle operated.
 6. Pressure Rating: 250 psig (1725 kPa).
 7. Design Installation: Horizontal or vertical.
- C. Valve Supervisory Switches:
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Potter Electric Signal Company.
 2. Standard: UL 346.

3. Type: Electrically supervised.
4. Components: Single-pole, double-throw switch with normally closed contacts.
5. Design: Signals that controlled valve is in other than fully open position.

2.12 PRESSURE GAGES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 1. AMETEK; U.S. Gauge Division.
 2. Ashcroft, Inc.
 3. Brecco Corporation.
 4. WIKA Instrument Corporation.
- B. Standard: UL 393.
- C. Dial Size: 3-1/2- to 4-1/2-inch (90- to 115-mm) diameter.
- D. Pressure Gage Range: 0 to 250 psig (0 to 1725 kPa) minimum.
- E. Water System Piping Gage: Include "WATER" label on dial face.

2.13 ESCUTCHEONS

- A. General: Manufactured ceiling, floor, and wall escutcheons and floor plates.
- B. One-Piece, Stamped Steel or Plastic Split Escutcheons: Polished chrome-plated or white painted finish.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Perform fire-hydrant flow test according to NFPA 13 and NFPA 291. Use results for system design calculations required in "Quality Assurance" Article.
- B. Report test results promptly and in writing.

3.2 SERVICE-ENTRANCE PIPING

- A. Connect to sprinkler piping stubbed up through the floor for fire protections service entrance to building provided in Division 33.
- B. Install shutoff valve, backflow preventer, pressure gage, drain, and other accessories indicated at connection to water-service piping. Comply with requirements for backflow preventers.
- C. Install shutoff valve, check valve, pressure gage, and drain at connection to water service.

3.3 PIPING INSTALLATION

- A. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated, as far as practical.
 - 1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.
- B. Piping Standard: Comply with requirements for installation of sprinkler piping in NFPA 13.
- C. Install seismic restraints on piping. Comply with requirements for seismic-restraint device materials and installation in NFPA 13.
- D. Use listed fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.
- E. Install unions adjacent to each valve in pipes NPS 2 (DN 50) and smaller.
- F. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 (DN 65) and larger end connections.
- G. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, and sized and located according to NFPA 13.
- H. Install sprinkler piping with drains for complete system drainage.
- I. Install sprinkler control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.
- J. Install automatic (ball drip) drain valve at each check valve for fire-department connection, to drain piping between fire-department connection and check valve. Install drain piping to and spill over floor drain or to outside building.
- K. Install alarm devices in piping systems.
- L. Install hangers and supports for sprinkler system piping according to NFPA 13. Comply with requirements for hanger materials in NFPA 13.
- M. Install pressure gages on riser or feed main, at each sprinkler test connection, and at top of each standpipe. Include pressure gages with connection not less than NPS 1/4 (DN 8) and with soft metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal and install where they will not be subject to freezing.
- N. Fill sprinkler system piping with water.

3.4 JOINT CONSTRUCTION

- A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system's pressure rating for aboveground applications unless otherwise indicated.

- B. Install unions adjacent to each valve in pipes NPS 2 (DN 50) and smaller.
- C. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 (DN 65) and larger end connections.
- D. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- E. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- F. Flanged Joints: Select appropriate gasket material in size, type, and thickness suitable for water service. Join flanges with gasket and bolts according to ASME B31.9.
- G. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- H. Steel-Piping, Pressure-Sealed Joints: Join lightwall steel pipe and steel pressure-seal fittings with tools recommended by fitting manufacturer.
- I. Steel-Piping, Cut-Grooved Joints: Cut square-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe joints.

3.5 VALVE AND SPECIALTIES INSTALLATION

- A. Install listed fire-protection valves, trim and drain valves, specialty valves and trim, controls, and specialties according to NFPA 13 and authorities having jurisdiction.
- B. Install listed fire-protection shutoff valves supervised open, located to control sources of water supply except from fire-department connections. Install permanent identification signs indicating portion of system controlled by each valve.
- C. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water-supply sources.
- D. Specialty Valves:
 - 1. General Requirements: Install in vertical position for proper direction of flow, in main supply to system.
 - 2. Alarm Valves: Include bypass check valve and retarding chamber drain-line connection.

3.6 SPRINKLER INSTALLATION

- A. Install sprinklers in suspended ceilings in the center of acoustical ceiling panels.

3.7 FIRE-DEPARTMENT CONNECTION INSTALLATION

- A. Install wall-type, fire-department connections.
- B. Install automatic (ball drip) drain valve at each check valve for fire-department connection.

3.8 ESCUTCHEON INSTALLATION

- A. Install escutcheons for penetrations of walls, ceilings, and floors.
- B. Escutcheons for New Piping:
 - 1. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated or white painted finish.
 - 2. Bare Piping at Ceiling Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated or white painted finish.
 - 3. Bare Piping in Unfinished Service Spaces: One piece, cast brass with polished chrome-plated finish.
 - 4. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece floor plate.

3.9 SLEEVE INSTALLATION

- A. General Requirements: Install sleeves for pipes and tubes passing through foundation and floors.
- B. Sleeves are not required for core-drilled holes.
- C. Permanent sleeves are not required for holes formed by removable PE sleeves.
- D. Cut sleeves to length for mounting flush with both surfaces unless otherwise indicated.
- E. Install sleeves in slabs, and walls as they are built.
- F. For exterior wall penetrations above grade, seal annular space between sleeve and pipe using joint sealants appropriate for size, depth, and location of joint. Comply with requirements for joint sealants in Division 07 Section "Joint Sealants."
- G. For exterior wall penetrations below grade, seal annular space between sleeve and pipe using sleeve seals.
- H. Seal space outside of sleeves in concrete slabs and walls with grout.
- I. Install sleeves that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation unless otherwise indicated.
- J. Install sleeve materials according to the following applications:
 - 1. Sleeves for Piping Passing through Concrete Floor Slabs: Galvanized-steel pipe.
 - 2. Sleeves for Piping Passing through Concrete Floor Slabs of Mechanical Equipment Areas or Other Wet Areas: Galvanized-steel pipe.
 - a. Extend sleeves 2 inches (50 mm) above finished floor level.
 - 3. Sleeves for Piping Passing through Exterior Concrete Walls:
 - a. PVC-pipe or Galvanized-steel-pipe sleeves for pipes smaller than NPS 6 (DN 150).

- b. Install sleeves that are large enough to provide 1-inch (25-mm) annular clear space between sleeve and pipe or pipe insulation when sleeve seals are used.
 - 4. Sleeves for Piping Passing through Interior Concrete Walls:
 - a. PVC-pipe or Galvanized-steel-pipe sleeves for pipes smaller than NPS 6 (DN 150).
- K. 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 firestop materials and installations in Division 07 Section "Penetration Firestopping."

3.10 IDENTIFICATION

- A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13.
- B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Division 26 Section "Electrical Identification."

3.11 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 - 1. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - 3. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.
 - 4. Energize circuits to electrical equipment and devices.
 - 5. Coordinate with fire-alarm tests. Operate as required.
 - 6. Verify that equipment hose threads are same as local fire-department equipment.
- C. Sprinkler piping system will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

3.12 CLEANING

- A. Clean dirt and debris from sprinklers.
- B. Remove and replace sprinklers with paint other than factory finish.

3.13 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain the system.

3.14 PIPING SCHEDULE

- A. Standard-pressure, wet-pipe sprinkler system, NPS 2 (DN 50) and smaller, shall be one of the following:

1. Standard-weight, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.
 2. Standard-weight black-steel pipe with cut grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
- B. Standard-pressure, wet-pipe sprinkler system, NPS 2-1/2 to NPS 4 (DN 65 to DN 100) shall be one of the following:
1. Standard-weight, black-steel pipe with cut grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
 2. Schedule 10 black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
- C. Standard-pressure, wet-pipe sprinkler system, NPS 5 (DN 125) and larger, shall be one of the following:
1. Standard-weight black-steel pipe with cut grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.
 2. Schedule 10 black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

3.15 SPRINKLER SCHEDULE

- A. Use sprinkler types in subparagraphs below for the following applications:
1. Rooms without Ceilings: Upright sprinklers
 2. Rooms with Suspended Acoustical Tile Ceilings: Concealed plate type sprinklers.
 3. Hard ceilings (gypsum) and soffits: Concealed plate type sprinklers.
 4. Ceilings Painted Black or with Wood Grain: Factory painted flat black concealed plate type sprinklers.
 5. Wall Mounting: Sidewall sprinklers.
 6. Spaces Subject to Freezing: Pendent, dry sprinklers.
 7. Attic Spaces: Upright sprinklers
- B. Provide sprinkler types in subparagraphs below with finishes indicated.
1. Concealed Sprinklers: Rough brass, with factory-painted white cover plate.
 2. Upright Sprinklers: Factory-painted white in finished spaces exposed to view; rough bronze in unfinished spaces not exposed to view. Provide protective cage in mechanical rooms.
 3. White ceilings suspended or hard: Factory painted white concealed plate type.
 4. Ceilings Painted Black or with Wood Grain: Flat black Concealed Plate type sprinklers.
 5. Building exterior: White semi recessed dry sidewall sprinklers where required.
 6. Attic Spaces: Brass Upright Sprinklers

END OF SECTION 211313

SECTION 220500 - COMMON WORK RESULTS FOR PLUMBING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions apply to this Section.
- B. Related Sections:
 - 1. Division 23 Section "Common Work Results for HVAC."

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Piping materials and installation instructions common to most piping systems.
 - 2. Transition fittings.
 - 3. Dielectric fittings.
 - 4. Mechanical sleeve seals.
 - 5. Sleeves.
 - 6. Escutcheons.
 - 7. Equipment installation requirements common to equipment sections.
 - 8. Painting and finishing.
 - 9. Concrete bases.
 - 10. Supports and anchorages.
 - 11. Access panels required for items furnished under Division 22 shall be provided under this Division.
- B. The plumbing contractor is responsible for obtaining the plumbing permit for the project.

1.3 DEFINITIONS

- A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspace, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.
- E. 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.

- a. The following are industry abbreviations for plastic materials:
 - 2. ABS: Acrylonitrile-butadiene-styrene plastic.
 - 3. CPVC: Chlorinated polyvinyl chloride plastic.
 - 4. PVC: Polyvinyl chloride plastic.
- F. The following are industry abbreviations for rubber materials:
 - 1. EPDM: Ethylene-propylene-diene terpolymer rubber.
 - 2. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS

- A. Product Data: For the following:
 - 1. Transition fittings.
 - 2. Mechanical sleeve seals.
 - 3. Escutcheons.
- B. Welding certificates.

1.5 QUALITY ASSURANCE

- A. Electrical Characteristics for Plumbing Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
- B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.7 COORDINATION

- A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for plumbing installations.
- B. Coordinate requirements for access panels and doors for plumbing items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the manufacturers specified.
2. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 PIPE, TUBE, AND FITTINGS

- A. Refer to individual Division 22 piping Sections for pipe, tube, and fitting materials and joining methods.
- B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.3 JOINING MATERIALS

- A. Refer to individual Division 22 piping Sections for special joining materials not listed below.
- B. Solvent Cements for Joining Plastic Piping:
 1. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.

2.4 TRANSITION FITTINGS

- A. AWWA Transition Couplings: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined.
 1. Manufacturers:
 - a. Cascade Waterworks Mfg. Co.
 - b. Dresser Industries, Inc.; DMD Div.
 - c. Ford Meter Box Company, Incorporated (The); Pipe Products Div.
 - d. JCM Industries.
 - e. Smith-Blair, Inc.
 - f. Viking Johnson.
 2. Underground Piping NPS 2 (DN 50) and Larger: AWWA C219, metal sleeve-type coupling.
 3. Aboveground Pressure Piping: Pipe fitting.
- B. Flexible Transition Couplings for 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.
 1. Manufacturers:
 - a. Cascade Waterworks Mfg. Co.
 - b. Fernco, Inc.
 - c. Mission Rubber Company.
 - d. Plastic Oddities, Inc.

2.5 DIELECTRIC FITTINGS

- A. Description: Combination fitting of copper alloy and ferrous materials with threaded, plain, or weld-neck end connections that match piping system materials.
- B. Insulating Material: Suitable for system fluid, pressure, and temperature.
- C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig (1725-kPa) minimum working pressure at 180 deg F (82 deg C).
 - 1. Manufacturers:
 - a. Capitol Manufacturing Co.
 - b. Central Plastics Company.
 - c. Eclipse, Inc.
 - d. Epco Sales, Inc.
 - e. Hart Industries, International, Inc.
 - f. Watts Industries, Inc.; Water Products Div.
 - g. Zurn Industries, Inc.; Wilkins Div.
- D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig (1035- or 2070-kPa) minimum working pressure as required to suit system pressures.
 - 1. Manufacturers:
 - a. Capitol Manufacturing Co.
 - b. Central Plastics Company.
 - c. Epco Sales, Inc.
 - d. Watts Industries, Inc.; Water Products Div.
- E. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig (2070-kPa) minimum working pressure at 225 deg F (107 deg C).
 - 1. Available Manufacturers:
 - a. Calpico, Inc.
 - b. Lochinvar Corp.
- F. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig (2070-kPa) minimum working pressure at 225 deg F (107 deg C).
 - 1. Available Manufacturers:
 - a. Perfection Corp.
 - b. Precision Plumbing Products, Inc.
 - c. Sioux Chief Manufacturing Co., Inc.
 - d. Victaulic Co. of America.

2.6 SLEEVES

- A. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.
- B. PVC Pipe: ASTM D 1785, Schedule 40.

2.7 ESCUTCHEONS

- A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.
- C. One-Piece, Stamped-Steel Type: With set screw or spring clips and chrome-plated finish.

2.8 ACCESS PANELS

- A. Selection and installation of access panels shall be in accordance with Division 08 Section "Access Doors and Frames". Access panels shall be standard panels, 8 in. x 8 in. (305 mm x 305 mm) minimum unless indicated otherwise. Panels installed in areas of high moisture concentration, such as restrooms and locker rooms, shall be fabricated of paintable stainless steel or aluminum for corrosion resistance. Access panels in fire-rated construction shall have the same UL rating as the building assembly in which they are installed.
- B. Provide access panels in building construction where required for access to control valves, tempering valves and other related items

PART 3 - EXECUTION

3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

- A. Install piping according to the following requirements and Division 22 Sections specifying piping systems.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.
- D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- F. Install piping to within 18" of the ceiling to permit valve servicing.
- G. Install piping at indicated slopes.
- H. Install piping free of sags and bends.

- I. Install fittings for changes in direction and branch connections.
- J. Install piping to allow application of insulation.
- K. Select system components with pressure rating equal to or greater than system operating pressure.
- L. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
 - 1. New Piping:
 - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
 - b. Insulated Piping: One-piece, stamped-steel type with spring clips.
 - c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
 - d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
- M. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section "Penetration Firestopping" for materials.
- N. Verify final equipment locations for roughing-in.
- O. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.2 PIPING JOINT CONSTRUCTION

- A. Join pipe and fittings according to the following requirements and Division 22 Sections specifying piping systems.
- B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- D. Plastic Piping Solvent-Cement Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
 - 1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
 - 2. PVC Non-pressure Piping: Join according to ASTM D 2855.

3.3 PIPING CONNECTIONS

- A. Make connections according to the following, unless otherwise indicated:
 - 1. Install unions, in piping NPS 2 (DN 50) and smaller, adjacent to each valve and at final connection to each piece of equipment.

3.4 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

- A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.
- B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.
- C. Install plumbing equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations.
- D. Install equipment to allow right of way for piping installed at required slope.

END OF SECTION 220500

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SECTION 220519 - METERS AND GAGES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Thermometers.
 - 2. Gages.
- B. Related Sections:
 - 1. Division 22 Section "Domestic Water Piping" for domestic and fire-protection water service meters outside the building.
 - 2. Division 22 Section "Domestic Water Piping" for domestic and fire-protection water service meters inside the building.

1.3 DEFINITIONS

- A. CR: Chlorosulfonated polyethylene synthetic rubber.
- B. EPDM: Ethylene-propylene-diene terpolymer rubber.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated; include performance curves.

PART 2 - PRODUCTS

2.1 DIRECT-MOUNTING, LIQUID ACTUATED DIAL THERMOMETERS

- A. Manufacturers: Subject to compliance with requirements., provide products by one of the following
- B. Basis-of-Design Product: Subject to compliance with requirements, provide Trerice, H.O. Co. or comparable product by one of the following:
 - 1. Ashcroft Commercial Instrument Operations; Dresser Industries; Instrument Div.
 - 2. KOBOLD Instruments, Inc.
 - 3. Marsh Bellofram.
 - 4. Trerice, H. O. Co.
 - 5. Weiss Instruments, Inc.
 - 6. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.
- C. Case: Dry type, cast aluminum metal, 6-inch (152-mm) diameter.

- D. Element: Bourdon tube or other type of pressure element.
- E. Movement: Mechanical, connecting element and pointer.
- F. Dial: Satin-faced, nonreflective aluminum with permanently etched scale markings.
- G. Pointer: Black metal.
- H. Window: Glass.
- I. Ring: Metal.
- J. Connector: Adjustable type, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device.
- K. Thermal System: Liquid activated.
- L. Accuracy: Plus or minus 1 percent of range or plus or minus 1 scale division to maximum of 1.5 percent of range.

2.2 THERMOWELLS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- B. Basis-of-Design Product: Subject to compliance with requirements, provide Trerice H.O., Co. or comparable product by one of the following:
 - 1. AMETEK, Inc.; U.S. Gauge Div.
 - 2. Ashcroft Commercial Instrument Operations; Dresser Industries; Instrument Div.
 - 3. Palmer - Wahl Instruments Inc.
 - 4. Trerice, H. O. Co.
 - 5. Weiss Instruments, Inc.
 - 6. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.
- C. Manufacturers: Same as manufacturer of thermometer being used.
- D. Description: Pressure-tight, socket-type metal fitting made for insertion into piping and of type, diameter, and length required to hold thermometer.

2.3 PRESSURE GAGES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- B. Basis-of-Design Product: Subject to compliance with requirements, provide Trerice H.O. Co. product indicated on Drawings or comparable product by one of the following:
 - 1. AMETEK, Inc.; U.S. Gauge Div.
 - 2. Ashcroft Commercial Instrument Operations; Dresser Industries; Instrument Div.
 - 3. Palmer - Wahl Instruments Inc.
 - 4. Trerice, H. O. Co.
 - 5. Weiss Instruments, Inc.
 - 6. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.

- C. Direct-Mounting, Dial-Type Pressure Gages: Indicating-dial type complying with ASME B40.100.
 - 1. Case: Dry type, drawn steel or cast aluminum, 6-inch (152-mm) diameter.
 - 2. Pressure-Element Assembly: Bourdon tube, unless otherwise indicated.
 - 3. Pressure Connection: Brass, NPS 1/4 (DN 8), bottom-outlet type unless back-outlet type is indicated.
 - 4. Movement: Mechanical, with link to pressure element and connection to pointer.
 - 5. Dial: Satin-faced, non-reflective aluminum with permanently etched scale markings.
 - 6. Pointer: Red or other dark-color metal.
 - 7. Window: Glass or plastic .
 - 8. Ring: Metal, Brass or Stainless steel.
 - 9. Accuracy: Grade A, plus or minus 1 percent of middle half scale.
 - 10. Range for Fluids under Pressure: Two times operating pressure.
- D. Pressure-Gage Fittings:
 - 1. Valves: NPS 1/4 (DN 8) brass or stainless-steel needle type.
 - 2. Snubbers: ASME B40.5, NPS 1/4 (DN 8) brass bushing with corrosion-resistant, porous-metal disc of material suitable for system fluid and working pressure.

2.4 TEST PLUGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- B. Basis-of-Design Product: Subject to compliance with requirements, provide Trerice H.O. Co. or comparable product by one of the following:
 - 1. Flow Design, Inc.
 - 2. MG Piping Products Co.
 - 3. National Meter, Inc.
 - 4. Peterson Equipment Co., Inc.
 - 5. Sisco Manufacturing Co.
 - 6. Trerice, H. O. Co.
 - 7. Watts Industries, Inc.; Water Products Div.
- C. Description: Corrosion-resistant brass or stainless-steel body with core inserts and gasketed and threaded cap, with extended stem for units to be installed in insulated piping.
- D. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F (3450 kPa at 93 deg C).
- E. Core Inserts: One or two self-sealing rubber valves.
 - 1. Insert material for water service at 20 to 200 deg F (minus 7 to plus 93 deg C) shall be CR.
 - 2. Insert material for water service at minus 30 to plus 275 deg F (minus 35 to plus 136 deg C) shall be EPDM.

PART 3 - EXECUTION

3.1 THERMOMETER APPLICATIONS

- A. Install thermometers on the inlet and outlet of each domestic, hot-water storage tank.

- B. Provide the following temperature ranges for thermometers:
 - 1. Domestic Hot Water: 30 to 240 deg F, with 2-degree scale divisions (Minus 1 to plus 82 deg C, with 1-degree scale divisions) .
 - 2. Domestic Cold Water: 0 to 100 deg F, with 2-degree scale divisions (Minus 18 to plus 38 deg C, with 1-degree scale divisions) .

3.2 GAGE APPLICATIONS

- A. Install dry-case-type pressure gages for discharge upstream and downstream of each pressure-reducing valve.
- B. Pressure scale: 0 to 100 psi at 2 psi scale divisions.

3.3 INSTALLATIONS

- A. Install direct-mounting thermometers and adjust vertical and tilted positions.
- B. Install remote-mounting dial thermometers on panel, with tubing connecting panel and thermometer bulb supported to prevent kinks. Use minimum tubing length.
- C. Install thermowells with socket extending one-third of diameter of pipe and in vertical position in piping tees where thermometers are indicated.
- D. Install direct-mounting pressure gages in piping tees with pressure gage located on pipe at most readable position.
- E. Install remote-mounting pressure gages on panel.
- F. Install needle-valve and snubber fitting in piping for each pressure gage.
- G. Install test plugs in tees in piping.
- H. Install permanent indicators on walls or brackets in accessible and readable positions.
- I. Install connection fittings for attachment to portable indicators in accessible locations.
- J. Install thermometers and gages adjacent to machines and equipment to allow service and maintenance for thermometers, gages, machines, and equipment.
- K. Adjust faces of thermometers and gages to proper angle for best visibility from the floor.

END OF SECTION 220519

SECTION 220523 - GENERAL-DUTY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Brass ball valves.
 - 2. Brass swing check valves.
- B. Related Sections:
 - 1. Division 22 Section "Identification for Plumbing Piping and Equipment" for valve tags and schedules.

1.3 DEFINITIONS

- A. CWP: Cold working pressure.
- B. EPDM: Ethylene propylene copolymer rubber.
- C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.
- D. NRS: Nonrising stem.
- E. OS&Y: Outside screw and yoke.
- F. RS: Rising stem.
- G. SWP: Steam working pressure.

1.4 SUBMITTALS

- A. Product Data: For each type of valve indicated.

1.5 QUALITY ASSURANCE

- A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
- B. ASME Compliance:
 - 1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
 - 2. ASME B31.1 for power piping valves.
 - 3. ASME B31.9 for building services piping valves.

- C. NSF Compliance: NSF 61 for valve materials for potable-water service.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
 - 1. Protect internal parts against rust and corrosion.
 - 2. Protect threads, flange faces, grooves, and weld ends.
 - 3. Set ball and plug valves open to minimize exposure of functional surfaces.
- B. Use the following precautions during storage:
 - 1. Maintain valve end protection.
 - 2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

- A. Refer to valve schedule articles for applications of valves.
- B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- C. Valve Sizes: Same as upstream piping unless otherwise indicated.
- D. Valves in Insulated Piping: With 2-inch (50-mm) stem extensions and the following features:
 - 1. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
- E. Valve-End Connections:
 - 1. Solder Joint: With sockets according to ASME B16.18.
 - 2. Threaded: With threads according to ASME B1.20.1.
- F. Valve Bypass and Drain Connections: MSS SP-45.

2.2 BRASS BALL VALVES

- A. Two-Piece, Full-Port, Brass Ball Valves with Brass Trim:
 - 1. Manufacturers: Subject to compliance with requirements, provide products from Apollo Valve or one of the following:
 - a. Watts Industries.
 - b. Nibco.
 - 2. Description:
 - a. Standard: MSS SP-110.
 - b. SWP Rating: 150 psig (1035 kPa).
 - c. CWP Rating: 600 psig (4140 kPa).
 - d. Body Design: Two piece.
 - e. Body Material: "Lead Free" Forged brass.

- f. Ends: Threaded.
- g. Seats: PTFE or TFE.
- h. Stem: Brass.
- i. Ball: Chrome-plated brass.
- j. Port: Full.

2.3 BRONZE SWING CHECK VALVES

- A. Class 125, Bronze Swing Check Valves with Bronze Disc:
 - a. Subject to compliance with requirements, provide products from Apollo Valve or one of the following: Watts Industries.
 - b. Nibco.
- 2. Description:
 - a. Standard: MSS SP-80, Type 3.
 - b. CWP Rating: 200 psig (1380 kPa).
 - c. Body Design: Horizontal flow.
 - d. Body Material: "Lead Free" ASTM B 62, bronze.
 - e. Ends: Threaded.
 - f. Disc: Bronze.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- C. Examine threads on valve and mating pipe for form and cleanliness.
- D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- E. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Locate valves for easy access and provide separate support where necessary.
- C. Install valves in horizontal piping with stem at or above center of pipe.
- D. Install valves in position to allow full stem movement.

- E. Install check valves for proper direction of flow and as follows:
 - 1. Swing Check Valves: In horizontal position with hinge pin level.

3.3 ADJUSTING

- A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. If valve applications are not indicated, use the following:
 - 1. Shutoff Service: Ball valves.
 - 2. Throttling Service: Ball valves.
- B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.
- C. Select valves, except wafer types, with the following end connections:
 - 1. For Copper Tubing, NPS 2 (DN 50) and Smaller: Threaded ends except where PropPress option is indicated in valve schedules below.
 - 2. For Copper Tubing, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Flanged ends except where threaded valve-end option is indicated in valve schedules below.

3.5 DOMESTIC, HOT- AND COLD-WATER VALVE SCHEDULE

- A. Pipe NPS 3 and Smaller:
 - 1. Ball Valves: May be provided with ProPress ends instead of threaded ends.
 - 2. Ball Valves: Two piece, full port, brass with bronze trim.
 - 3. Bronze Swing Check Valves: Class 150, bronze disc.

END OF SECTION 220523

SECTION 220529 - HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following hangers and supports for plumbing system piping and equipment:
 - 1. Steel pipe hangers and supports.
 - 2. Copper pipe supports.
- B. Trapeze pipe hangers.
- C. Pipe positioning and acoustical isolation systems.
- D. Equipment supports.

1.3 DEFINITIONS

- A. MSS: Manufacturers Standardization Society for The Valve and Fittings Industry Inc.
- B. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.4 SUBMITTALS

- A. Product Data: For the following:
 - 1. Steel pipe hangers and supports.
 - 2. Copper pipe supports.
 - 3. Pipe positioning and acoustical isolation systems.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

2.2 STEEL PIPE HANGERS AND SUPPORTS

- A. Description: MSS SP-58, Types 1 through 58, factory-fabricated components. Refer to Part 3 "Hanger and Support Applications" Article for where to use specific hanger and support types.

- B. Available Manufacturers:
 - 1. B-Line Systems, Inc.; a division of Cooper Industries.
 - 2. Carpenter & Paterson, Inc.
 - 3. ERICO/Michigan Hanger Co.
 - 4. Grinnell Corp.
- C. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion for support of bearing surface of piping.

2.3 TRAPEZE PIPE HANGERS

- A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural-steel shapes with MSS SP-58 hanger rods, nuts, saddles, and U-bolts.

2.4 METAL FRAMING SYSTEMS

- A. Description: MFMA-3, shop- or field-fabricated pipe-support assembly made of steel channels and other components.
- B. Available Manufacturers:
 - 1. B-Line Systems, Inc.; a division of Cooper Industries.
 - 2. ERICO/Michigan Hanger Co.; ERISTRUT Div.
 - 3. Power-Strut Div.; Tyco International, Ltd.
 - 4. Unistrut Corp.; Tyco International, Ltd.
- C. Coatings: Manufacturer's standard finish unless bare metal surfaces are indicated.

2.5 PIPE POSITIONING AND ACOUSTICAL ISOLATION SYSTEMS

- A. Description: IAPMO PS 42, system of metal brackets, clips, and straps for positioning piping in pipe spaces for plumbing fixtures for commercial applications.
- B. Available Manufacturers:
 - 1. HOLDRITE Corp.; Hubbard Enterprises.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS

- A. Specific hanger and support requirements are specified in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Sections.
- C. Use hangers and supports with galvanized, metallic coatings for piping and equipment that will not have field-applied finish.

- D. Use nonmetallic coatings or copper on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated stationary pipes, NPS 1/2 to NPS 30 (DN 15 to DN 750).
 - 2. Pipe Hangers (MSS Type 5): For suspension of pipes, NPS 1/2 to NPS 4 (DN 15 to DN 100), to allow off-center closure for hanger installation before pipe erection.
- F. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8 (DN 15 to DN 200).
- G. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20 (DN 20 to DN 500).
 - 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20 (DN 20 to DN 500), if longer ends are required for riser clamps.
- H. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joint construction to attach to top flange of structural shape.
 - 2. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
 - 3. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
 - 4. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
- I. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
- J. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.
- K. Use pipe positioning and acoustical isolation systems in walls and pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

3.2 HANGER AND SUPPORT INSTALLATION

- A. Steel Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.
 - 1. Unless specifically noted otherwise piping shall be attached to the top of steel bar joist at panel points, top or bottom of steel beam flanges and sides of wooden beams. Piping shall not be attached to steel decking under any circumstances.

- B. Trapeze Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated trapeze pipe hangers.
 - 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.
 - 2. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D1.1.
- C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled metal framing systems.
- D. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- E. Pipe Positioning and Acoustical Isolation System Installation: Install support devices to make rigid and quiet supply and waste piping connections to each plumbing fixture. Refer to Division 22 Section "Plumbing Fixtures" for plumbing fixtures.
- F. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.
- G. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.9 (for building services piping) are not exceeded.
- H. Insulated Piping: Comply with the following:
 - 1. Attach clamps and spacers to piping.
 - a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
 - b. Do not exceed pipe stress limits according to ASME B31.9 for building services piping.
 - 2. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN 100) and larger if pipe is installed on rollers.
 - 3. Shield Dimensions for Pipe: Not less than the following:
 - a. NPS 1/4 to NPS 3-1/2 (DN 8 to DN 90): 12 inches (305 mm) long and 0.048 inch (1.22 mm) thick.
 - 4. Insert Material: Length at least as long as protective shield.
 - 5. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.3 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers.

3.4 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

END OF SECTION 220529

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SECTION 220553 - IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Equipment labels.
 - 2. Warning signs and labels.
 - 3. Pipe labels.
 - 4. Valve tags.
 - 5. Warning tags.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Samples: For color, letter style, and graphic representation required for each identification material and device.
- C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
- D. Valve numbering scheme.
- E. Valve Schedules: For each piping system to include in maintenance manuals.

1.4 COORDINATION

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

- A. Plastic Labels for Equipment:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch (1.6 mm) thick, and having predrilled holes for attachment hardware.
 2. Letter Color: White.
 3. Background Color: Black.
 4. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).
 5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
 6. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
 7. Fasteners: Stainless-steel self-tapping screws.
 8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), plus the Specification Section number and title where equipment is specified.

2.2 WARNING SIGNS AND LABELS

- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch (1.6 mm).

2.3 PIPE LABELS

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
- B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.
- C. Manufacturer's Labels for Heat Traced Piping may be adhesive type.
- D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings, pipe size, and an arrow indicating flow direction.
1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
 2. Lettering Size: At least 1-1/2 inches (38 mm) high.

2.4 VALVE TAGS

- A. Valve Tags: Stamped or engraved with 1/4-inch (6.4-mm) letters for piping system abbreviation and 1/2-inch (13-mm) numbers.
1. Tag Material: Brass, 0.032-inch (0.8-mm minimum thickness, and having predrilled or stamped holes for attachment hardware.
 2. Fasteners: Brass wire-link or beaded chain; or S-hook .
- B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch (A4) bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve

(room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.

1. Valve-tag schedule shall be included in operation and maintenance data.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.

3.3 PIPE LABEL INSTALLATION

- A. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 1. Near each valve and control device.
 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
 3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
 4. At access doors, manholes, and similar access points that permit view of concealed piping.
 5. Near major equipment items and other points of origination and termination.
 6. Spaced at maximum intervals of 50 feet (15 m) along each run. Reduce intervals to 25 feet (7.6 m) in areas of congested piping and equipment.
 7. "Heat Traced" Labels shall be located every ten feet along each run.
- B. Pipe Label Color Schedule:
 1. Domestic Cold Water Piping:
 - a. Background Color: Green.
 - b. Letter Color: White.
 2. Domestic Hot Water and Hot Water Return Piping:
 - a. Background Color: Yellow.
 - b. Letter Color: Black.
 3. Natural Gas Piping:
 - a. Background Color: Yellow.
 - b. Letter Color: Black.
 4. Storm Drainage Piping:
 - a. Background Color: Green.
 - b. Letter Color: White.
 5. Compressed Air Piping:
 - a. Background Color: Blue.

- b. Letter Color: White.

3.4 VALVE-TAG INSTALLATION

- A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; faucets; convenience and lawn-watering hose connections; and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.
- B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:
 - 1. Valve-Tag Size and Shape:
 - a. Cold Water: 1-1/2 inches (38 mm), round.
 - b. Hot Water: 1-1/2 inches (38 mm), round.
 - c. Natural Gas: 1-1/2 inches (38 mm), round.
 - 2. Valve-Tag Color:
 - a. Cold Water: Natural.
 - b. Hot Water: Natural.
 - c. Natural Gas: Natural.

3.5 WARNING-TAG INSTALLATION

- A. Write required message on, and attach warning tags to, equipment and other items where required.

END OF SECTION 220553

SECTION 220700 - PLUMBING INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Insulation Materials:
 - a. Flexible elastomeric.
 - b. Fiberglass.
 - 2. Tapes.
 - 3. Securements.
 - 4. Corner angles.

1.3 SUBMITTALS

- A. Product Data: For each type of product indicated. Include thermal conductivity, thickness, and jackets (both factory and field applied, if any).
- B. Shop Drawings:
 - 1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
 - 2. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
 - 3. Detail removable insulation at piping specialties, equipment connections, and access panels.
 - 4. Detail field application for each equipment type.
- C. Qualification Data: For qualified Installer.
- D. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.
- E. Field quality-control reports.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

- B. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.
 - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.6 COORDINATION

- A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."
- B. Coordinate clearance requirements with piping Installer for piping insulation application and equipment Installer for equipment insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.
- C. Coordinate installation and testing of heat tracing.

1.7 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

- A. Comply with requirements in Part 3 schedule articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- F. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Aeroflex USA Inc.; Aerocel.
 - b. Armacell LLC; AP Armaflex.
 - c. RBX Corporation; Insul-Sheet 1800 and Insul-Tube 180.
- G. Fiberglass, Preformed Pipe Insulation:
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Johns Manville; Micro-Lok.
 - b. Knauf Insulation; 1000 Pipe Insulation.
 - c. Owens Corning; Fiberglas Pipe Insulation.
 - 2. Type I, 850 deg F (454 deg C) Materials: lass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

2.2 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.
- B. Fiberglass Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Products, Division of ITW; CP-82.
 - b. Foster Products Corporation, H. B. Fuller Company; 85-20.
 - c. ITW TACC, Division of Illinois Tool Works; S-90/80.
 - d. Marathon Industries, Inc.; 225.
 - e. Mon-Eco Industries, Inc.; 22-25.
 - 2. For indoor applications, use adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- C. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Products, Division of ITW; CP-82.
 - b. Foster Products Corporation, H. B. Fuller Company; 85-20.
 - c. ITW TACC, Division of Illinois Tool Works; S-90/80.
 - d. Marathon Industries, Inc.; 225.
 - e. Mon-Eco Industries, Inc.; 22-25.
 - 2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- D. PVC Jacket Adhesive: Compatible with PVC jacket.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Dow Chemical Company (The); 739, Dow Silicone.
 - b. Johns-Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
 - c. P.I.C. Plastics, Inc.; Welding Adhesive.
 - d. Speedline Corporation; Speedline Vinyl Adhesive.

2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.3 SEALANTS

- A. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Products, Division of ITW; CP-76.

2.4 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0835.
 - b. Compac Corp.; 104 and 105.
 - c. Ideal Tape Co., Inc., an American Biltrite Company; 428 AWF ASJ.
 - d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
 2. Width: 3 inches (75 mm).
 3. Thickness: 11.5 mils (0.29 mm).
 4. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
 5. Elongation: 2 percent.
 6. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
 7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
- B. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive. Suitable for indoor and outdoor applications.
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0555.
 - b. Compac Corp.; 130.
 - c. Ideal Tape Co., Inc., an American Biltrite Company; 370 White PVC tape.
 - d. Venture Tape; 1506 CW NS.
 2. Width: 2 inches (50 mm).
 3. Thickness: 6 mils (0.15 mm).
 4. Adhesion: 64 ounces force/inch (0.7 N/mm) in width.
 5. Elongation: 500 percent.
 6. Tensile Strength: 18 lbf/inch (3.3 N/mm) in width.

2.5 CORNER ANGLES

- A. PVC Corner Angles: 30 mils (0.8 mm) thick, minimum 1 by 1 inch (25 by 25 mm), PVC according to ASTM D 1784, Class 16354-C. White or color-coded to match adjacent surface.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.
 - 1. Verify that systems and equipment to be insulated have been tested and are free of defects.
 - 2. Verify that surfaces to be insulated are clean and dry.
 - 3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment and piping including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment and pipe system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Keep insulation materials dry during application and finishing.
- F. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- G. Install insulation with least number of joints practical.
- H. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 - 1. Install insulation continuously through hangers and around anchor attachments.
 - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
 - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.

4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- I. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- J. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- K. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- L. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches (100 mm) beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
- M. For above ambient services, do not install insulation to the following:
 1. Vibration-control devices.
 2. Testing agency labels and stamps.
 3. Nameplates and data plates.
 4. Manholes.
 5. Handholes.
 6. Cleanouts.

3.4 PENETRATIONS

- A. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
 1. Seal penetrations with flashing sealant.
 2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches (50 mm).
 4. Seal jacket to wall flashing with flashing sealant.
- B. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- C. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
 1. Comply with requirements in Division 07 Section "Penetration Firestopping" and fire-resistive joint sealers.
- D. Insulation Installation at Floor Penetrations:
 1. Pipe: Install insulation continuously through floor penetrations.
 2. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 07 Section "Penetration Firestopping".

3.5 GENERAL PIPE INSULATION INSTALLATION

- A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.
- B. Insulation Installation on Fittings, Valves and Unions:
 - 1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.
 - 2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
 - 3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
 - 4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
 - 5. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
 - 6. Stencil or label the outside insulation jacket of each union with the word "UNION." Match size and color of pipe labels.
- C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.
- D. Install removable insulation covers at locations indicated. Installation shall conform to the following:
 - 1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
 - 2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
 - 3. Construct removable valve insulation covers in same manner as for flanges except divide the two-part section on the vertical center line of valve body.

3.6 FIBERGLASS INSULATION INSTALLATION

- A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
 2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
 3. For insulation with factory-applied jackets on above ambient surfaces, secure laps with outward clinched staples at 6 inches (150 mm) o.c.
 4. For insulation with factory-applied jackets on below ambient surfaces, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.
- B. Insulation Installation on Pipe Fittings and Elbows:
1. Not used.
 2. Install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Place PVC cover fitting over the elbow and secure with bands.
- C. Insulation Installation on Valves and Pipe Specialties:
1. Not used.
 2. Install sections of pipe insulation, to a thickness equal to adjoining pipe insulation.
 3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
 4. Install insulation to flanges as specified for flange insulation application.

3.7 FINISHES

- A. All insulated piping located in the mechanical rooms shall be covered and sealed with white PVC jacketing.
- B. All exposed insulated piping within kitchens, custodial closets, coolers and freezers shall be covered and sealed with white PVC jacketing.

3.8 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
1. Inspect field-insulated equipment, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location(s) for each type of equipment defined in the "Equipment Insulation Schedule" Article. For large equipment, remove only a portion adequate to determine compliance.
 2. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.
- C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.9 PIPING INSULATION SCHEDULE, GENERAL

- A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.
- B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
 - 1. Underground piping.

3.10 INDOOR PIPING INSULATION SCHEDULE

- A. Domestic Cold Water:
 - 1. NPS ½ and NPS ¾ : Insulation shall be one of the following:
 - a. Fiberglass, Preformed Pipe Insulation, Type I: 1/2 inch (13 mm) thick.
 - 2. NPS 1 (DN 25) and NPS 1-1/4 (DN 32): Insulation shall be one of the following:
 - a. Fiberglass, Preformed Pipe Insulation, Type I: 1/2 inch (13 mm) thick.
 - 3. NPS 1-1/2 (DN 40) and Larger: Insulation shall be one of the following:
 - a. Fiberglass, Preformed Pipe Insulation, Type I: 1 inch (25 mm) thick.
- B. Domestic Hot Water:
 - 1. NPS 1 (DN 25) and Smaller: Insulation shall be one of the following:
 - a. Fiberglass, Preformed Pipe Insulation, Type I: 1 inch (25 mm) thick.
 - 2. NPS 1-1/4 (DN 32) : Insulation shall be the following:
 - a. Fiberglass, Preformed Pipe Insulation, Type I: 1-1/2 inch (38 mm) thick.
 - 3. NPS 1-1/2 (DN 40) and NPS 2 (DN 50) : Insulation shall be the following:
 - a. Fiberglass, Preformed Pipe Insulation, Type I: 1-1/2 inch (38 mm) thick.
- C. Roof Drain Piping, Roof Drains and Overflow Drain Bodies:
 - 1. All Pipe Sizes: Insulation shall be one of the following:
 - a. Flexible Elastomeric: 1 inch (25 mm) thick.
 - b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch (25 mm) thick.
- D. Roof Drain Piping, Roof Drains Bodies:
 - 1. All Pipe Sizes: Insulation shall be the following:
 - a. Flexible Elastomeric: Two overlapping layers of 1 inch (25 mm) thick.
- E. Condensate Drain Piping, Equipment condensate:
 - 1. All Pipe Sizes: Insulation shall be the following:
 - a. Mineral Fiber: Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch (13 mm) thick.

END OF SECTION 220700

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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 apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Above ground domestic water pipes, tubes, fittings, and specialties inside the building.
 - 2. Copper tube and fittings.
 - 3. PEX tube and fittings.
 - 4. Escutcheons.
 - 5. Sleeves and sleeve seals.

1.3 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF 61 for potable domestic water piping and components.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

- A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.2 COPPER TUBE AND FITTINGS

- A. Hard Copper Tube: ASTM B 88, Type L (ASTM B 88M, Type B) water tube, drawn temper.
 - 1. Cast-Copper Solder-Joint Fittings: ASME B16.18, pressure fittings.
 - 2. Wrought-Copper Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.
 - 3. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces, and threaded ends.
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Elkhart Products Corporation; Industrial Division.
 - 2) NIBCO INC.
- B. Copper Pressure-Seal-Joint Fittings:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by Viega or one of the following:

- a. Viega Pro-Press
 - b. NIBCO INC.
 - c. Apollo
 - d. Pure-Pro
- 2. Fittings for NPS 2 (DN 50) and Smaller: Wrought-copper fitting with EPDM-rubber, O-ring seal in each end.
- 3. Fittings for NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Cast-bronze or wrought-copper fitting with EPDM-rubber, O-ring seal in each end.

2.3 COPPER PIPING JOINING MATERIALS

- A. Pressure-Sealed Joints for Copper Tubing: Join copper tube and pressure-seal fittings with tools recommended by fitting manufacturer.

2.4 PEX TUBE AND FITTINGS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide the following product:
 - 1. Uponor AquaPEX potable water piping and fittings.
- B. Tube Material: PEX-a plastic according to ASTM F 876 and F877 and certified to NSF Standards 14 and 61.
 - 1. Tubing shall be blue color for buried trap primer tubing.
- C. Fittings: ASTM F 1960, ProPEX expansion fittings.

2.5 TRANSITION FITTINGS

- A. General Requirements:
 - 1. Same size as pipes to be joined.
 - 2. Pressure rating at least equal to pipes to be joined.
 - 3. End connections compatible with pipes to be joined.
- B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.

PART 3 - EXECUTION

3.1 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- B. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve, inside the building at each domestic water service entrance.
- C. Install domestic water piping level and plumb.

- D. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
- E. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.
- G. Install piping adjacent to equipment and specialties to allow service and maintenance.
- H. Install piping to permit valve servicing.
- I. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than system pressure rating used in applications below unless otherwise indicated.
- J. Install piping free of sags and bends.
- K. Install fittings for changes in direction and branch connections.

3.2 JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- C. Pressure-Sealed Joints for Copper Tubing: Join copper tube and pressure-seal fittings with tools recommended by fitting manufacturer.

3.3 VALVE INSTALLATION

- A. General-Duty Valves: Comply with requirements in Division 22 Section "General-Duty Valves for Plumbing Piping" for valve installations.
- B. Install shutoff valve close to water main on each branch and riser serving plumbing fixtures or equipment, on each water supply to equipment, and on each water supply to plumbing fixtures that do not have supply stops. Use ball valves for piping NPS 2 (DN 50) and smaller.
- C. Install drain valves for equipment at base of each water riser, at low points in horizontal piping, and where required to drain water piping. Drain valves are specified in Division 22 Section "Domestic Water Piping Specialties."
 - 1. Hose-End Drain Valves: At low points in water mains, risers, and branches.
 - 2. Stop-and-Waste Drain Valves: Instead of hose-end drain valves where indicated.

3.4 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support products and installation.

- B. Support vertical piping and tubing at base and at each floor.
- C. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch (10 mm).
- D. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 3/4 (DN 20) and Smaller: 60 inches (1500 mm) with 3/8-inch (10-mm) rod.
 - 2. NPS 1 and NPS 1-1/4 (DN 25 and DN 32): 72 inches (1800 mm) with 3/8-inch (10-mm) rod.
 - 3. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 96 inches (2400 mm) with 3/8-inch (10-mm) rod.
 - 4. NPS 2-1/2 (DN 65): 108 inches (2700 mm) with 1/2-inch (13-mm) rod.
 - 5. NPS 3 to NPS 5 (DN 80 to DN 125): 10 feet (3 m) with 1/2-inch (13-mm) rod.
 - 6. NPS 6 (DN 150): 10 feet (3 m) with 5/8-inch (16-mm) rod.
 - 7. NPS 8 (DN 200): 10 feet (3 m) with 3/4-inch (19-mm) rod.
- E. Install supports for vertical copper tubing every 10 feet (3 m).
- F. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1-1/4 (DN 32) and Smaller: 84 inches (2100 mm) with 3/8-inch (10-mm) rod.
 - 2. NPS 1-1/2 (DN 40): 108 inches (2700 mm) with 3/8-inch (10-mm) rod.
 - 3. NPS 2 (DN 50): 10 feet (3 m) with 3/8-inch (10-mm) rod.
 - 4. NPS 2-1/2 (DN 65): 11 feet (3.4 m) with 1/2-inch (13-mm) rod.
 - 5. NPS 3 and NPS 3-1/2 (DN 80 and DN 90): 12 feet (3.7 m) with 1/2-inch (13-mm) rod.
 - 6. NPS 4 and NPS 5 (DN 100 and DN 125): 12 feet (3.7 m) with 5/8-inch (16-mm) rod.
 - 7. NPS 6 (DN 150): 12 feet (3.7 m) with 3/4-inch (19-mm) rod.
 - 8. NPS 8 to NPS 12 (DN 200 to DN 300): 12 feet (3.7 m) with 7/8-inch (22-mm) rod.
- G. Install supports for vertical steel piping every 15 feet (4.5 m).

3.5 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment and machines to allow service and maintenance.
- C. Connect domestic water piping to water piping provided by division 33.
 - 1. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:
 - a. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
 - b. Plumbing Fixtures: Cold- and hot-water supply piping in sizes indicated, but not smaller than required by plumbing code. Comply with requirements in Division 22 plumbing fixture Sections for connection sizes.
 - c. Equipment: Cold- and hot-water supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 (DN 65) and larger.

3.6 ESCUTCHEON INSTALLATION

- A. Install escutcheons for penetrations of walls, ceilings, and floors.
- B. Escutcheons for New Piping:
 - 1. Piping with Fitting or Sleeve Protruding from Wall: One piece, deep pattern.
 - 2. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish.
 - 3. Bare Piping at Ceiling Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish.
- C. Escutcheons for Existing Piping:
 - 1. Chrome-Plated Piping: Split casting, cast brass with chrome-plated finish.
 - 2. Insulated Piping: Split plate, stamped steel with concealed hinge and spring clips.

3.7 IDENTIFICATION

- A. Identify system components. Comply with requirements in Division 22 Section "Identification for Plumbing Piping and Equipment" for identification materials and installation.
- B. Label pressure piping with system operating pressure.

3.8 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Piping Inspections:
 - 1. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
 - 2. During installation, notify authorities having jurisdiction at least one day 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 final inspection for 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 tests or inspections, make required corrections and arrange for reinspection.
 - 4. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- C. Piping Tests:
 - 1. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
 - 2. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
 - 3. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.

4. Cap and subject piping to static water pressure of 50 psig (345 kPa) 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.
 5. Repair leaks and defects with new materials and retest piping or portion thereof until satisfactory results are obtained.
 6. Prepare reports for tests and for corrective action required.
- D. Domestic water piping will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

3.9 ADJUSTING

- A. Perform the following adjustments before operation:
1. Close drain valves, hydrants, and hose bibbs.
 2. Open shutoff valves to fully open position.
 3. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
 4. Remove and clean strainer screens. Close drain valves and replace drain plugs.
 5. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
 6. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.10 CLEANING

- A. Clean and disinfect potable domestic water piping as follows:
1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
 2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:
 - a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
 - b. Fill and isolate system according to either of the following:
 - 1) Fill system or part thereof with water/chlorine solution with at least 50 ppm (50 mg/L) of chlorine. Isolate with valves and allow to stand for 24 hours.
 - 2) Fill system or part thereof with water/chlorine solution with at least 200 ppm (200 mg/L) of chlorine. Isolate and allow to stand for three hours.
 - c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
 - d. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.
- B. Prepare and submit reports of purging and disinfecting activities.
- C. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.11 PIPING SCHEDULE

- A. Aboveground domestic water piping, NPS 2 and smaller, shall be one of the following:

1. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B); cast-copper pressure-seal joints.

3.12 VALVE SCHEDULE

- A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
 1. Shutoff Duty: Use ball valves for piping NPS 2" and smaller.
 2. Drain Duty: Hose-end drain valves.
- B. Use check valves to maintain correct direction of domestic water flow to and from equipment.

END OF SECTION 221116

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SECTION 221119 - DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following domestic water piping specialties:
 - 1. Water Meters.
 - 2. Vacuum breakers.
 - 3. Backflow preventers.
 - 4. Digital Thermostatic water mixing valves.
 - 5. Thermostatic Hot Water Recirculation Valves
 - 6. Strainers.
 - 7. Outlet boxes.
 - 8. Hose bibbs.
 - 9. Wall hydrants.
 - 10. Drain valves.
 - 11. Dishwasher air-gap fittings.
 - 12. Water hammer arresters.
 - 13. Trap-seal primer valves.
- B. Related Sections include the following:
 - 1. Division 22 Section "Meters and Gages for Plumbing Piping" for thermometers, pressure gages, and flow meters in domestic water piping.
 - 2. Division 22 Section "Domestic Water Piping" for water meters.

1.3 PERFORMANCE REQUIREMENTS

- A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig (860 kPa), unless otherwise indicated.

1.4 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Field quality-control test reports.
- C. Operation and Maintenance Data: For domestic water piping specialties to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. NSF Compliance:
 - 1. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic domestic water piping components.
 - 2. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 01 through 09."

PART 2 - PRODUCTS

2.1 WATER METERS

- A. Water Meters: Purchased through the Water Utility.
 - 1. Manufacturers:
 - a. Coordinated with utility.
 - 2. Description:
 - a. Standard: AWWA C700.
 - b. Pressure Rating: 150-psig (1035-kPa) working pressure.
 - c. Body Design: Nutating disc; totalization meter.
 - d. Registration: In gallons (liters) or cubic feet (cubic meters) as required by utility.
 - e. Remote read type: Required.
 - f. Case: Bronze.
 - g. End Connections: Flanged.

2.2 VACUUM BREAKERS

- A. Pipe-Applied, Atmospheric-Type Vacuum Breakers:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Ames Co.
 - b. FEBCO; SPX Valves & Controls.
 - c. Watts Industries, Inc.; Water Products Div.
 - d. Zurn Plumbing Products Group; Wilkins Div.
 - 2. Standard: ASSE 1001.
 - 3. Size: NPS 1/4 to NPS 3 (DN 8 to DN 80), as required to match connected piping.
 - 4. Body: Bronze.
 - 5. Inlet and Outlet Connections: Threaded.
 - 6. Finish: Rough bronze.

2.3 BACKFLOW PREVENTERS

- A. Main water Service Entrance: Reduced-Pressure-Principle Backflow Preventers:
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Watts or a comparable product by one of the following:
 - a. Watts Industries, Inc.; Water Products Div.

- b. Ames Co.
 - c. FEBCO; SPX Valves & Controls.
 - d. Zurn Plumbing Products Group; Wilkins Div.
 - 2. Standard: ASSE 1013.
 - 3. Operation: Continuous-pressure applications.
 - 4. Water Entrance Size: (2) 2" NPS (DN).
 - 5. Design Flow Rate: 75 gpm (L/s).
 - 6. Pressure Loss at Design Flow Rate: 12 psig.
 - 7. Body: Bronze.
 - 8. End Connections: Threaded for NPS 2 (DN 50) and smaller.
 - 9. Configuration: Designed for horizontal, straight through flow.
 - 10. Valves: Ball Valves.
 - 11. Relief Valve: stainless steel seat and trim
 - 12. Test Cocks: Lead Free bronze body ball valve.
- B. Mechanical Service Connection: Reduced-Pressure-Principle Backflow Preventer:
- 1. Basis-of-Design Product: Subject to compliance with requirements, provide Watts, or a comparable product by one of the following:
 - a. Watts Industries, Inc.; Water Products Div.
 - b. Ames Co.
 - c. FEBCO; SPX Valves & Controls.
 - d. Zurn Plumbing Products Group; Wilkins Div.
 - 2. Standard: ASSE 1013.
 - 3. Operation: Continuous-pressure applications.
 - 4. Size: 3/4" NPS (DN).
 - 5. Design Flow Rate: 1 gpm.
 - 6. Pressure Loss at Design Flow Rate: 15 psig.
 - 7. Body: Bronze.
 - 8. End Connections: Threaded for NPS 2 (DN 50) and smaller.
 - 9. Configuration: Designed for horizontal, straight through flow.
 - 10. Valves: Ball Valves.
 - 11. Relief Valve: stainless steel seat and trim
 - 12. Test Cocks: Lead Free bronze body ball valve.

2.4 STRAINERS FOR DOMESTIC WATER PIPING

- A. Y-Pattern Strainers:
- 1. Pressure Rating: 125 psig (860 kPa) minimum, unless otherwise indicated.
 - 2. Body: Lead-Free Bronze for NPS 2 (DN 50) and smaller; cast iron with interior lining complying with AWWA C550 for NPS 2-1/2 (DN 65) and larger.
 - 3. End Connections: Threaded for NPS 2 (DN 50) and smaller; flanged for NPS 2-1/2 (DN 65) and larger.
 - 4. Screen: Stainless steel with round perforations, unless otherwise indicated.
 - 5. Perforation Size:
 - a. Strainers NPS 2 (DN 50) and Smaller: 0.020 inch (0.51 mm) .
 - b. Strainers NPS 2-1/2 to NPS 4 (DN 65 to DN 100): 0.045 inch (1.14 mm) .
 - 6. Drain: Factory-installed, hose-end drain valve.

2.5 OUTLET BOXES

A. Dishwasher OB-1:

1. Manufacturers: Subject to compliance with requirements, provide products by Oatey or one of the following:
 - a. Acorn Engineering Company.
 - b. Sioux Chief.
2. Mounting: Recessed.
3. Material and Finish: Plastic box and semi-cover faceplate.
4. Faucet: Valved fitting complying with ASME A112.18.1. Include NPS 1/2 (DN 15) or smaller copper tube outlet.
5. Supply Shutoff Fitting: Supply Shutoff Fitting: NPS 1/2 (DN 15) independent ball valve with integral hammer arrestor on valve and NPS 1/2 (DN 15) copper, water tubing.
6. Drain: N/A

2.6 HOSE BIBBS

A. Hose Bibbs in Mechanical Rooms:

1. Basis-of-Design Product: Subject to compliance with requirements, provide a comparable product by one of the following: Chicago Faucet.
2. Standard: ASME A112.18.1 for sediment faucets.
3. Body Material: Polished Chrome.
4. Seat: Slow Compression, replaceable.
5. Supply Connections: NPS 1/2 threaded or solder-joint inlet.
6. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.
7. Pressure Rating: 125 psig (860 kPa).
8. Vacuum Breaker: Integral nonremovable, drainable, hose-connection vacuum breaker complying with ASSE 1011.
9. Finish for Equipment Rooms: Chrome plated.
10. Finish for Service Areas: Chrome plated.
11. Finish for Finished Rooms: Chrome plated.
12. Operation for Equipment Rooms: Operating key.
13. Operation for Service Areas: Operating key.
14. Operation for Finished Rooms: Operating key.
15. Include operating key with each operating-key hose bibb.

B. Include wall flange with each chrome-plated hose bibb.

2.7 WALL HYDRANTS

A. Non-freeze Wall Hydrants WH-1:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Josam Company.
 - b. MIFAB, Inc.
 - c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - d. Tyler Pipe; Wade Div.
 - e. Watts Drainage Products Inc.

- f. Woodford Manufacturing Company.
 - g. Zurn Plumbing Products Group; Specification Drainage Operation.
- 3. Standard: ASME A112.21.3M for concealed -outlet, self-draining wall hydrants.
- 4. Pressure Rating: 125 psig (860 kPa).
- 5. Operation: Loose key.
- 6. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
- 7. Inlet: NPS 3/4.
- 8. Outlet: Concealed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
- 9. Box: Deep, flush mounting with cover.
- 10. Box and Cover Finish: Polished nickel bronze.
- 11. Outlet: Exposed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
- 12. Nozzle and Wall-Plate Finish: Polished nickel bronze.
- 13. Operating Keys(s): One with each wall hydrant.

2.8 DRAIN VALVES

- A. Ball-Valve-Type, Hose-End Drain Valves:
 - 1. Standard: MSS SP-110 for standard-port, two-piece ball valves.
 - 2. Pressure Rating: 400-psig (2760-kPa) minimum CWP.
 - 3. Size: NPS 3/4 (DN 20).
 - 4. Body: Copper alloy.
 - 5. Ball: Chrome-plated brass.
 - 6. Seats and Seals: Replaceable.
 - 7. Handle: Vinyl-covered steel.
 - 8. Inlet: Threaded or solder joint.
 - 9. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

2.9 WATER HAMMER ARRESTERS

- A. Water Hammer Arresters:
 - 1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 2. Manufacturers: Subject to compliance with requirements, provide products by Sioux Chief or one of the following:
 - a. Oatey
 - b. PPP Inc
 - c. Watts Drainage Products Inc.
 - d. Zurn Plumbing Products Group; Specification Drainage Operation.
 - 3. Standard: ASSE 1010 or PDI-WH 201.
 - 4. Type: Copper tube with piston.
 - 5. Size: ASSE 1010, Sizes AA and A through F or PDI-WH 201, Sizes A through F.

2.10 TRAP-SEAL PRIMER SYSTEMS

- A. Recessed Trap Seal Primer

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
2. Basis-of-Design Product: Mifab.
 - a. PPP Inc.
 - b. Zurn Plumbing Products Group.
3. Standard: ASSE 1044,
4. Piping: NPS 3/4, ASTM B 88, Type L (DN 20, ASTM B 88M, Type B); copper, water tubing.
5. Cabinet: Flush-mounting 16 gauge galvanized steel box with stainless-steel cover with integral trap primer, timer control, manual switch.
6. Electric Controls: 24-hour timer, solenoid valve, and manual switch for 120-V ac power.
7. Vacuum Breaker: ASSE 1001.
8. Size inlet: 1/2".
9. Size Outlets: NPS 1/2 (DN 15).
10. Number of outlets: 5 or 10 as scheduled on the drawings.
11. Operation: Set to operate once per 24 hour period.

2.11 PRESSURE REDUCING VALVE

- A. Pressure Reducing Valve:
 1. Manufacturers: Subject to compliance with requirements, provide products by Watts or one of the following:
 2. Basis-of-Design Product: Watts, with integral union, strainer and pressure gauge.
 - a. Watts
 - b. Wilkins.
 3. Standard: ASSE 1003,
 4. Pressure Setting: 70 psi.
 5. Inlet/Outlet Size: NPS 1".

2.12 THERMOSTATIC WATER MIXING VALVES

- A. Digital Thermostatic, Water-Mixing-Valve Assembly TV-1:
 1. Acceptable Manufacturers:
 - a. Powers
 - b. Leonard
 - c. Armstrong "Brain"
 2. Basis-of-Design Product: Subject to compliance with requirements, provide Powers, Lead Free Digital Thermostatic Mixing Valve.
 3. Description: Factory-fabricated pre-assembled with all components. Fully configurable controller.
 4. 3.5" full color user-selectable touch screen display.
 5. User programmable high temperature alarm.
 6. Settings can be adjusted/monitored at the controller or remotely through BAS (Building Automation System).
 7. In case of power or cold water failure, valve flows full cold for safety with manual override feature to set mixed outlet temperature.
 8. Provide thermometers on the inlets and outlet of the mixing valve.
 9. Water Regulator(s): Comply with ASSE 1003. Include pressure gage on inlet and outlet.
 10. Component Pressure Ratings: 200 psig (860 kPa) maximum, unless otherwise indicated.
 11. Tempered-Water Setting: 120 deg F.

12. Unit Tempered-Water Design Flow Rate: 34.1 gpm.
13. Unit Minimum Tempered-Water Design Flow Rate: 3.0 gpm (Must be ASSE 1017 Rated flow with constant recirculation).
14. Unit Pressure Drop at Design Flow Rate: 5 psig.
15. Unit Tempered-Water Outlet Size: 3/4" NPS end connection.
16. Unit Hot- and Cold-Water Inlet Size: 3/4" NPS end connections.
- 17.

2.13 THERMOSTATIC HOT WATER TEMPERATURE BALANCING VALVES "TFC"

- A. Basis of Design: Provide Therm-Omega-Tech, Inc., "Circuit Solver" self-adjusting thermostatic balancing valve.
- B. Description: The valve shall regulate the flow of recirculated domestic hot water based on water temperature regardless of system operating pressure. Even when fully closed the shall bypass a small amount hot water to maintain dynamic control of the recirculating loop. The body and all internal components shall be constructed of stainless steel with major components constructed of type 303 stainless steel. Sizes 1/2 inch through 2 inch shall be rated to 200 PSIG maximum working pressure. All shall be standard tapered female pipe thread, NPT. All shall be rated to 300° F (148.9°C) maximum working temperature. All shall be NSF-61 certified for use in all domestic water systems. Thermal actuator shall be spring loaded and self cleaning, delivering closing thrust sufficient to keep orifice opening free of scale deposits. Installation of shall be made by qualified tradesmen. Install in each domestic hot water return piping branch beyond last hot water device in that branch.
- C. Capacities:
 1. 1/2" size capable of 2.9 gpm at 5 psi differential.
 2. 3/4" size capable of 4.0 gpm at 5 psi differential.
 3. 1" size capable of 7.4 gpm at 5 psi differential.
 4. 1-1/4" size capable of 11.4 gpm at 5 psi differential.
 5. 1-1/2" size capable of 17.0 gpm at 5 psi differential.
 6. 2" size capable of 31.8 gpm at 5 psi differential.
- D. Temperature: Unit shall be factory set to maintain 115° f.
- E. Features to be provided:
 1. Unions.
 2. Strainer
 3. Themometer
 4. Check Valve
 5. ProPress ends.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Refer to Division 22 Section "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.

- B. Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.
 - 1. Locate backflow preventers in same room as connected equipment or system.
 - 2. Backflow preventers shall be accessible from a standing position on the floor.
 - 3. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe to floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are not acceptable for this application.
 - 4. Do not install bypass piping around backflow preventers.
- C. Install water control valves with inlet and outlet shutoff valves. Install pressure gages on inlet and outlet.
- D. Install balancing valves in locations where they can easily be adjusted.
- E. Install temperature-actuated water mixing valves with check stops or shutoff valves on inlets and with shutoff valve on outlet.
 - 1. Install thermometers and water regulators if specified.
 - 2. Install cabinet-type units recessed in or surface mounted on wall as specified.
- F. Install outlet boxes recessed in wall. Install 2-by-4-inch (38-by-89-mm) fire-retardant-treated-wood blocking wall reinforcement between studs. Fire-retardant-treated-wood blocking is specified in Division 06 Section "Rough Carpentry."
- G. Install water hammer arresters in water piping according to PDI-WH 201.
- H. Install supply-type, trap-seal primer valves with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust valve for proper flow
- I. Install drainage-type, trap-seal primer valves as lavatory trap or flushometer with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting.
- J. Install trap-seal primer systems with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust system for proper flow.

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping and specialties.
- B. Ground equipment according to Division 26 Section "Grounding and Bonding."
- C. Connect wiring according to Division 26.

3.3 LABELING AND IDENTIFYING

- A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:
 - 1. Primary, thermostatic, water mixing valves.
 - 2. Primary water tempering valves.
 - 3. Trap-seal primer systems.
- B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Division 22 Section "Identification for Plumbing Piping and Equipment."

3.4 FIELD QUALITY CONTROL

- A. Perform the following tests and prepare test reports:
 - 1. Test each reduced-pressure-principle backflow preventer according to authorities having jurisdiction and the device's reference standard.
- B. Remove and replace malfunctioning domestic water piping specialties and retest as specified above.

3.5 ADJUSTING

- A. Set field-adjustable pressure set points of water pressure-reducing valves.
- B. Set field-adjustable temperature set points of temperature-actuated water mixing valves.

END OF SECTION 221119

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SECTION 221123 - DOMESTIC WATER PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Close-coupled, in-line, seal-less centrifugal domestic Hot Water Recirculation pumps.

1.3 SUBMITTALS

- A. Product Data: For each type and size of domestic water pump specified. Include certified performance curves with operating points plotted on curves; and rated capacities of selected models, furnished specialties, and accessories.
- B. Shop Drawings: Diagram power, signal, and control wiring.
- C. Operation and Maintenance Data: For domestic water pumps to include in emergency, operation, and maintenance manuals.

1.4 REFERENCE STANDARDS

- A. The work in this section is subject to the requirements of applicable portions of the following standards:
 - 1. Hydraulic Institute
 - 2. ANSI – American National Standards Institute
 - 3. ASTM – American Society for Testing and Materials
 - 4. IEEE – Institute of Electrical and Electronics Engineers
 - 5. NEMA – National Electrical Manufacturers Association
 - 6. NEC – National Electrical Code
 - 7. ISO – International Standards Organization
 - 8. UL – Underwriters Laboratories, Inc.

1.5 QUALITY ASSURANCE

- A. Product Options: Drawings indicate size, profiles, and dimensional requirements of domestic water pumps and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. UL Compliance: Comply with UL 778 for motor-operated water pumps.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Retain shipping flange protective covers and protective coatings during storage.
- B. Protect bearings and couplings against damage.
- C. Comply with pump manufacturer's written rigging instructions for handling.

1.7 COORDINATION

- A. Coordinate size and location of concrete bases. See drawings.

PART 2 - PRODUCTS

2.1 CLOSE COUPLED, IN-LINE, SEALLESS CENTRIFUGAL PUMPS FOR DOMESTIC HOT WATER RECIRCULATION

- A. Manufacturers:
 - 1. Grundfos
 - 2. Bell and Gossett.
 - 3. Taco
- B. Description DCP-1: Lead Free, NSF-61 certified for potable use, Factory-assembled and -tested, single-stage, close-coupled, in-line, sealless centrifugal pumps as defined in HI 5.1-5.6.
 - 1. Pump and Motor Assembly: Hermetically sealed, replaceable-cartridge-type unit with motor and impeller on common shaft and designed for installation with pump and motor shaft mounted horizontally.
 - 2. Casing: Stainless Steel, with threaded companion-flange connections.
 - 3. Impeller: Corrosion-resistant material.
 - 4. Motor: Variable speed.
 - 5. Mode: Set to maintain constant pressure.
- C. Capacities and Characteristics:
 - 1. Capacity: 7 gpm.
 - 2. Total Dynamic Head: 21 feet head
 - 3. Maximum Operating Pressure: 145 psig.
 - 4. Maximum Continuous Operating Temperature: 230 deg F.
 - 5. Inlet and Outlet Size: 3/4".
 - 6. Electrical Characteristics:
 - a. Volts: 120.
 - b. Phases: Single.
 - c. Hertz: 60 hz
 - d. H.P.: 1/4.
- D. BUILDING-AUTOMATION-SYSTEM INTERFACE
 - 1. Provide auxiliary contacts in pump controllers for interface to building automation system. Include the following:
 - a. Run status of each pump.
 - b. Alarm status.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in of domestic-water-piping system to verify actual locations of connections before pump installation.

3.2 PUMP INSTALLATION

- A. Comply with HI 1.4.
- B. Install pumps with access for periodic maintenance including removal of motors, impellers, couplings, and accessories.
- C. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.
- D. Install vertical in-line pumps on concrete bases. Install pumps with motor and pump shafts vertical.

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to pumps to allow service and maintenance.
- C. Connect domestic water piping to pumps. Install suction and discharge piping equal to or greater than size of pump nozzles. Refer to Division 22 Section "Domestic Water Piping."
 - 1. Install shutoff valve and strainer on suction side of pumps, and check valve and throttling valve on discharge side of pumps. Install valves same size as connected piping. Refer to Division 22 Section "General-Duty Valves for Plumbing Piping" for general-duty valves for domestic water piping.
 - 2. Install pressure gages at suction and discharge of pumps. Install at integral pressure-gage tappings where provided or install pressure-gage connectors in suction and discharge piping around pumps. Refer to Division 22 Section "Meters and Gages for Plumbing Piping" for pressure gages and gage connectors.
- D. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
- E. Connect wiring according to Division 26.

3.4 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.
 - 2. Check piping connections for tightness.
 - 3. Set automated controls for automatic starting and stopping operation of pumps.
 - 4. Perform the following startup checks for each pump before starting:

- a. Verify that pump is free to rotate by hand. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
 - b. Verify that pump is rotating in the correct direction.
5. Prime pump by opening suction valves and closing drains, and prepare pump for operation.
6. Start motor.
7. Open discharge valve slowly.

3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain controls and pumps. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 221123

SECTION 221316 - SANITARY WASTE, VENT AND CONDENSATE PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following for soil, waste, sanitary vent piping inside the building including vents through the roof:
 - 1. Pipe, tube, and fittings.
 - 2. Special pipe fittings.

1.3 DEFINITIONS

- A. ABS: Acrylonitrile-butadiene-styrene plastic.
- B. PVC: Polyvinyl chloride plastic.

1.4 PERFORMANCE REQUIREMENTS

- A. Components and installation shall be capable of withstanding the following minimum working pressure, unless otherwise indicated:
- B. Soil, Waste, and Vent Piping: 10-foot head of water 30 kPa or 5 psi.

1.5 SUBMITTALS

- A. Product Data: For pipe, tube, fittings, and couplings.
- B. Field quality-control inspection and test reports.

1.6 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-DWV" for plastic drain, waste, and vent piping; "NSF-drain" for plastic drain piping; "NSF-tubular" for plastic continuous waste piping; and "NSF-sewer" for plastic sewer piping.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 PIPING MATERIALS

- A. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.

2.3 PVC PIPE AND FITTINGS

- A. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.
 - 1. PVC Socket Fittings: ASTM D 2665, socket type, made to ASTM D 3311, drain, waste, and vent patterns.
- B. Solvent Cement and Adhesive Primer:
 - 1. Use PVC solvent cement that has a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 2. Use adhesive primer that has a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.4 PEX TUBE AND FITTINGS FOR TRAP PRIMER DRAINS

- A. PEX Distribution System: ASTM F 877, SDR 9 tubing.
 - 1. Fittings for PEX Tube: ASTM F 1807, metal-insert type with copper or stainless-steel crimp rings and matching PEX tube dimensions

2.5 CONDENSATE PIPING

- A. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.
 - 1. PVC Socket Fittings: ASTM D 2665, socket type, made to ASTM D 3311, drain, waste, and vent patterns.
- B. Solvent Cement and Adhesive Primer:
 - 1. Use PVC solvent cement that has a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 - 2. Use adhesive primer that has a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

PART 3 - EXECUTION

3.1 EXCAVATION

- A. Refer to Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.

3.2 PIPING APPLICATIONS

- A. Aboveground, soil and waste piping shall be the following:
 - 1. Solid-wall PVC DWV pipe, PVC socket fittings, and solvent-cemented joints.
- B. Underground, soil, waste, and vent piping shall be the following:
 - 1. Solid-wall PVC DWV pipe, PVC socket fittings, and solvent-cemented joints.
- C. Condensate Waste Piping: PVC Schedule 40 pipe, PVC socket fittings, and solvent-cemented joints.

3.3 PIPING INSTALLATION

- A. Basic piping installation requirements are specified in Division 22 Section "Common Work Results for Plumbing."
- B. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers.
- C. Install cleanout fitting with closure plug inside the building in sanitary force-main piping.
- D. Install wall-penetration fitting at each service pipe penetration through foundation wall. Make installation watertight.
- E. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if 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.
- F. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.
- G. Install soil and waste drainage and vent piping at the following minimum slopes, unless otherwise indicated:
 - 1. Horizontal Sanitary Drainage Piping: 2 percent downward in direction of flow for piping NPS 3 (DN 80) and smaller; 2 percent downward in direction of flow for piping NPS 4 (DN 100) and larger.

2. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.

H. Install PVC soil and waste drainage and vent piping according to ASTM D 2665.

I. Install underground PVC soil and waste drainage piping according to ASTM D 2321.

J. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

3.4 JOINT CONSTRUCTION

A. Basic piping joint construction requirements are specified in Division 22 Section "Common Work Results for Plumbing."

B. PVC Non-pressure Piping Joints: Join piping according to ASTM D 2665.

3.5 HANGER AND SUPPORT INSTALLATION

A. Pipe hangers and supports are specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment." Install the following:

1. Vertical Piping: MSS Type 8 or Type 42, clamps.
2. Install individual, straight, horizontal piping runs according to the following:

B. Install supports according to Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."

C. Support vertical piping and tubing at base and at each floor.

D. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch (10-mm) minimum rods.

E. Maximum spans below were taken from MSS SP-69 for water service and from model plumbing codes. Most restrictive piping and spacing dimensions are shown.

F. Install hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 48 inches (1200 mm) with 3/8-inch (10-mm) rod.
2. NPS 3 (DN 80): 48 inches (1200 mm) with 1/2-inch (13-mm) rod.
3. NPS 4 and 5 (DN 100 and 125): 48 inches (1200 mm) with 5/8-inch (16-mm) rod.
4. NPS 6 (DN 150): 48 inches (1200 mm) with 3/4-inch (19-mm) rod.

G. Install supports for vertical PVC piping every 48 inches (1200 mm).

H. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.6 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

- B. Connect drainage and vent piping to the following:
 - 1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.
 - 2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
 - 3. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.

3.7 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. Re-inspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
- C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- D. Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
 - 1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
 - 2. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 - 3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping, except outside leaders, on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water (30 kPa). From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.
 - 4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg (250 Pa). Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.
 - 5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
 - 6. Prepare reports for tests and required corrective action.

3.8 CLEANING

- 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 221319 - SANITARY WASTE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following sanitary drainage piping specialties:
 - 1. Cleanouts.
 - 2. Floor Drains
 - 3. Floor Sinks
- B. Related Sections include the following:
 - 1. Division 22 Section "Plumbing Fixtures".

PART 2 - PRODUCTS

2.1 CLEANOUTS

- A. Metal Floor Cleanouts FCO-1 & FCO-2:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 2. Basis-of-Design Product: Subject to compliance with requirements, provide product by Watts or one of the following:
 - a. Josam Company; Josam Div.
 - b. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - c. Watts Drainage Products Inc.
 - d. Zurn Plumbing Products Group; Specification Drainage Operation.
 - 3. Standard: ASME A112.36.2M for threaded, adjustable housing cleanout.
 - 4. Size: Same as connected branch.
 - 5. Type: Threaded, adjustable housing.
 - 6. Body or Ferrule: Cast iron.
 - 7. Clamping Device: Not required.
 - 8. Outlet Connection: Inside caulk.
 - 9. Closure: Plastic plug.
 - 10. Adjustable Housing Material: Cast iron with threads.
 - 11. Frame and Cover Material and Finish: Stainless Steel.
 - 12. Frame and Cover Shape:
 - a. FCO: Round, Heavy Duty.
 - 13. Cover type:
 - a. FCO: Flat stainless steel.
 - 14. Riser: ASTM A 74, Service class, cast-iron drainage pipe fitting and riser to cleanout.
 - 15. Standard: ASME A112.3.1.

16. Size: Same as connected branch.
17. Coordinate cleanout top design with floor surface.

B. Wall Cleanouts

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
2. Basis-of-Design Product: Subject to compliance with requirements, provide Watts CO-590-RD or a comparable product by one of the following:
 - a. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - b. Watts Drainage Products Inc.
 - c. Zurn Plumbing Products Group; Specification Drainage Operation.
3. Standard: ASME A112.36.2M. Include wall access.
4. Size: Same as connected drainage piping.
5. Body: Brass plug with stainless steel round cover plate.
6. Closure: Countersunk plug.
7. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
8. Wall Access: Round, stainless-steel cover plate with screw.

C. Access Doors for cleanout plugs:

2.2 FLOOR DRAINS

A. Floor Drains FD-1:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Watts or a comparable product by one of the following:
 - a. Josam Company; Josam Div.
 - b. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - c. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASME A112.6.3
3. Pattern: Floor drain.
4. Body Material: Gray iron.
5. Seepage Flange: Required.
6. Anchor Flange: Required.
7. Outlet: Bottom.
8. Backwater Valve: Not required.
9. Coating on Interior and Exposed Exterior Surfaces: Not required.
10. Sediment Bucket: Not required.
11. Top or Strainer Material: Stainless Steel.
12. Top of Body and Strainer Finish: Stainless Steel.
13. Top Shape: 6" Round.
14. Dimensions of Top or Strainer: Round, size as scheduled.
15. Top Loading Classification: Heavy Duty
16. Funnel: Not required.
17. Inlet Fitting: Not required.
18. Trap Material: PVC.
19. Trap Pattern: Standard P-trap.
20. Drain Tailpiece Features: Trap-seal primer valve drain connection.

B. Floor Drains FD-2:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Watts or a comparable product by one of the following:

- a. Josam Company; Josam Div.
 - b. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - c. Zurn Plumbing Products Group; Specification Drainage Operation.
 - 2. Standard: ASME A112.6.3
 - 3. Pattern: Floor drain.
 - 4. Body Material: Gray iron.
 - 5. Seepage Flange: Required.
 - 6. Anchor Flange: Required.
 - 7. Outlet: Bottom.
 - 8. Backwater Valve: Not required.
 - 9. Coating on Interior and Exposed Exterior Surfaces: Not required.
 - 10. Sediment Bucket: Not required.
 - 11. Top or Strainer Material: Stainless Steel.
 - 12. Top of Body and Strainer Finish: Stainless Steel.
 - 13. Top Shape: 8" Round.
 - 14. Dimensions of Top or Strainer: Round, size as scheduled.
 - 15. Top Loading Classification: Heavy Duty
 - 16. Funnel: Not required.
 - 17. Inlet Fitting: Not required.
 - 18. Trap Material: PVC.
 - 19. Trap Pattern: Standard P-trap.
 - 20. Drain Tailpiece Features: Trap-seal primer valve drain connection.
- C. Floor Drains FD-3:
- 1. Basis-of-Design Product: Subject to compliance with requirements, provide Watts or a comparable product by one of the following:
 - a. Josam Company; Josam Div.
 - b. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - c. Zurn Plumbing Products Group; Specification Drainage Operation.
 - 2. Standard: ASME A112.6.3
 - 3. Pattern: Floor drain.
 - 4. Body Material: Gray iron.
 - 5. Seepage Flange: Required.
 - 6. Anchor Flange: Required.
 - 7. Outlet: Bottom.
 - 8. Backwater Valve: Not required.
 - 9. Coating on Interior and Exposed Exterior Surfaces: Not required.
 - 10. Sediment Bucket: Not required.
 - 11. Top or Strainer Material: Epoxy Coated aluminum.
 - 12. Top of Body and Strainer Finish: Epoxy Coated aluminum.
 - 13. Top Shape: 6" Round.
 - 14. Top Loading Classification: Medium Duty
 - 15. Flange: Wood Deck Flange
 - 16. Inlet Fitting: Not required.
 - 17. Trap Material: PVC.
 - 18. Trap Pattern: Standard P-trap.
 - 19. Drain Tailpiece Features: Trap-seal primer valve drain connection.

2.3 TRENCH DRAINS

2.4 TRENCH DRAINS TD-1

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
2. Basis-of-Design Product: Subject to compliance with requirements, provide Watts or a comparable product by one of the following:
 - a. Josam Company; Josam Div.
 - b. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - c. Watts Drainage Products Inc.
 - d. Zurn Plumbing Products Group; Specification Drainage Operation.
3. Pattern: Pre-sloped, 6" wide trench drain.
4. Body Material: Polypropylene.
5. Frame material: Ductile Iron.
6. Outlet: Bottom.
7. Top or Strainer Material: Slotted Stainless Steel.
8. Top of Body and Strainer Finish: Stainless Steel.
9. Dimensions of Top or Strainer: 6" wide.
10. Top Loading Classification: Heavy Duty
11. Trap Material: PVC.
12. Trap Pattern: Standard P-trap.
13. Drain Length: 8'-0" including catch basin
14. Catch Basin: 6" x 24" with ductile iron frame, slotted stainless steel grate and removable stainless steel trash basket.

2.5 FLOOR SINKS

A. Floor Drains FS-1:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Watts or a comparable product by one of the following:
 - a. Josam Company; Josam Div.
 - b. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
 - c. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASME A112.6.3
3. Pattern: Floor Sink, 6" deep.
4. Body Material: Stainless Steel.
5. Seepage Flange: Required.
6. Anchor Flange: Required.
7. Clamping Device: Required.
8. Outlet: Bottom.
9. Backwater Valve: Not required.
10. Sediment Bucket: Not required.
11. Top or Strainer Material: Stainless Steel.
12. Top of Body and Strainer Finish: Stainless Steel.
13. Top Shape: Square with three quartergrate.
14. Dimensions of Top or Strainer: Square, size as scheduled.
15. Top Loading Classification: Heavy Duty
16. Funnel: Not required.
17. Inlet Fitting: Not required.
18. Trap Material: Cast Iron.
19. Trap Pattern: Standard P-trap.
20. Drain Tailpiece Features: Trap-seal primer valve drain connection.

2.6 SOLIDS INTERCEPTOR

A. Solids Interceptor SI-1:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Mifab.
2. Description: MIFAB® Lil-(specify size)-S HDPE injection molded solids interceptor. Unit shall include: internal perforated sediment bucket (1/4" diameter holes) with optional stainless-steel screen, baffle assembly and HDPE injection molded, non skid, rectangular gasketed lid with securing latches.

2.7 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

A. Open Drains:

1. Description: Shop or field fabricate, PVC Schedule 40, soil-pipe fittings. Include P-trap, and riser section; and where required, increaser fitting joined with ASTM C 564, rubber gaskets.
2. Size: Same as connected waste piping.

B. Floor-Drain, Trap-Seal Primer Fittings:

1. Description: Cast iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
2. Size: Same as floor drain outlet with NPS 1/2 (DN 15) side inlet.
3. Trap primer connections may be made to the tailpiece of the floor drain.

C. Air-Gap Fittings:

1. Standard: ASME A112.1.2, for fitting designed to ensure fixed, positive air gap between installed inlet and outlet piping.
2. Body: Bronze or cast iron.
3. Inlet: Opening in top of body.
4. Outlet: Larger than inlet.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Refer to Division 22 Section "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.
- B. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
 1. Size same as drainage piping up to NPS 4 (DN 100). Use NPS 4 (DN 100) for larger drainage piping unless larger cleanout is indicated.
 2. Locate at each change in direction of piping greater than 45 degrees.
 3. Locate at minimum intervals of 100 feet for all piping.
 4. Locate at base of each vertical soil and waste stack.
- C. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.

- D. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Tests and Inspections:
 - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

3.3 PROTECTION

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

END OF SECTION 221319

SECTION 221616 - FACILITY LIQUEFIED-PETROLEUM GAS PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Pipes, tubes, and fittings.
 - 2. Piping specialties.
 - 3. Piping and tubing joining materials.
 - 4. Valves.
 - 5. Pressure regulators.
- B. The one above grade propane tank, preparation, interconnected piping, pressure regulators, valves, gauges, interconnected underground piping, underground piping from the tank up to and including the building regulator shall be installed by a company the owner negotiates a fuel contract with.
- C. For bidding purposes Dead River Company shall be contacted to provide pricing. The installation for the tank and pipe trenching/backfilling shall be provided by Division 31-33.
 - 1. Contact: David Luce.
 - 2. Address: Dead River Company, 82 Running Hill Road, Suite 400, South Portland, ME 04106.
 - 3. Telephone:
 - a. Office: (207) 358-5787
 - b. Mobile: (207) 712-6141
 - c. Toll Free: (800) 287-5841
 - 4. Email: david.luce@deadriverriver.com

1.3 DEFINITIONS

- A. 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, crawlspace, and tunnels.
- B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.
- C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.
- D. LPG: Liquefied-petroleum gas.

1.4 PERFORMANCE REQUIREMENTS

- A. Minimum Operating-Pressure Ratings:
 - 1. For Piping Containing Only Vapor:
 - a. Piping and Valves: 125 psig (862 kPa unless otherwise indicated).
- B. LPG System Pressure between tank and Building: Maximum pressure of 5 PSI shall be delivered from tank to building.
- C. LPG System Pressure within Buildings: One pressure range; 11 inches water column

1.5 SUBMITTALS

- A. Product Data: For each type of the following:
 - 1. Piping specialties.
 - 2. Corrugated stainless-steel tubing with associated components.
 - 3. Valves. Include pressure rating, capacity, settings, and electrical connection data of selected models.
 - 4. Pressure regulators
 - 5. Dielectric fittings.
 - 6. Escutcheons.
- B. Delegated-Design Submittal: For LPG piping and equipment indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 - 1. Detail fabrication and assembly of seismic restraints.
 - 2. Design Calculations: Calculate requirements for selecting seismic restraints.
 - 3. Underground L.P. pipe sizing from the tanks to the building and the emergency generator by the gas supplier.
- C. Coordination Drawings: Plans and details, drawn to scale, on which LPG piping is shown and coordinated with other installations, using input from installers of the items involved.
- D. Site Survey: Plans, drawn to scale, on which LPG piping is shown and coordinated with other services and utilities.
- E. Qualification Data: For qualified professional engineer.
- F. Welding certificates.
- G. Field quality-control reports.
- H. Operation and Maintenance Data: For LPG equipment and accessories to include in emergency, operation, and maintenance manuals.
- I. Fire Safety Analysis Report for LP-Gas Storage Facilities: Provide and file a Fire Safety Analysis report to the State of Maine before proceeding with the installation of underground storage tanks. The Fire Analysis Report is required when the aggregate capacity of LP-storage is greater than 4,000 gallons.

1.6 QUALITY ASSURANCE

- A. Steel Support Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Handling Flammable Liquids: Remove and dispose of liquids from existing LPG piping according to requirements of authorities having jurisdiction.
- B. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.
- C. Store pipes and tubes with protective PE coating to avoid damaging coating and protect from direct sunlight.
- D. Protect stored PE pipes and valves from direct sunlight.

1.8 PROJECT CONDITIONS

- A. Perform site survey, research public utility records, and verify existing utility locations. Contact utility-locating service for area where Project is located.
- B. Provide one above grade 1,000 gallon above ground tank and associated accessories.

1.9 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.
- B. Coordinate requirements for access panels and doors for valves installed concealed behind finished surfaces. Comply with requirements in Division 08 Section "Access Doors and Frames."

PART 2 - PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

- A. Steel Pipe: ASTM A 53/A 53M, black steel, Schedules 40 and 80, Type E or S, Grade B.
 - 1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
 - 2. Wrought-Steel Welding Fittings: ASTM A 234/A 234M for butt welding and socket welding.

3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.
 4. Protective Coating for Underground Piping: Factory-applied, three-layer coating of epoxy, adhesive, and PE.
 - a. Joint Cover Kits: Epoxy paint, adhesive, and heat-shrink PE sleeves.
- B. Corrugated, Stainless-Steel Tubing: Comply with ANSI/IAS LC 1.
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. OmegaFlex, Inc.
 - b. Parker Hannifin Corporation; Parflex Division.
 - c. Titeflex.
 - d. Tru-Flex Metal Hose Corp.
 2. Tubing: ASTM A 240/A 240M, corrugated, Series 300 stainless steel.
 3. Coating: PE with flame retardant.
 - a. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
 - 1) Flame-Spread Index: 25 or less.
 - 2) Smoke-Developed Index: 50 or less.
 4. Fittings: Copper-alloy mechanical fittings with ends made to fit and listed for use with corrugated stainless-steel tubing and capable of metal-to-metal seal without gaskets. Include brazing socket or threaded ends complying with ASME B1.20.1.
 5. Striker Plates: Steel, designed to protect tubing from penetrations.
 6. Manifolds: Malleable iron or steel with factory-applied protective coating. Threaded connections shall comply with ASME B1.20.1 for pipe inlet and corrugated tubing outlets.
 7. Operating-Pressure Rating: 5 psig (34.5 kPa).
- C. PE Pipe: ASTM D 2513, SDR 11.
1. PE Fittings: ASTM D 2683, socket-fusion type or ASTM D 3261, butt-fusion type with dimensions matching PE pipe.
 2. PE Transition Fittings: Factory-fabricated fittings with PE pipe complying with ASTM D 2513, SDR 11; and steel pipe complying with ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.
 3. Anodeless Service-Line Risers: Factory fabricated and leak tested.
 - a. Underground Portion: PE pipe complying with ASTM D 2513, SDR 11 inlet.
 - b. Casing: Steel pipe complying with ASTM A 53/A 53M, Schedule 40, black steel, Type E or S, Grade B with corrosion-protective coating covering. Vent casing aboveground.
 - c. Aboveground Portion: PE transition fitting.
 - d. Outlet shall be threaded or flanged or suitable for welded connection.
 - e. Tracer wire connection.
 - f. Ultraviolet shield.
 - g. Stake supports with factory finish to match steel pipe casing or carrier pipe.
 4. Transition Service-Line Risers: Factory fabricated and leak tested.
 - a. Underground Portion: PE pipe complying with ASTM D 2513, SDR 11 inlet connected to steel pipe complying with ASTM A 53/A 53M, Schedule 40, Type E or S, Grade B, with corrosion-protective coating for aboveground outlet.
 - b. Outlet shall be threaded or flanged or suitable for welded connection.

- c. Bridging sleeve over mechanical coupling.
- d. Factory-connected anode.
- e. Tracer wire connection.
- f. Ultraviolet shield.
- g. Stake supports with factory finish to match steel pipe casing or carrier pipe.
- 5. Plastic Mechanical Couplings, NPS 1-1/2 (DN 40) and Smaller: Capable of joining PE pipe to PE pipe.
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Lyall, R. W. & Company, Inc.
 - 2) Mueller Co.; Gas Products Div.
 - 3) Perfection Corporation; a subsidiary of American Meter Company.
 - b. PE body with molded-in, stainless-steel support ring.
 - c. Buna-nitrile seals.
 - d. Acetal collets.
 - e. Electro-zinc-plated steel stiffener.

2.2 PIPING SPECIALTIES

- A. Flexible Piping Joints:
 - 1. Approved for LPG service.
 - 2. Stainless-steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket.
 - 3. Minimum working pressure of 250 psig (1723 kPa) and 250 deg F (121 deg C) operating temperature.
 - 4. Flanged- or threaded-end connections to match equipment connected and shall be capable of minimum 3/4-inch (20-mm) misalignment.
 - 5. Maximum 36-inch (914-mm) length for liquid LPG lines.
- B. Appliance Flexible Connectors:
 - 1. Indoor, Fixed-Appliance Flexible Connectors: Comply with ANSI Z21.24.
 - 2. Indoor, Movable-Appliance Flexible Connectors: Comply with ANSI Z21.69.
 - 3. Corrugated stainless-steel tubing with polymer coating.
 - 4. Operating-Pressure Rating: 0.5 psig (3.45 kPa).
 - 5. End Fittings: Zinc-coated steel.
 - 6. Threaded Ends: Comply with ASME B1.20.1.
 - 7. Maximum Length: 72 inches (1830 mm).
- C. Quick-Disconnect Devices: Comply with ANSI Z21.41.
 - 1. Copper-alloy convenience outlet and matching plug connector.
 - 2. Nitrile seals.
 - 3. Hand operated with automatic shutoff when disconnected.
 - 4. For indoor or outdoor applications.
 - 5. Adjustable, retractable restraining cable.
- D. Y-Pattern Strainers:
 - 1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
 - 2. End Connections: Threaded ends for NPS 2 (DN 50) and smaller; flanged ends for NPS 2-1/2 (DN 65) and larger.
 - 3. Strainer Screen: 40-mesh startup strainer and perforated stainless-steel basket with 50 percent free area.

4. CWP Rating: 125 psig (862 kPa).

- E. Weatherproof Vent Cap: Cast- or malleable-iron increaser fitting with corrosion-resistant wire screen, with free area at least equal to cross-sectional area of connecting pipe and threaded-end connection.

2.3 JOINING MATERIALS

- A. Joint Compound and Tape: Suitable for LPG.
- B. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- C. Brazing Filler Metals: Alloy with melting point greater than 1000 deg F (540 deg C) complying with AWS A5.8/A5.8M.

2.4 MANUAL GAS SHUTOFF VALVES

- A. See "Aboveground Manual Gas Shutoff Valve Schedule" Articles for where each valve type is applied in various services.
- B. General Requirements for Metallic Valves, NPS 2 (DN 50) and Smaller for Vapor Service: Comply with ASME B16.33.
1. CWP Rating: 125 psig (862 kPa).
 2. Threaded Ends: Comply with ASME B1.20.1.
 3. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.
 4. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 5. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch (25 mm) and smaller.
 6. Service Mark: Valves 1-1/4 inch (32 mm) to NPS 2 (DN 50) shall have initials "WOG" permanently marked on valve body.
- C. General Requirements for Metallic Valves, NPS 2-1/2 (DN 65) and Larger: Comply with ASME B16.38.
1. CWP Rating: 25 psig (862 kPa)
 2. Flanged Ends: Comply with ASME B16.5 for steel flanges.
 3. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 4. Service Mark: Initials "WOG" shall be permanently marked on valve body.
- D. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim: MSS SP-110.
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. BrassCraft Manufacturing Company; a Masco company.
 - b. Watts
 - c. Conbraco Industries, Inc.; Apollo Div.

- d. Lyall, R. W. & Company, Inc.
- e. McDonald, A. Y. Mfg. Co.
- f. Perfection Corporation; a subsidiary of American Meter Company.
- 2. Body: Bronze, complying with ASTM B 584.
- 3. Ball: Chrome-plated bronze.
- 4. Stem: Bronze; blowout proof.
- 5. Seats: Reinforced TFE; blowout proof.
- 6. Packing: Threaded-body packnut design with adjustable-stem packing.
- 7. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
- 8. CWP Rating: 600 psig (4143 kPa).
- 9. Listing: Valves NPS 1 (DN 25) and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
- 10. Service: Suitable for LPG service with "WOG" indicated on valve body.

2.5 PRESSURE REGULATORS

A. General Requirements:

- 1. Single stage and suitable for LPG.
- 2. Steel jacket and corrosion-resistant components.
- 3. Elevation compensator.
- 4. End Connections: Threaded for regulators NPS 2 (DN 50) and smaller; flanged for regulators NPS 2-1/2 (DN 65) and larger.

B. Line Pressure Regulators: Comply with ANSI Z21.80.

- 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:
- 2. Basis-of-Design Product: Subject to compliance with requirements, Itron Model, B34 or comparable product by one of the following:
 - a. American Meter Company.
 - b. Fisher Control Valves and Regulators; Division of Emerson Process Management.
 - c. Invensys.
 - d. Maxitrol Company.
- 3. Body and Diaphragm Case: Cast iron or die-cast aluminum.
- 4. Springs: Zinc-plated steel; interchangeable.
- 5. Diaphragm Plate: Zinc-plated steel.
- 6. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
- 7. Orifice: Aluminum; interchangeable.
- 8. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
- 9. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet and no pressure sensing piping external to the regulator.
- 10. Pressure regulator shall maintain discharge pressure setting downstream and not exceed 150 percent of design discharge pressure at shutoff.
- 11. Overpressure Protection Device: Factory mounted on pressure regulator.
- 12. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.
- 13. Maximum Inlet Pressure: 5 psig.
- 14. Set regulator to deliver 12" water column.

15. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
16. Factory-Applied Finish: Minimum three-layer polyester and polyurethane paint finish.
17. Regulator may include vent limiting device, instead of vent connection, if approved by authorities having jurisdiction.
18. ALTERNATE #5: Provide regulator set to deliver the required operating pressure for the emergency generator.

2.6 DIELECTRIC FITTINGS

A. Dielectric Unions:

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. Capitol Manufacturing Company.
 - b. Central Plastics Company.
 - c. Hart Industries International, Inc.
 - d. McDonald, A. Y. Mfg. Co.
 - e. Watts Regulator Co.; Division of Watts Water Technologies, Inc.
 - f. Wilkins; Zurn Plumbing Products Group.
2. Minimum Operating-Pressure Rating: 150 psig (1034 kPa).
3. Combination fitting of copper alloy and ferrous materials.
4. Insulating materials suitable for LPG.
5. Combination fitting of copper alloy and ferrous materials with threaded, brazed-joint, plain, or welded end connections that match piping system materials.

2.7 SLEEVES

- A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.
- B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

2.8 MECHANICAL SLEEVE SEALS

- A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Advance Products & Systems, Inc.
 - b. Calpico Inc.
 - c. Metraflex Company (The).
 - d. Pipeline Seal and Insulator, Inc.
 2. Sealing Elements: EPDM interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe and sleeve.
 3. Pressure Plates: Carbon steel.
 4. Connecting Bolts and Nuts: steel of length required to secure pressure plates to sealing elements. Include one nut and bolt for each sealing element.

2.9 ESCUTCHEONS

- A. General Requirements for Escutcheons: Manufactured wall and ceiling escutcheons and floor plates, with ID to fit around pipe or tube, and OD that completely covers opening.
- B. One-Piece, Deep-Pattern Escutcheons: Deep-drawn brass with polished chrome-plated finish.
- C. One-Piece, Cast-Brass Escutcheons: With set screw.
 - 1. Finish: Polished chrome-plated.

2.10 LABELING AND IDENTIFYING

- A. Detectable Warning Tape: Acid- and alkali-resistant PE film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches (150 mm) wide and 4 mils (0.1 mm) thick, continuously inscribed with a description of utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches (750 mm) deep; colored yellow.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in for LPG piping system to verify actual locations of piping connections before equipment installation.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 EARTHWORK

- A. Comply with requirements in Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.

3.3 PREPARATION

- A. Close equipment shutoff valves before turning off LPG to premises or piping section.
- B. Inspect LPG piping according to NFPA 58 and the International Fuel Gas Code to determine that LPG utilization devices are turned off in piping section affected.
- C. Comply with NFPA 58 and the International Fuel Gas Code requirements for prevention of accidental ignition.

3.4 OUTDOOR PIPING INSTALLATION

- A. Comply with NFPA 58 and the International Fuel Gas Code requirements for installation and purging of LPG piping.

- B. Install underground, LPG piping buried at least 36 inches (900 mm) below finished grade. Comply with requirements in Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.
 - 1. If LPG piping is installed less than 36 inches (914 mm) below finished grade, install it in containment conduit.
- C. Install underground, PE, LPG piping according to ASTM D 2774.
- D. Steel Piping with Protective Coating:
 - 1. Apply joint cover kits to pipe after joining to cover, seal, and protect joints.
 - 2. Repair damage to PE coating on pipe as recommended in writing by protective coating manufacturer.
 - 3. Replace pipe having damaged PE coating with new pipe. CSA B149.1 requires protective coating for Type G and Type L (Type B) copper pipe and tube installed underground.
- E. Install fittings for changes in direction and branch connections.
- F. Joints for connection to inlets and outlets on vaporizers, air mixers, regulators, and valves may be flanged or threaded to match the equipment.
- G. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
 - 1. Install steel pipe for sleeves smaller than 6 inches (150 mm) in diameter.
 - 2. Install cast-iron "wall pipes" for sleeves 6 inches (150 mm) and larger in diameter.
- H. Install pressure gage upstream and downstream from each service regulator. Pressure gages are specified in Division 22 Section "Meters and Gages for Plumbing Piping."

3.5 INDOOR PIPING INSTALLATION

- A. Comply with NFPA 58 and the International Fuel Gas Code for installation and purging of LPG piping.
- B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- C. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction, to allow for mechanical installations.
- D. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- E. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

- G. Locate valves for easy access.
- H. Install LPG piping at uniform grade of 2 percent down toward drip and sediment traps.
- I. Install piping free of sags and bends.
- J. Install fittings for changes in direction and branch connections.
- K. Install escutcheons for penetrations of interior walls, ceilings, and floors.
 - 1. New Piping:
 - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
 - b. Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
 - c. Piping in Unfinished Service Spaces: One-piece, cast-brass type with polished chrome-plated finish.
- L. 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 in Division 07 Section "Penetration Firestopping" for materials.
- M. Verify final equipment locations for roughing-in.
- N. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.
- O. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets. Locate where readily accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.
 - 1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 3 inches (75 mm) long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.
- P. Extend relief vent connections for service regulators, line regulators, and overpressure protection devices to outdoors and terminate with weatherproof vent cap.
- Q. Conceal pipe installations in walls, pipe spaces, utility spaces, above ceilings, below grade or floors, and in floor channels unless indicated to be exposed to view.
- R. Concealed Location Installations: Except as specified below, install concealed LPG piping and piping installed under the building in containment conduit constructed of steel pipe with welded joints as described in Part 2. Install a vent pipe from containment conduit to outdoors and terminate with weatherproof vent cap.
 - 1. Above Accessible Ceilings: LPG piping, fittings, valves, and regulators may be installed in accessible spaces without containment conduit.
 - 2. In Floors: Install LPG corrugated stainless steel piping with PE covering suitable for direct bury with integral vented jacket and vent relief fittings. Piping may not be in physical contact with other metallic structures such as reinforcing rods or electrically neutral conductors. Do not embed piping in concrete slabs containing quick-set additives or cinder aggregate.

3. In Walls or Partitions: Protect tubing installed inside partitions or hollow walls from physical damage using steel striker barriers at rigid supports.
 - a. Exception: Tubing passing through partitions or walls does not require striker barriers.
 4. Prohibited Locations:
 - a. Do not install LPG piping in or through circulating air ducts, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator shafts.
 - b. Do not install LPG piping in solid walls or partitions.
 - S. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.
 - T. Connect branch piping from top or side of horizontal piping.
 - U. Install unions in pipes NPS 2 (DN 50) and smaller, adjacent to each valve, at final connection to each piece of equipment. Unions are not required at flanged connections.
 - V. Do not use LPG piping as grounding electrode.
 - W. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.
 - X. Install pressure gage upstream and downstream from each line regulator. Pressure gages are specified in Division 22 Section "Meters and Gages for Plumbing Piping."
- 3.6 VALVE INSTALLATION
- A. Install manual gas shutoff valve for each gas appliance ahead of corrugated stainless-steel tubing, aluminum, or copper connector.
- 3.7 PIPING JOINT CONSTRUCTION
- A. Ream ends of pipes and tubes and remove burrs.
 - B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
 - C. 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 ID of pipe.
 4. Apply appropriate tape or thread compound to external pipe threads unless dryseal 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.
 - D. Welded Joints:
 1. Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators.

2. Bevel plain ends of steel pipe.
3. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.

3.8 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements for pipe hangers and supports specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."
- B. Install hangers for horizontal steel piping with the following maximum spacing and minimum rod sizes:
 1. NPS 1 (DN 25) and Smaller: Maximum span, 96 inches (2438 mm); minimum rod size, 3/8 inch (10 mm).
 2. NPS 1-1/4 (DN 32): Maximum span, 108 inches (2743 mm); minimum rod size, 3/8 inch (10 mm).
 3. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): Maximum span, 108 inches (2743 mm); minimum rod size, 3/8 inch (10 mm).
 4. NPS 2-1/2 to NPS 3-1/2 (DN 65 to DN 90): Maximum span, 10 feet (3 m); minimum rod size, 1/2 inch (13 mm).
 5. NPS 4 (DN 100) and Larger: Maximum span, 10 feet (3 m); minimum rod size, 5/8 inch (16 mm).

3.9 CONNECTIONS

- A. Connect to utility's gas main according to utility's procedures and requirements.
- B. Install LPG piping electrically continuous, and bonded to gas appliance equipment grounding conductor of the circuit powering the appliance according to NFPA 70.
- C. Install piping adjacent to appliances to allow service and maintenance of appliances.
- D. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches (1830 mm) of each gas-fired appliances and equipment. Install union between valve and appliances or equipment.
- E. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.

3.10 LABELING AND IDENTIFYING

- A. Comply with requirements in Division 22 Section "Identification for Plumbing Piping and Equipment" for piping and valve identification.
- B. Install detectable warning tape directly above gas piping, 12 inches (305 mm) below finished grade, except 6 inches (150 mm) below subgrade under pavements and slabs.

3.11 PAINTING

- A. Comply with requirements in Division 09 painting Sections for painting interior and exterior LPG piping.
- B. Paint exposed, exterior metal piping, valves, service regulators, service meters and meter bars, earthquake valves, and piping specialties, except components with factory-applied paint or protective coating.
 - 1. Alkyd System: MPI EXT 5.1D.
 - a. Prime Coat: Alkyd anticorrosive metal primer.
 - b. Intermediate Coat: Exterior alkyd enamel matching topcoat.
 - c. Topcoat: Exterior alkyd enamel semigloss.
 - d. Color: To Match the Building exterior color.
- C. Damage and Touchup: Repair marred and damaged factory-applied finishes with materials and by procedures to match original factory finish.

3.12 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Tests and Inspections:
 - 1. Test, inspect, and purge LPG according to NFPA 58 and the International Fuel Gas Code and requirements of authorities having jurisdiction.
- C. LPG piping will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

3.13 DEMONSTRATION

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

3.14 OUTDOOR PIPING SCHEDULE

- A. Retain and revise applicable piping applications. Coordinate with materials specified in Part 2. Retain multiple materials for Contractor's option.
 - 1. Retain "one of" option in first paragraph below to allow Contractor to select piping materials from those retained.
- B. Underground LPG vapor piping shall be the following:
 - 1. PE pipe and fittings joined by heat-fusion, or mechanical couplings; service-line risers with tracer wire terminated in an accessible location.
- C. Aboveground LPG vapor piping shall be one of the following:
 - 1. Schedule 40, steel pipe with malleable-iron fittings and threaded or pressed joints.
 - 2. Schedule 40, steel pipe with wrought-steel fittings and welded joints, or mechanical couplings.

- 3.15 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURES LESS THAN 0.5 PSIG (3.45 kPa)
- A. Aboveground, branch piping NPS 1 (DN 25) and smaller shall be one of the following:
 - 1. Corrugated stainless-steel tubing with mechanical fittings having socket or threaded ends to match adjacent piping.
 - 2. Schedule 40, steel pipe with malleable-iron fittings and threaded or pressed joints.
 - B. Aboveground, distribution piping shall be one of the following:
 - 1. Schedule 40, steel pipe with malleable-iron fittings and threaded or pressed joints.
 - 2. Schedule 40, steel pipe with wrought-steel fittings and welded joints.
 - C. Underground, below building, piping shall be the following:
 - 1. Corrugated stainless-steel tubing with mechanical fittings having socket or threaded ends to match adjacent piping.
 - D. Distribution piping valves for pipe NPS 2 (DN 50) and smaller shall be the following:
 - 1. Two-piece, full-port, bronze ball valves with bronze trim.
 - E. Distribution piping valves for pipe NPS 2-1/2 (DN 65) and larger shall be the following:
 - 1. Two-piece, full-port, bronze ball valves with bronze trim.
 - F. Valves in branch piping for single appliance shall be the following:
 - 1. Two-piece, full-port, bronze ball valves with bronze trim.

END OF SECTION 221616

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SECTION 221619 - SOIL GAS VENTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following soil gas piping inside the building:
 - 1. Pipe, fittings and soil gas exhaust fans.
 - 2. Special pipe fittings.

1.3 DEFINITIONS

- A. ABS: Acrylonitrile-butadiene-styrene plastic.
- B. PVC: Polyvinyl chloride plastic.

1.4 PERFORMANCE REQUIREMENTS

- A. Components and installation shall be capable of withstanding the following minimum working-pressure, unless otherwise indicated:

1.5 SUBMITTALS

- A. Product Data: For pipe, fittings, and soil gas exhaust fans.
- B. Field quality-control inspection and test reports.

1.6 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-drain" for plastic drain piping and "NSF-sewer" for plastic sewer piping.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 PIPING MATERIALS

- A. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.

2.3 PVC PIPE AND FITTINGS

- A. Solid-Wall PVC Pipe: ASTM D 2665.
- B. Solvent Cement and Adhesive Primer:
 1. Use PVC solvent cement that has a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 2. Use adhesive primer that has a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.4 SOIL GAS EXHAUST FAN COMPONENTS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- C. Basis-of-Design Product: Subject to compliance with requirements, provide Fantech, white color, 115 volts, 6" diameter fan with 4" PVC inlet and outlet pipe connector and flexible couplings or a comparable product by one of the following:
 1. Fantech or approved equal.
- D. Check Point Mitigation Alarm: Alarm shall incorporate an audible alarm, green and red light readout, factory preset to activate when the vacuum pressure falls below 0.25" W.C., low voltage. The alarm shall be located as indicated on the plans.
 1. Basis-of-Design Product: Subject to compliance with requirements, provide RadonAway Checkpoint IIAR alarm with power provided by a plug-in transformer.
 - a. Provide 3/16" od clear tubing for locations up to 50 feet of tubing length from the stack to the alarm
 - b. Provide 5/16" od clear tubing for locations requiring more than 50 feet of tubing length from the stack to the alarm. Maximum length of tubing 125 feet from stack to alarm.
- E. The exhaust fan shall run continuously.

PART 3 - EXECUTION

3.1 EXCAVATION

- A. Refer to Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.

3.2 PIPING APPLICATIONS

- A. Flanges and unions may be used on aboveground pressure piping, unless otherwise indicated.
- B. Aboveground soil gas piping NPS 6 (DN 150) and smaller shall be the following:
 - 1. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
- C. Underground soil gas piping NPS 6 (DN 150) and smaller shall be the following:
 - 1. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.
 - 2. Provide perforated piping in the crushed stone layer.

3.3 PIPING INSTALLATION

- A. Basic piping installation requirements are specified in Division 22 Section "Common Work Results for Plumbing."
- B. Make changes in direction for soil gas piping using appropriate branches, bends, and long-sweep bends. 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.
- C. Lay buried soil gas piping within the crushed stone for air permeation to occur.
- D. Install soil gas piping at the following minimum slopes, unless otherwise indicated:
 - 1. Soil Gas Piping: 2 percent upward toward the vent terminal.
- E. Install underground PVC storm drainage piping according to ASTM D 2321.
- F. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

3.4 JOINT CONSTRUCTION

- A. Basic piping joint construction requirements are specified in Division 22 Section "Common Work Results for Plumbing."
- B. PVC Nonpressure Piping Joints: Join piping according to ASTM D 2665.

3.5 HANGER AND SUPPORT INSTALLATION

- A. Seismic-restraint devices are specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."

- B. Pipe hangers and supports are specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment." Install the following:
 - 1. Vertical Piping: MSS Type 8 or Type 42, clamps.
 - 2. Individual, Straight, Horizontal Piping Runs: According to the following:
 - a. MSS Type 1, adjustable, steel clevis hangers.
 - 3. Base of Vertical Piping: MSS Type 52, spring hangers.
- C. Install supports according to Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."
- D. Support vertical piping and tubing at base and at each floor.
- E. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch (10-mm) minimum rods.
- F. Install hangers for PVC piping with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 4 (DN 100): 48 inches (1200 mm) with 5/8-inch (16-mm) rod.
 - 2. NPS 6 (DN 150): 48 inches (1200 mm) with 3/4-inch (19-mm) rod.
- G. Install supports for vertical PVC piping every 48 inches (1200 mm).
- H. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.6 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect underground soil gas piping to the exterior piping.
- C. Connect soil gas piping to roof drains and soil gas specialties.

3.7 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.
 - 2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
- B. Re-inspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.
- C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- D. Test soil gas 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 soil gas piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
3. Test Procedure: Test soil gas 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 (30 kPa) 5 psi. From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.
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.

3.8 CLEANING

- A. Clean interior of piping. Remove dirt and debris as work progresses.
- B. Protect vents 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 221619

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SECTION 223400 - FUEL-FIRED DOMESTIC WATER HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following fuel-fired water heater:
 - 1. Propane gas water heater.
 - 2. Water heater accessories.
 - 3. Intake and exhaust flue with accessories.

1.3 SUBMITTALS

- A. Product Data: For each type and size of water heater indicated. Include rated capacities, operating characteristics, furnished specialties, and accessories.
- B. Shop Drawings: Diagram power, signal, and control wiring.
- C. Product Certificates: For each type of commercial water heater, signed by product manufacturer.
- D. Source quality-control test reports.
- E. Field quality-control test reports.
- F. Operation and Maintenance Data: For water heaters to include in emergency, operation, and maintenance manuals.
- G. Warranty: Special warranty specified in this Section.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain same type of water heaters through one source from a single manufacturer.
- B. Product Options: Drawings indicate size, profiles, and dimensional requirements of water heaters and are based on the specific system indicated. Refer to Division 01.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- D. ASHRAE/IESNA 90.1-2016 Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2016.

- E. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9" for all components that will be in contact with potable water.

1.5 COORDINATION

- A. Coordinate size and location of concrete bases with Architectural and Structural Drawings.

1.6 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of fuel-fired water heaters that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures including storage tank and supports.
 - b. Faulty operation of controls.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal use.
 - 2. Warranty Period(s): From date of Substantial Completion:
 - a. Commercial, Gas Water Heaters:
 - 1) Tank: 5 years.
 - 2) Controls and Other Components: Three years.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Gas Water Heater
 - 1. Available Manufacturers:
 - a. HTP Heat Thermal Products
 - b. A.O Smith
 - c. Lochinvar
- B. Basis of Design: HTP Phoenix.
- C. Description: Propane gas water heater shall be, minimum 95% thermal efficiency, a storage capacity of 55 gallons, an input rating of 40,000 to 130,000 BTUs per hour, a recovery rating of 173 gallons per hour (gph) at 100°F rise.
 - 1. Design:
 - a. Tank: 316 Stainless Steel.
 - b. Tappings: ASME B1.20.1 pipe thread.
 - c. Pressure Rating: 150 psig (1035 kPa).
 - d. Insulation: Comply with ASHRAE/IESNA 90.1-2004.
 - e. Burner: For use with water heaters and for propane gas.
 - f. Automatic Ignition:
 - g. Temperature Control: Adjustable digital controller.
 - h. Jacket: Metal with enameled finish.
 - 2. Capacity and Characteristics:
 - a. Temperature Setting: 140 deg F.
 - b. Fuel Gas Input: 40,000 btu/h to 130,000 btu/h
 - c. Tank Size: 55 Gallons

- d. Gas Pressure Required at Burner: 7.0 inches water column.
- e. Electrical Characteristics:
 - 1) Volts: 120.
 - 2) Phase: Single.
 - 3) Hertz: 60.
- f. Minimum intake Vent and exhaust flue Diameter: 3".
- g. Flue Material: Polypropylene
- h. Intake Material: Polypropylene
- i. Options:
 - 1) Five Year Warranty.
 - 2) Optional Condensate neutralizing kit: (7450P-212).

2.2 WATER HEATER ACCESSORIES

- A. Gas Shutoff Valves: ANSI Z21.15/CGA 9.1, manually operated. Furnish for installation in piping.
- B. Gas Pressure Regulators: ANSI Z21.18, appliance type. Include pressure rating, capacity, and pressure differential required between gas supply and water heater.
- C. Gas Automatic Valves: ANSI Z21.21, appliance, electrically operated, on-off automatic valve.
- D. Pressure Relief Valves: Include pressure setting less than working-pressure rating of water heater.
 - 1. Gas Water Heaters: ANSI Z21.22/CSA 4.4

PART 3 - EXECUTION

3.1 WATER HEATER INSTALLATION

- A. Install water heaters level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.
- B. Install gas water heaters according to NFPA 54.
- C. Install gas shutoff valves on gas supplies to gas water heaters without shutoff valves.
- D. Install gas pressure regulators on gas supplies to gas water heaters without gas pressure regulators if gas pressure regulators are required to reduce gas pressure at burner.
- E. Install automatic gas valves on gas supplies to gas water heaters, if required for operation of safety control.
- F. Install thermometer on outlet piping of water heaters. Refer to Division 22 Section "Meters and Gages for Plumbing Piping" for thermometers.
- G. Install pressure gage(s) on inlet and outlet piping of commercial, fuel-fired water heater piping. Refer to Division 22 Section "Meters and Gages for Plumbing Piping" for pressure gages.

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to water heaters to allow service and maintenance. Arrange piping for easy removal of water heaters.
- C. Ground equipment according to Division 26 Section "Grounding and Bonding."
- D. Connect wiring according to Division 26 Section "Wire and Cable."

3.3 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.
- B. Perform the following field tests and inspections and prepare test reports:
 - 1. Leak Test: After installation, test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Operational Test: After electrical circuitry has been energized, confirm proper operation.
 - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- C. Remove and replace water heaters that do not pass tests and inspections and retest as specified above.

3.4 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain commercial water heaters. Refer to Division 01.

END OF SECTION 223400

SECTION 224000 - PLUMBING FIXTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following conventional plumbing fixtures and related components:
 - 1. Faucets for lavatories and sinks.
 - 2. Service Faucets
 - 3. Fixture supports.
 - 4. Dishwasher air-gap fittings.
 - 5. Water closets.
 - 6. Urinals.
 - 7. Lavatories.
 - 8. Stainless steel sinks.
 - 9. Mop Basins.
 - 10. Showers and shower faucets.
- B. Related Sections include the following:
 - 1. Division 10.
 - 2. Division 22 Section "Domestic Water Piping Specialties" and "Sanitary Waste Piping Specialties" for backflow preventers, floor drains, and specialty fixtures not included in this Section.
 - 3. Division 22 Section "Drinking Fountains and Water Coolers."

1.3 DEFINITIONS

- A. Accessible Fixture: Plumbing fixture that can be approached, entered, and used by people with disabilities.
- B. Fitting: Device that controls the flow of water into or out of the plumbing fixture. Fittings specified in this Section include supplies and stops, faucets and spouts, drains and tailpieces, and traps and waste pipes. Piping and general-duty valves are included where indicated.
- C. FRP: Fiberglass-reinforced plastic.
- D. PVC: Polyvinyl chloride plastic.
- E. Solid Surface: Nonporous, homogeneous, cast-polymer-plastic material with heat-, impact-, scratch-, and stain-resistance qualities.

1.4 SUBMITTALS

- A. Product Data: For each type of plumbing fixture indicated. Include selected fixture and trim, fittings, accessories, appliances, appurtenances, equipment, and supports. Indicate materials and finishes, dimensions, construction details, and flow-control rates.
- B. Shop Drawings: Diagram power, signal, and control wiring.
- C. Operation and Maintenance Data: For plumbing fixtures to include in emergency, operation, and maintenance manuals.
- D. Warranty: Special warranty specified in this Section.

1.5 QUALITY ASSURANCE

- A. Source Limitations: Obtain plumbing fixtures, faucets, and other components of each category through one source from a single manufacturer.
 - 1. 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. 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"; for plumbing fixtures for people with disabilities.
- C. Regulatory Requirements: Comply with requirements in Public Law 102-486, "Energy Policy Act," about water flow and consumption rates for plumbing fixtures.
- D. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.
- E. Select combinations of fixtures and trim, faucets, fittings, and other components that are compatible.
- F. Comply with the following applicable standards and other requirements specified for plumbing fixtures:
 - 1. Plastic Mop-Service Basins: ANSI Z124.6.
 - 2. Stainless-Steel Sinks: ASME A112.19.3.
 - 3. Vitreous-China Fixtures: ASME A112.19.2M.
- G. Comply with the following applicable standards and other requirements specified for sink faucets:
 - 1. Faucets: ASME A112.18.1.
 - 2. Integral, Atmospheric Vacuum Breakers: ASSE 1001.
 - 3. NSF Potable-Water Materials: NSF 61.
 - 4. Pipe Threads: ASME B1.20.1.
 - 5. Sensor-Actuated Faucets and Electrical Devices: UL 1951.
 - 6. Supply Fittings: ASME A112.18.1.
 - 7. Brass Waste Fittings: ASME A112.18.2.

- H. Comply with the following applicable standards and other requirements specified for shower faucets:
 - 1. Combination, Pressure-Equalizing and Thermostatic-Control Antiscald Faucets: ASSE 1016.
 - 2. Faucets: ASME A112.18.1.
 - 3. High-Temperature-Limit Controls for Thermal-Shock-Preventing Devices: ASTM F 445.
 - 4. Hose-Coupling Threads: ASME B1.20.7.
 - 5. Manual-Control Antiscald Faucets: ASTM F 444.
 - 6. Pipe Threads: ASME B1.20.1.
 - 7. Pressure-Equalizing-Control Antiscald Faucets: ASTM F 444 and ASSE 1016.
 - 8. Sensor-Actuated Faucets and Electrical Devices: UL 1951.
- I. Comply with the following applicable standards and other requirements specified for miscellaneous fittings:
 - 1. Atmospheric Vacuum Breakers: ASSE 1001.
 - 2. Brass and Copper Supplies: ASME A112.18.1.
 - 3. Dishwasher Air-Gap Fittings: ASSE 1021.
 - 4. Brass Waste Fittings: ASME A112.18.2.
 - 5. Sensor-Operation Flushometers: ASSE 1037 and UL 1951.
- J. Comply with the following applicable standards and other requirements specified for miscellaneous components:
 - 1. Dishwasher Air-Gap Fittings: ASSE 1021.
 - 2. Flexible Water Connectors: ASME A112.18.6.
 - 3. Floor Drains: ASME A112.6.3.
 - 4. Hose-Coupling Threads: ASME B1.20.7.
 - 5. Off-Floor Fixture Supports: ASME A112.6.1M.
 - 6. Pipe Threads: ASME B1.20.1.
 - 7. Plastic Toilet Seats: ANSI Z124.5.
 - 8. Supply and Drain Protective Shielding Guards: ICC A117.1.

1.6 WARRANTY

- A. Special Warranties: Manufacturer's standard form in which manufacturer agrees to repair or replace components of whirlpools that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures of unit shell.
 - b. Faulty operation of controls, blowers, pumps, heaters, and timers.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal use.
 - 2. Warranty Period for Commercial Applications: Three year(s) from date of Substantial Completion.

1.7 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Faucet Cartridges and O-Rings: Equal to 5 percent of amount of each type and size installed.

2. Flushometer Valve, Repair Kits: 4 of each type.
3. Toilet Seats: 4 of each type installed.

PART 2 - PRODUCTS

2.1 LAVATORY FAUCETS

- A. Lavatory Faucets: L-1:
 1. Basis-of-Design Product: Subject to compliance with requirements.
 2. Description: ADA compliant, sensor operated, hydropowered. Coordinate faucet inlets with supplies and fixture holes; coordinate outlet with spout and fixture receptor.
 - a. Body Material: Commercial, solid brass.
 - b. Finish: Polished chrome plate.
 - c. Maximum Flow Rate: 0.5 gpm.
 - d. Mounting: Deck.
 - e. Trim Plate: N/A
 - f. Valve Handle: Integrated Side Mixer
 - g. Inlet(s): NPS 3/8 (DN 10) tubing, with NPS 1/2 (DN 15) male adaptor.
 - h. Spout: Rigid type.
 - i. Power: Self Generating Turbine Power
 - j. Operation: Sensor Operated
 - k. Drain: Grid Stainer
 - l. Tempering Device: Thermostatic mixer mounted within stainless steel shroud

2.2 SINK FAUCETS

- A. Sink Faucets SK-1
 1. Basis-of-Design Product: Subject to compliance with requirements, provide Chicago Faucet or comparable manufacturer from the following:
 - a. Chicago Faucets.
 - b. Water Saver
 - c. Zurn
 2. Description: Gooseneck spout with two handles, 1.0 gpm aerated flow outlet, ceramic disc cartridge; coordinate faucet inlets with supplies and fixture holes; coordinate outlet with spout and fixture receptor.
 - a. Body Material: General-duty, solid brass.
 - b. Finish: Polished chrome plate.
 - c. Maximum Flow Rate: 1.0 gpm, unless otherwise indicated.
 - d. Centers: 8 inches.
 - e. Mounting: Deck.
 - f. Handle(s): 4" Wrist blade handle.
 - g. Inlet(s): NPS 3/8 (DN 10) tubing with NPS 1/2 (DN 15) male adapter.
 - h. Spout Type: 8" rigid gooseneck.
 - i. Spout Outlet: Aerator.
 - j. Vacuum Breaker: Not required.
 - k. Operation: Ceramic Disc, manual.

2.3 MOP RECEPTOR FAUCETS

A. Mop Receptor Faucets MB-1:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Chicago Faucet or a comparable product by one of the following:
 - a. American Standard Companies, Inc.
 - b. Moen, Inc.
 - c. Zurn Plumbing Products Group; Commercial Brass Operation.
2. Description: polished chrome plated solid cast brass faucet with continuous pressure vacuum breaker spout with pail hook, wall brace and 3/4" male garden hose thread outlet, lever handles.
 - a. Body Material: Cast brass.
 - b. Finish: Polished chrome plate.
 - c. Mounting: Wall Mounted.
 - d. Handle(s): 2-3/8" Lever Handles
 - e. Spout outlet: 3/4" Male hose thread
 - f. Vacuum breaker: Pressure rated.
 - g. Inlet(s): NPS 3/8 (DN 10) tubing with NPS 1/2 (DN 15) male adapter.
 - h. Operation: Non-compression, ceramic disc, manual.

2.4 SHOWER FAUCETS

A. Shower Faucets: SH-1 & SH-2

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
2. Basis-of-Design Product: Subject to compliance with requirements, provide Zurn or a comparable product by one of the following:
 - a. American Standard Companies, Inc.
 - b. Kohler Co.
 - c. Leonard Valve Company.
 - d. Powers; a Watts Industries Co.
 - e. Zurn Plumbing Products Group; AquaSpec Commercial Faucet Operation.
3. Description: Single-handle pressure-balance valve. Include hot- and cold-water indicators; check stops; 24" slide bar with hand held spray handle with chrome plated finish and flexible 60" metal hose, wall bracket and shower head.
 - a. Body Material: Solid brass valve and handle.
 - b. Finish: Polished chrome plate metallic cover plate and handle.
 - c. Maximum Flow Rate: 1.5 gpm, unless otherwise indicated.
 - d. Diverter Valve: Not integral with mixing valve.
 - e. Mounting: Exposed.
 - f. Backflow Protection Device for Hand-Held Shower: Required.
 - g. Operation: Non-compression disc, manual.
 - h. Anti-scald Device: Integral with mixing valve..
 - i. Check Stops: Check-valve type, integral with or attached to body; on hot- and cold-water supply connections.
 - j. Supply Connections: NPS 1/2 (DN 15).
 - k. Shower Head Type: Zurn Model Z7000-i9, Institutional wall bracket, chrome plated brass with vandal resistant screws and a 1.5 gpm chrome plated adjustable shower head.

- l. Shower Spray: Zurn model Z7000-H9 1.5 gpm chrome plated hand held shower head.
- m. Shower Head Material: Nonmetallic with chrome-plated finish.
- n. Spray Pattern: Adjustable.

2.5 FIXTURE SUPPORTS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
- B. Manufacturers: Subject to compliance with requirements, provide Watts or one of the following:
 - 1. Watts Drainage Products Inc.; a div. of Watts Industries, Inc.
 - 2. Zurn Plumbing Products Group; Specification Drainage Operation.
- C. Water-Closet Supports:
 - 1. Description: Watts or equal, Combination carrier designed for accessible and standard mounting height of wall-mounting, water-closet-type fixture. Include single or double, vertical or horizontal, hub-and-spigot or hubless waste fitting as required for piping arrangement; faceplates; couplings with gaskets; feet; and fixture bolts and hardware matching fixture. Include additional extension coupling, faceplate, and feet for installation in wide pipe space.
- D. Bi-level water cooler Supports:
 - 1. Description: Watts or equal, floor mounted bi-level water cooler carrier with heavy gauge steel uprights with integral welded feet, universal steel hanger support plate, and plated hardware.

2.6 WATER CLOSETS

- A. Water Closets WC-1
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide product by American Standard or one of the following:
 - a. Kohler
 - 2. Description: HET, wall hung, elongated high efficiency toilet, 1.28 gpf, youth ADA compliant, back-outlet, top spud, vitreous-china fixture.
 - a. Supply: NPS 1 chrome-plated brass or copper with screwdriver stop.
 - b. Style: Piston type manual flushometer
 - 1) Bowl Type: elongated with high efficiency siphon-jet design.
 - 2) Design Consumption: 1.28 gal./flush (4.8 L/flush).
 - 3) Color: White.
 - c. Fixture Support: Water Closet Carrier
 - 3. Flushometer Manufacturer: Provide Sloan or a comparable product by one of the following:
 - a. American Standard Companies, Inc.
 - b. Kohler Co.
 - 4. Flushometer Description: Piston type flushometer with manual operation. Flushometer for water closet type fixture. Include brass body with corrosion-resistant internal

components, non-hold-open feature, control stop with check valve, vacuum breaker, copper or brass tubing, and polished chrome-plated finish on exposed parts.

- a. Internal Design: Diaphragm operation.
- b. Style: Exposed valve.
- c. Inlet Size: NPS 1”.
- d. Trip Mechanism: Manual Lever
- e. Consumption: 1.28 gal./flush.
- f. Tailpiece Size: NPS 1-1/2”.

B. Water Closets WC-2

1. Basis-of-Design Product: Subject to compliance with requirements, provide product by American Standard or one of the following:
 - a. Kohler
2. Description: HET, wall hung, elongated high efficiency toilet, 1.28 gpf, youth ADA compliant, back-outlet, top spud, vitreous-china fixture.
 - a. Supply: NPS 1 chrome-plated brass or copper with screwdriver stop.
 - b. Style: Piston type manual flushometer
 - 1) Bowl Type: elongated with high efficiency siphon-jet design.
 - 2) Design Consumption: 1.28 gal./flush (4.8 L/flush).
 - 3) Color: White.
 - c. Fixture Support: Water Closet Carrier
3. Flushometer Manufacturer: Provide Sloan or a comparable product by one of the following:
 - a. American Standard Companies, Inc.
 - b. Kohler Co.
4. Flushometer Description: Piston type flushometer with manual operation. Flushometer for water closet type fixture. Include brass body with corrosion-resistant internal components, non-hold-open feature, control stop with check valve, vacuum breaker, copper or brass tubing, and polished chrome-plated finish on exposed parts.
 - a. Internal Design: Diaphragm operation.
 - b. Style: Exposed valve.
 - c. Inlet Size: NPS 1”.
 - d. Trip Mechanism: Manual Lever
 - e. Consumption: 1.28 gal./flush.
 - f. Tailpiece Size: NPS 1-1/2”.

2.7 TOILET SEATS

A. Toilet Seat WC-1 & WC-2

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
2. Basis-of-Design Product: Subject to compliance with requirements, provide Church Seats or a comparable product by one of the following:
 - a. Kohler
 - b. Bemis Manufacturing Company.
 - c. American Standard
3. Description: Toilet seat for water-closet-type fixture.
 - a. Material: Molded, solid plastic.

- b. Configuration: Open front without cover.
- c. Size: Elongated.
- d. Hinge Type: CK, check.
- e. Class: Heavy-duty commercial.
- f. Color: White.

2.8 LAVATORIES

A. Lavatory L-1

- 1. Manufacturers: Subject to compliance with requirements, Basis of design American Standard:
- 2. Description: Accessible, under counter mount, white vitreous china fixture with insulated piping below.
 - a. Size: 19 3/4" wide x 13 3/4" front to back x 6-7/16" high.
 - b. Faucet Hole Punching: Single hole in counter
 - c. Faucet Hole Location: Countertop
 - d. Color: White.
 - e. Faucet: Lavatory L-1
 - f. Supplies: NPS 3/8 (DN 10) chrome-plated copper with stops.
 - g. Drain: Grid.
 - h. Drain Piping: NPS 1-1/4 by NPS 1-1/2 (DN 32 by DN 40) chrome-plated, cast-brass P-trap; NPS 1-1/2 (DN 40) tubular brass waste to wall; and wall escutcheon.
 - i. Protective Shielding Guard(s): N/A
 - j. Fixture Support: N/A

2.9 COMMERCIAL SINKS

A. Commercial Sinks, SK-1:

- 1. Basis-of-Design Product: Subject to compliance with requirements, provide Just or a comparable product by one of the following:
 - a. Elkay.
- 2. Description: Two-compartment, under counter mounted, stainless-steel commercial sink with rear center drain location, ADA compliant sink bowl, fully coated bottom.
 - a. Overall Dimensions: 31 3/4" left to right by 16 1/2" front to back by 5-3/8" deep.
 - b. Metal Thickness: 18 gauge.
 - c. Faucet Holes: Three
 - d. Compartment:
 - 1) Bowl Dimensions: 14" left to right by 14" front to back by 5-3/8" deep.
 - 2) Drain: Grid Strainer.
 - a) Location: Rear Center of compartment.
 - e. Supplies: NPS 1/2 (DN15) chrome-plated copper with chrome plated, quarter turn ball valve stops.
 - f. Drain Piping: NPS 1-1/2 (DN 40) chrome-plated, cast-brass P-trap; tubular brass waste to wall; and wall escutcheon(s).
 - g. Provide offset tailpiece.

2.10 INDIVIDUAL SHOWERS

A. One Piece Transfer Shower, SH-1:

1. Basis-of-Design Product: Subject to compliance with requirements, provide AquaBath.
 2. Description: Transfer, ADA Accessible, one-piece solid surface construction, open top, shower enclosure with molded-in soap dish, slip-resistant surface, factory installed shower rod, grab bars, fold-up seat and weighted antibacterial curtain.
 - a. Size: 36" x 36" x 80-3/4" high inside dimensions, 41" x 37" x 82-3/4" high overall dimensions. Surround: One piece.
 - b. Color: White solid acrylic.
 - c. Threshold: .75".
 - d. Drain Location: Front Center.
 - e. Valve Location: Right wall.
 - f. Fold-up seat: Left wall.
 - g. Accessibility Options: Include grab bars and fold up seat on left side.
 - h. Grab bars: GRAB BARS MUST BE MOUNTED MAXIMUM 33" TO THE TOP OF BAR.
 - i. Faucet: Shower SH-1.
 - j. Drain: Trench Drain, NPS 2 (DN 50).
 - k. Base: Grout.
 - l. Provide white, weighted, anti-bacterial curtain.
- B. One Piece Transfer Shower, SH-2:
1. Basis-of-Design Product: Subject to compliance with requirements, provide AquaBath.
 2. Description: Transfer, ADA Accessible, one-piece solid surface construction, open top, shower enclosure with molded-in soap dish, slip-resistant surface, factory installed shower rod, grab bars, fold-up seat and weighted antibacterial curtain.
 - a. Size: 36" x 36" x 80-3/4" high inside dimensions, 41" x 37" x 82-3/4" high overall dimensions. Surround: One piece.
 - b. Color: White solid acrylic.
 - c. Threshold: .75".
 - d. Drain Location: Front Center.
 - e. Valve Location: Left wall.
 - f. Fold-up seat: Right wall.
 - g. Accessibility Options: Include grab bars and fold up seat on left side.
 - h. Grab bars: GRAB BARS MUST BE MOUNTED MAXIMUM 33" TO THE TOP OF BAR.
 - i. Faucet: Shower SH-2.
 - j. Drain: Trench Drain, NPS 2 (DN 50).
 - k. Base: Grout.
 - l. Provide white, weighted, anti-bacterial curtain.
- C. One Piece Transfer Shower, SH-3:
1. Basis-of-Design Product: Subject to compliance with requirements, provide AquaBath.
 2. Description: One piece solid surface construction, open top, shower enclosure with molded-in soap dish, slip-resistant surface, factory installed shower rod, grab bars, and weighted antibacterial curtain.
 - a. Size: 36" x 36" x 80-3/4" high inside dimensions, 41" x 37" x 82-3/4" high overall dimensions. Surround: One piece.
 - b. high overall dimensions. Surround: One piece.
 - c. Color: White solid acrylic.
 - d. Threshold: 2".
 - e. Drain Location: Center.
 - f. Valve Location: Per drawings.

- g. Fold-up seat: Not required.
- h. Accessibility None
- i. Grab bars: GRAB BARS MUST BE MOUNTED MAXIMUM 33" TO THE TOP OF BAR.
- j. Faucet: Shower SH-3
- k. Drain: Grid, NPS 2 (DN 50).
- l. Base: Grout.
- m. Provide white, weighted, anti-bacterial curtain.

2.11 SERVICE BASINS

A. Service Basins, MB-1:

- 1. Basis-of-Design Product: Subject to compliance with requirements, provide Fiat.
- 2. Description: Flush-to-wall, floor-mounting, terrazzo fixture with rim guard.
 - a. Shape: Square.
 - b. Size: 24 by 24 inches with dropped front.
 - c. Height: 12 inches.
 - d. Wall Guards: stainless steel wall guards, two sides plus corner bracket by 12" high.
 - e. Rim Guard: Stainless on all top surfaces.
 - f. Faucet: MB-1.
 - g. Drain: Grid with NPS 2 (DN 50) outlet.
 - h. Accessories:
 - 1) 830AA Mop Service Basin Fitting
 - 2) 832AA Hose & Hose bracket
 - 3) MSG Stainless Steel wall guards.
 - i.

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 plumbing fixture installation.
- B. Examine cabinets, counters, floors, and walls for suitable conditions where fixtures will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Assemble plumbing fixtures, trim, fittings, and other components according to manufacturers' written instructions.
- B. Install water-supply piping with stop on each supply to each fixture to be connected to water distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.

- C. Install trap and tubular waste piping on drain outlet of each fixture to be directly connected to sanitary drainage system.
- D. Install escutcheons at piping wall ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding fittings. Escutcheons are specified in Division 22 Section "Common Work Results for Plumbing."
- E. Seal joints between fixtures and walls, floors, and countertops using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Sealants are specified in Division 07 Section "Joint Sealants."

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

3.4 FIELD QUALITY CONTROL

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

3.5 ADJUSTING

- A. Operate and adjust faucets and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.
- B. Operate and adjust high temperature limit stops on faucets. Replace damaged and malfunctioning units.

3.6 CLEANING

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

- B. After completing installation of exposed, factory-finished fixtures, faucets, and fittings, inspect exposed finishes and repair damaged finishes.

3.7 PROTECTION

- A. Provide protective covering for installed fixtures and fittings.
- B. Do not allow use of plumbing fixtures for temporary facilities.

END OF SECTION 224000

SECTION 224700 - DRINKING FOUNTAINS AND WATER COOLERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following water coolers and related components:
 - 1. Pressure water coolers.

1.3 DEFINITIONS

- A. Accessible Water Cooler: Fixture that can be approached and used by people with disabilities.

1.4 SUBMITTALS

- A. Product Data: For each fixture indicated. Include rated capacities, furnished specialties, and accessories.
- B. Shop Drawings: Diagram power, signal, and control wiring.
- C. Field quality-control test reports.
- D. Operation and Maintenance Data: For fixtures to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities" Public Law 101-336, "Americans with Disabilities Act" ; for fixtures for people with disabilities.
- C. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.
- D. ARI Standard: Comply with ARI's "Directory of Certified Drinking Water Coolers" for style classifications.

- E. ARI Standard: Comply with ARI 1010, "Self-Contained, Mechanically Refrigerated Drinking-Water Coolers," for water coolers and with ARI's "Directory of Certified Drinking Water Coolers" for type and style classifications.
- F. ASHRAE Standard: Comply with ASHRAE 34, "Designation and Safety Classification of Refrigerants," for water coolers. Provide HFC 134a (tetrafluoroethane) refrigerant, unless otherwise indicated.

PART 2 - PRODUCTS

2.1 PRESSURE WATER COOLERS

- A. Water Coolers EWC-1
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Elkay or a comparable product by one of the following:
 - a. Halsey Taylor.
 - 2. Description: Wall Hung with concealed chiller, hands free activation, dual height bubblers with bottle filler, Flexi-Guard bubbler, Accessible, ARI 1010, Pressure with bubbler.
 - a. Cabinet: Bilevel bowls on wall mounted cabinet
 - b. Bubbler: One, with flexible bubbler hood, adjustable stream regulator for each bowl.
 - c. Bottle Filler: 1.1 gpm with Water Sentry Plus 3,000 gallon water filter.
 - d. Controls: No-touch sensor operated bubblers, no-touch sensor for bottle filler.
 - e. Supply: NPS 3/8 (DN 10) with ball, gate valve.
 - f. Drain(s): Grid with NPS 1-1/2 minimum horizontal waste and trap complying with ASME A112.18.1.
 - g. Cooling System: Electric, with hermetically sealed compressor, cooling coil, air-cooled condensing unit, corrosion-resistant tubing, refrigerant, corrosion-resistant-metal storage tank, and adjustable thermostat.
 - 1) Capacity: 8.0 gph of 50 deg F (10 deg C) cooled water from 80 deg F (27 deg C) inlet water and 90 deg F (32 deg C) ambient air temperature.
 - 2) Electrical Characteristics: 120-V ac; single phase; 60 Hz.
 - h. Support: Type II, water cooler carrier. Refer to "Fixture Supports" Article.
 - i. Provide model 51300C_24PK, 24 spare filters.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in for water and waste piping systems to verify actual locations of piping connections before fixture installation. Verify that sizes and locations of piping and types of supports match those indicated.
- B. Examine walls and floors for suitable conditions where fixtures are to be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

- A. Use carrier off-floor supports for wall-mounting fixtures, unless otherwise indicated.

3.3 INSTALLATION

- A. Install off-floor supports affixed to building substrate and attach wall-mounting fixtures, unless otherwise indicated.
- B. Install mounting frames affixed to building construction and attach recessed water coolers to mounting frames, unless otherwise indicated.
- C. Install fixtures level and plumb. For fixtures indicated for children, install at height required by authorities having jurisdiction.
- D. Install water-supply piping with shutoff valve on supply to each fixture to be connected to water distribution piping. Use ball, gate, or globe valve. Install valves in locations where they can be easily reached for operation. Valves are specified in Division 22 Section "General-Duty Valves for Plumbing Piping."
- E. Install trap and waste piping on drain outlet of each fixture to be connected to sanitary drainage system.
- F. Install pipe escutcheons at wall penetrations in exposed, finished locations. Use deep-pattern escutcheons where required to conceal protruding pipe fittings. Escutcheons are specified in Division 22 Section "Common Work Results for Plumbing."
- G. Seal joints between fixtures and walls and floors using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color. Sealants are specified in Division 07 Section "Joint Sealants."

3.4 CONNECTIONS

- A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
- C. Ground equipment according to Division 26 Sections for "Grounding and Bonding."
- D. Connect wiring according to Division 26 Sections for "Wire and Cable".

3.5 FIELD QUALITY CONTROL

- A. Water Cooler Testing: After electrical circuitry has been energized, test for compliance with requirements. Test and adjust controls and safeties.
 - 1. Remove and replace malfunctioning units and retest as specified above.
 - 2. Report test results in writing.

3.6 ADJUSTING

- A. Adjust fixture flow regulators for proper flow and stream height.
- B. Adjust water cooler temperature settings.

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, on completion of installation, according to manufacturer's written instructions.

END OF SECTION 224700

SECTION 230500 – COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Provide labor, materials, accessories, and other related items as required to complete operations in connection with the complete installation of the HVAC and mechanical systems as indicated on the Drawings and as specified herein.

1.2 RELATED REQUIREMENTS

- A. Conditions of the Contract apply to the work, including the work of this Division. Examine Contract Documents for requirements affecting the work.
- B. Provide cooperation with, and assistance to, the Testing and Balancing (TAB) Agent specified in Division 23 Section “Testing, Adjusting, and Balancing for Mechanical Systems.”

1.3 MECHANICAL PRE-CONSTRUCTION MEETING

- A. Conduct a mechanical conference at Project site to comply with requirements of the following:
 - 1. At least 14 days prior to beginning of mechanical work, conduct a meeting to review detailed requirements for mechanical systems installation and testing requirements. Review mechanical Drawings and Specifications, discuss project specific details and requirements, and review and discuss expectations for quality control. Establish preliminary work progress schedule and procedures for materials inspection, testing, and certifications. Require representatives of each entity directly concerned with mechanical systems installation to attend conference, including, but not limited to, the following:
 - a. General Contractor's superintendent.
 - b. Mechanical Subcontractors' project managers.
 - c. Mechanical Subcontractors' job foremen.
 - d. Sheetmetal job foreman.
 - e. Plumbing job foreman.
 - f. Controls job foreman.
 - g. Project mechanical Engineer/designer.
 - h. Job clerk.
 - i. Architect's construction administrator.

1.4 CONTRACT DOCUMENTS

- A. The general location of the apparatus and the details of the work are indicated on the Drawings. Exact locations not indicated shall be determined at the site as the work progresses and shall be subject to the Architect's approval.
- B. It is not intended that the Drawings shall show every pipe, pipe rise, pipe drop, duct rise, duct drop, pipe fitting, duct fitting, or appliance, but it shall be a requirement to furnish, without additional expense, material and labor necessary to complete the systems in accordance with the design intent and with the highest possible quality available.

- C. The Contractor shall take no advantage of any apparent error or omission in the Drawings and Specifications, and the Designer shall be permitted to make such corrections and interpretations as may be deemed necessary for the fulfillment of the intent of the Drawings and Specifications. Where errors or omissions appear in the Contract Documents, the Contractor shall promptly notify the Designer in writing of such errors or omissions. Inconsistencies in the contract documents are to be reported before proposals are received, whenever found.
- D. 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.

1.5 ALTERATIONS

- A. Execute alterations, additions, removals, relocations, new work, and other related items as indicated or required to provide a complete installation in accordance with the intent of the Contract Documents, including changes required by building alterations.
- B. Existing work disturbed or damaged by the alterations or the new work shall be repaired or replaced to the Architect's satisfaction and at no additional cost to the Owner.
- C. Existing ductwork, piping, and other systems indicated to be removed, shall be removed from the site. Cap off existing services remaining. The Owner retains the right to ownership of heating and ventilating equipment scheduled to be removed; store such equipment where requested by the Owner. Material not retained by the Owner shall be removed from the site.

1.6 CONTINUITY OF SERVICE

- A. Arrange to execute the work at such times and in such locations as may be required to provide uninterrupted service for the building or any of its locations. Any unavoidable conditions requiring reduced building capacity shall be arranged for by programming with the Owner's duly authorized representative at the building subject to the Architect's approval. If necessary, temporary work shall be installed to provide for the condition. Authorization for interrupting service shall be obtained in writing from the Owner. Any interruption of normal service shall be performed during an overtime period to be scheduled with the Owner. Costs for overtime work shall be included in the Bid.

1.7 REQUIREMENTS

- A. Installation Instructions: Obtain manufacturer's printed installation instructions to aid in properly executing work on major pieces of equipment. Install equipment in accordance with manufacturer's recommendations.
- B. Objectionable Noise, Fumes and Vibration:
 - 1. Mechanical and electrical equipment shall operate without creating objectionable noise, fumes, or vibration, as determined by the Architect.
 - 2. If such objectionable noise, fumes, or vibration is produced and transmitted to occupied portions of building by apparatus, piping, ducts, or any other part of mechanical and electrical work, make necessary changes and additions, as approved, without extra cost to Owner.

- C. Equipment Design and Installation:
1. Uniformity: Unless otherwise specified, equipment or material of same type or classification, used for same purposes, shall be product of same manufacturer.
 2. Design: Equipment and accessories not specifically described or identified by manufacturer's catalog number shall be designed in conformity with ASME, IEEE, or other applicable technical standards, suitable for maximum working pressure, and with neat and finished appearance.
 3. Installation: Erect equipment aligned, level, and adjusted for satisfactory operation. Install so that connecting and disconnecting of piping and accessories can be made readily, and so that parts are easily accessible for inspection, operation, maintenance and repair. Minor deviations from indicated arrangements may be made, as approved.
- D. Hanging of Equipment, Ductwork and Piping:
1. Attach supports only to structural framing members and non-metal deck concrete slabs.
 2. Support equipment, ductwork, and piping from the top chord of bar joists at the "Panel Points" or from the top flange of beams. Provide intermediate support consisting of steel angle or equal as required where supports are installed between joist spaces.
 3. Piping 2-inch (50 mm) nominal and smaller may be supported from the bottom chord of the bar joists at the "Panel Points" or from the bottom flange of the beams.
 4. Do not anchor supports to metal decking with or without a concreted slab.
- E. Protection of Equipment and Materials: Responsibility for care and protection of materials and mechanical work rests with the Contractor until the entire project has been completed, tested and the project is accepted by the Owner.
- F. Ceiling Mounting: Where ceiling mounting is indicated or specified, use suspended platform, threaded rod, or strap hangers, bracket or shelf, whichever is most suitable for equipment and its location. Construct of structural steel members, steel plates, or rods, as required; brace and fasten to building structure or to inserts as approved, or as detailed.
- G. Foundations: Provide Housekeeping pad in accordance with Section "Hangers and Supports for HVAC Piping and Equipment"

1.8 ACCESS PANELS

- A. Access panels required for items furnished under Division 23 shall be provided under this Division.
- B. Selection and installation of access panels shall be in accordance with Division 08 Section "Access Doors and Frames."
- C. Access panels shall be standard panels, 12 inch x 16 inch (305 mm x 406 mm) minimum unless indicated otherwise. Panels installed in areas of high moisture concentration, such as locker rooms, near plumbing fixtures, food preparation areas, or outdoors, shall be fabricated of paintable stainless steel or aluminum for corrosion resistance.
- D. Access panels in fire-rated construction shall have the same UL rating as the building assembly in which they are installed.
- E. Provide access panels in building construction where required for access to duct access doors or other components such as valves, air vents, actuators, volume dampers, motorized dampers

in ductwork, duct smoke detectors, and other related items.

1.9 ELECTRIC WORK

- A. Provide motors, pilot lights, controllers, limit switches, and other related items for equipment provided under Division 23.
- B. Except as noted, required line switches, fused switches, and other related items and necessary wiring to properly connect equipment to motors and switches shall be furnished and installed under Division 26, Electric.
- C. Provide complete wiring system for automatic temperature controls as specified under Section Division 23 Section "Instrumentation and Controls for Mechanical Systems."
- D. Wiring shall conform to the requirements of the National Electrical Code.

1.10 FIRESTOPPING

- A. Firestopping for penetrations of ductwork, piping and equipment through fire rated and smoke rated building assemblies, including but not limited to partitions, walls, floors, ceilings, and roofs, shall be provided by Division 07 Section "Through Penetration Firestop Systems."
- B. Selection of firestopping materials and installation of firestopping materials shall be in accordance with Division 07 Section "Through Penetration Firestop Systems." Coordinate with other trades for a consistent installation.
- C. Refer to Architectural Drawings for locations of fire rated building assemblies.

1.11 DUCT MOUNTED SMOKE DETECTORS

- A. Duct mounted smoke dampers shall be furnished under Division 26.
- B. Smoke sampling tubes shall be installed by Division 23. Coordinate location with Division 26.
- C. Whether or not indicated on the Drawings, air handling systems with a design capacity over 2000 CFM shall have duct mounted smoke detection equipment in accordance with the requirements of NFPA 90A and BOCA.

1.12 SUBMITTALS

- A. After award of Contract and before installation, submit for approval Shop Drawings, bulletins, Product Data, Samples, and other related items.
- B. Submit Shop Drawings and Product Data as required in each Section. Submittal shall include physical data and performance data required to verify compliance with the Contract Documents.
- C. Submit Mock-Ups as required in each Section, and as indicated on the Drawings. For general mock-up procedures, refer to Division 01 Section "Quality Requirements." Deliver to the Architect/Engineer for review if so indicated. Provide return shipping.
- D. Architect/Engineer's review will not include the review, coordination, or verification of

dimensions or quantities; these shall be the responsibility of the Contractor.

1.13 SUBSTITUTIONS

- A. Comply with provisions of the Instructions to Bidders and General Requirements of the Specifications.
- B. The first item listed under “Acceptable Manufacturers”, “Approved Manufacturers” or “Manufacturers” is the design basis.
 - 1. Other manufacturers listed may be used in the base Bid, but conformance with details of the Specifications, as well as dimensional and electrical data, shall be verified by the Contractor.
 - 2. Architect/Engineer has not verified that each listed manufacturer has the ability to provide an acceptable substitution for the basis-of-design product. Contractor may not assume that substitutions will be approved.
 - 3. Modifications required as a result of differences between the design basis item and the submitted and approved item must be approved by the Architect and made at the Contractor's expense. As an example, if a rooftop HVAC unit is submitted and approved and if the unit's dimensions and weight are different from those of the unit which was used as the design basis, the Contractor shall be responsible for building structural modifications required to accommodate the submitted and approved unit, at no additional cost to the Owner.
 - 4. When, in the Architect or Engineer's opinion, architectural or engineering services are necessary for the coordination of substituted items, the Contractor shall reimburse the Owner for the cost of these services.
 - 5. For items which have no manufacturers listed, any item conforming with the Contract Documents is acceptable.
- C. Substitutions from manufacturers or providers which are not listed may be proposed within the time allowed in the General Requirements of the Specifications.
 - 1. The exception to this is products for which the list of manufacturers or providers is limited by the wording “no substitutions” or similar wording.

1.14 COORDINATION

- A. Coordinate scheduling, submittals, and Work of the various Sections of Specifications to assure efficient and orderly sequence of installation of interdependent construction elements, with provisions for accommodating items installed later.
- B. Verify that utility requirement characteristics of operating equipment are compatible with building utilities. Coordinate work of various Divisions having interdependent responsibilities for installing, connecting to, and placing in service, such equipment.
- C. Coordinate space requirements and installation of mechanical and electrical work which are indicated diagrammatically on Drawings. Follow routing shown for pipes, ducts, and conduit, as closely as practicable; place runs parallel with line of building. Utilize spaces efficiently to maximize accessibility for other installations, for maintenance, and for repairs.
- D. In finished areas, conceal pipes, ducts, and wiring within the construction. Coordinate locations of fixtures and outlets with finish elements.

- E. Coordinate completion and clean-up of work of separate Sections in preparation for Substantial Completion.
- F. After Owner occupancy of premises, coordinate access to site for correction of defective work and work not in accordance with Contract Documents, to minimize disruption of Owner's activities.
- G.

1.15 REQUESTS FOR ARCHITECT'S CADD DRAWINGS

- A. In lieu of generating their own CADD drawings, the Contractor may elect to use the Architect's electronic copies of CADD drawings for the purpose of developing coordination drawings, developing control system graphics or for other reasons that pertain to the requirements of this Contract. If the Contractor elects to utilize the Architect's electronic copies of CADD drawings, the electronic files shall be purchased from the Architect at the Architect's current billing rate per drawing. The Contractor shall provide payment and shall sign a release-of-liability form before electronic CADD drawings are released.

1.16 CLEANING

- A. Remove debris from site daily.
- B. Material and pieces of equipment shall be turned over to the Owner free of dust and dirt, both inside and out.
- C. At the completion of the Project, equipment shall have a clean, neat appearance of factory finish by cleaning or repainting as required.
- D. At the completion of the Project, surfaces exposed to view shall have a clean, neat appearance of finish free from smudges and scratches by cleaning or repainting as required.

1.17 STARTING SYSTEMS

- A. Coordinate schedule for start-up of various equipment and systems.
- B. Notify Architect/Engineer 7 days prior to start-up of each item.
- C. Verify that each piece of equipment or system has been checked for proper lubrication, drive rotation, belt tension, control sequence, or other conditions which may cause damage.
- D. Verify that tests, meter readings, and specified electrical characteristics agree with those required by the equipment or system manufacturer.
- E. Verify that wiring and support components for equipment are complete and tested.
- F. Execute start-up under supervision of responsible manufacturer's representative in accordance with manufacturer's instructions.
- G. When specified in individual Specification Sections, require manufacturer to provide authorized representative to be present at site to inspect, check, and approve equipment or system installation prior to start-up, and to supervise placing equipment or system in

operation.

- H. Submit a written report that equipment or system has been properly installed and is functioning correctly.

1.18 FACTORY START-UP AND START-UP REPORTS

- A. Provide factory start-up of mechanical equipment listed below. Factory start-up shall be performed by a factory authorized representative of the equipment manufacturer. When factory start-up is successfully completed for each piece of mechanical equipment listed below, submit a formal start-up report to the Architect for approval. Start-up report shall be formatted in accordance with equipment manufacturer's recommendations. Start-up report shall be typed, not hand written, and shall be submitted in a clean and legible form.
- B. Equipment requiring factory start-up
 1. Air handling units
 2. Boilers
 3. Kitchen Hood Fire Suppression Systems.

1.19 ADJUSTMENTS AND OWNER'S INSTRUCTIONS

- A. After completion of the installation work called for in the Contract Documents, furnish necessary mechanics or engineers for the adjustment and operation of the systems, to the end that the systems are perfectly adjusted and turned over to the Owner in perfect working order. Further instruct the Owner's authorized representative in the care and operation of the installation, providing framed instruction charts, directions, and other related items.
- B. Instructors providing Owner training shall be experienced and familiar with the jobsite.

1.20 TESTING

- A. After the entire installation is completed and ready for operation, test the systems as outlined in Division 23 Section "Testing, Adjusting and Balancing for HVAC." These tests are supplementary to detailed tests specified herein or directed. The Owner will provide water and electric current for the test. Provide necessary labor, test pump, gauges, meters, other instruments, and materials. Perform tests in the presence of the Architect or their representative.
- B. Perform other tests specified in individual Sections of this Specification.

1.21 COMPLETION OF SYSTEMS

- A. The following mechanical systems shall not be complete until the following conditions are satisfied:
 1. Ductwork Systems:
 - a. Ductwork and related components and accessories shall be completely installed and insulated as specified.
 - b. Ductwork leakage testing shall be completed and leakage testing reports shall be submitted and approved.
 - c. Ductwork shall be balanced and a balancing report shall be submitted and approved.

- d. Commissioning shall be completed.
- 2. Piping Systems:
 - a. Piping, valves and accessories shall be completely installed, insulated and labeled as specified.
 - b. Piping pressure testing be completed and pressure testing reports shall be submitted and approved.
 - c. Piping systems shall be balanced and a balancing report shall be submitted and approved.
 - d. Commissioning shall be completed.
- 3. Equipment:
 - a. Equipment, including but not limited to boilers, heat exchangers, terminal heat transfer units, pumps, air handling units, condensing units, chillers, split system air conditioning equipment, and exhaust fans, shall be completely installed.
 - b. Equipment start-up reports shall be completed, submitted and approved.
 - c. Equipment balancing shall be completed and the balancing report shall be submitted and approved.
 - d. Commissioning shall be completed.
- 4. Automatic Temperature Controls (ATC):
 - a. ATC system shall be completely installed.
 - b. Commissioning shall be completed.
 - c. ATC system shall operate in an automatic mode for a minimum of 4 months during Owner occupancy without substantial deficiencies.

1.22 OPERATING AND MAINTENANCE MANUALS

- A. Furnish quantity required in the Specifications, of bound operating and maintenance manuals. Deliver to the Architect for review. Required quantity is for the Owner; the Architect will not retain a bound copy.
- B. For maintenance purposes, provide approved Submittals, parts lists, specifications, and manufacturer's maintenance bulletins for each piece of equipment. For materials used which have been submitted to the Architect for approval but do not require regular maintenance, such as piping, ductwork, and insulation, provide one copy of approved Submittals.
- C. Provide name, address and telephone number of the manufacturer's representative and service company, for each piece of equipment or material so that service or spare parts can be readily obtained.

1.23 WARRANTY

- A. Provide guarantees and warranties for work under this Contract as indicated in the General Requirements of the Specifications.
- B. Provide manufacturers' standard warranties and guarantees for work by the mechanical trades. However, such warranties and guarantees shall be in addition to and not in lieu of other liabilities which the manufacturer and the Mechanical Contractor may have by law or by other provisions of the Contract Documents.
- C. Guarantee that elements of the systems provided under this Contract are of sufficient capacity to meet the specified performance requirements as set forth in these Specifications or as indicated on the Drawings.

- D. Upon receipt of notice from the Owner of failure of any part of the mechanical systems or equipment during the warranty period, the Mechanical Subcontractor shall replace the affected part or parts.
- E. Furnish a written guarantee covering the above requirements before submitting the application for final payment.

PART 2 - PRODUCTS (NOT USED)

PART 3 - EXECUTION (NOT USED)

END OF SECTION 230500

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SECTION 230513 – COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Common requirements for electric motors furnished on equipment specified in other Sections, including single phase and three phase electric motors.
- B. Shaft Grounding Rings.
- C. Starters.
- D. Thermal Overload Protection.
- E. Belt Drives.
- F. Variable Speed Drives.

1.2 REFERENCES

- A. AFBMA.
- B. NEMA MG 1 - Motors and Generators.
- C. NFPA 70 - National Electrical Code.
- D. UL.

1.3 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Company specializing in manufacturing the Products specified in this Section with minimum 3 years' experience.
- B. Installer Qualifications: Company specializing in performing the work of this Section with minimum 3 years' experience.

1.4 REGULATORY REQUIREMENTS

- A. Conform to UL Component Recognition for appropriate sizes.
- B. Conform to NFPA 70 and local energy code.

1.5 DELIVERY, STORAGE, AND PROTECTION

- A. Transport, handle, store, and protect products.
- B. Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weather-proof covering. For extended outdoor storage, remove motors from equipment and store separately.

PART 2 - PRODUCTS

2.1 MOTORS

- A. Acceptable Manufacturers:
 - 1. A.O. Smith.
 - 2. Baldor.
 - 3. Emerson Motor Technologies.
 - 4. General Electric.
 - 5. Greenheck Fan Corporation
 - 6. Marathon Electric.
 - 7. Siemens.
 - 8. Teco-Westinghouse.
 - 9. Toshiba.
 - 10. U.S. Motors (division of Emerson Motor Technologies).
 - 11. Substitutions: Approved equal. See Section 016000 - Product Requirements.
- B. General Construction and Requirements:
 - 1. Motors Less Than 250 Watts, for Intermittent Service: Equipment manufacturer's standard and need not conform to these Specifications.
 - 2. Motors shall have integral thermal overload protection.
 - 3. Single Phase Motors for general applications: PSC (permanent split capacitor) where available.
 - 4. Single Phase Motors for fans:
 - a. EC (electronically commutated) where available.
 - b. PSC (permanent split capacitor) where available, if EC is not available.
 - 5. Open drip-proof type except where specifically noted otherwise.
 - 6. Design for continuous operation in 40 degrees C environment.
 - 7. Design for temperature rise in accordance with NEMA MG 1 limits for insulation class, service factor, and motor enclosure type.
 - 8. Explosion-Proof Motors: UL approved for hazard classification.
 - 9. Visible Nameplate: Indicating manufacturer's name and model number, motor horsepower, RPM, frame size, voltage, phase, cycles, full load amps, insulation system class, service factor, maximum ambient temperature, temperature rise at rated horsepower, minimum efficiency.
- C. Inverter Duty: Motors for use with variable frequency drives shall be rated for "inverter duty", with winding insulation rated for 1600 Volts and Class H (180 degrees C) temperature rating.
- D. Single-Phase Power for Fans - Electronically-Commutated (EC) Motors - Also Known As Brush-Free DC (BFDC) Motors:
 - 1. Drive: Direct-drive only, not for use with belt drive.
 - 2. Power Supply: Internal motor circuitry shall convert AC power supplied to DC power to operate the motor.
 - 3. Turndown: Speed-controllable down to 20 percent of full speed (80 percent turndown).
 - 4. Speed Control: Integral potentiometer with screwdriver setting, remote potentiometer dial with 24 VDC transformer to generate a 0-10 VDC signal, or integral circuitry to accept a 0-10 VDC signal from the building control system, as indicated and specified.
 - 5. Efficiency: Minimum of 85 percent efficient at all speeds.
 - 6. Soft-start type, capable of reliable start at any speed setting.
 - 7. Enclosure: Open drip-proof.

8. Bearings: Permanently lubricated heavy duty ball bearings.
 9. Overload Protection:
 - a. Automatic Speed Control: In the event of overheating or overloading, the motor electronics slow the motor to operate within its acceptable range.
 - b. Thermal Overload: Internally fused, one-shot type as a last resort to prevent fires.
 - c. Locked Rotor: If the motor sees a locked rotor condition, it will automatically shut itself down, then try to restart 3 times. After the 3rd try, the motor will not attempt to restart until the power is cycled.
- E. Single Phase Power - Permanent-split Capacitor Motors:
1. Starting Torque: Exceeding one fourth of full load torque.
 2. Starting Current: Up to six times full load current.
 3. Multiple Speed: Through tapped windings.
 4. Open Drip-proof or Enclosed Air Over Enclosure: Class A (50 degrees C temperature rise) insulation, minimum 1.0 Service Factor, prelubricated sleeve or ball bearings, automatic reset overload protector.
- F. Single Phase Power - Capacitor Start Motors:
1. Starting Torque: Three times full load torque.
 2. Starting Current: Less than five times full load current.
 3. Pull-up Torque: Up to 350 percent of full load torque.
 4. Breakdown Torque: Approximately 250 percent of full load torque.
 5. Motors: Capacitor in series with starting winding; provide capacitor-start/capacitor-run motors with two capacitors in parallel with run capacitor remaining in circuit at operating speeds.
 6. Drip-proof Enclosure: Class A (50 degrees C temperature rise) insulation, NEMA Service Factor, prelubricated bearings.
 7. Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor, prelubricated ball bearings.
- G. Single Phase Power - Split Phase Motors:
1. Starting Torque: Less than 150 percent of full load torque.
 2. Starting Current: Up to seven times full load current.
 3. Breakdown Torque: Approximately 200 percent of full load torque.
 4. Drip-proof Enclosure: Class A (50 degrees C temperature rise) insulation, NEMA Service Factor, prelubricated sleeve or ball bearings.
 5. Enclosed Motors: Class A (50 degrees C temperature rise) insulation, 1.0 Service Factor, prelubricated ball bearings.
- H. Three Phase Power - Squirrel-cage Motors:
1. Starting Torque: Between 1 and 1-1/2 times full load torque.
 2. Starting Current: Six times full load current.
 3. Power Output, Locked Rotor Torque, Breakdown or Pull Out Torque: NEMA Design B characteristics.
 4. Design, Construction, Testing, and Performance: Conform to NEMA MG 1 for Design B energy-efficient motors.
 5. Insulation System: NEMA Class B or better.
 6. Motor Frames: NEMA Standard T-Frames of steel, aluminum, or cast iron with end brackets of cast iron or aluminum with steel inserts.
 7. Bearings: Grease lubricated anti-friction ball bearings with housings equipped with plugged provision for relubrication, rated for minimum AFBMA 9, L-10 life of 200,000

- hours. Calculate bearing load with NEMA minimum V-belt pulley with belt center line at end of NEMA standard shaft extension. Stamp bearing sizes on nameplate.
- 8. Sound Power Levels: To NEMA MG 1.
- 9. Part Winding Start Above 254T Frame Size: Use part of winding to reduce locked rotor starting current to approximately 60 percent of full winding locked rotor current while providing approximately 50 percent of full winding locked rotor torque.
- 10. Weatherproof Epoxy Sealed Motors: Epoxy seal windings using vacuum and pressure with rotor and starter surfaces protected with epoxy enamel; bearings double shielded with waterproof non-washing grease.
- 11. Nominal Efficiency: To NEMA MG 1, energy efficient for motor sizes 10 and larger.

2.2 SHAFT GROUNDING RINGS

- A. Manufacturers:
 - 1. Electro Static Technology Inc. - Aegis SGR product line.
 - 2. Inpro/Seal, a division of Waukesha Bearings Corporation - CDR product line.
- B. Provide shaft grounding rings (SGRs) on 3-phase motors which are intended to be used with variable-frequency drives (VFDs). The SGRs may be furnished by the motor manufacturer as an integral part of the motor, furnished factory-installed by the equipment manufacturer, or furnished for field installation by the equipment installer.
- C. Description: Circumferential micro-fiber ring with metal frame, designed to conduct VFD-induced bearing currents from the motor shaft to ground. Provides protection recommended in NEMA MG 1. Provide with mounting kit including bolts and bracket, or conductive epoxy to adhere to motor casing, to ensure ground connection from the SGR to the motor frame.
- D. Provide SGRs on at least one end of the motor. On motors above 100 hp (74.5 kW), provide a bearing insulation kit on the end of the motor without an SGR.

2.3 STARTERS AND OVERLOADS

- A. Acceptable Manufacturers:
 - 1. Cerus Industrial, Inc.
 - 2. Allen-Bradley (division of Rockwell Automation).
 - 3. Cutler Hammer (division of Eaton Corporation).
 - 4. General Electric.
 - 5. Siemens.
 - 6. Square D (division of Schneider Electric).
 - 7. Substitutions: Approved equal. See Section 016000 - Product Requirements.
- B. Provide motor starters for motors provided under this Division of these Specifications.
- C. Cerus Industrial "BAS" building automation HVAC starters are the basis of design. Features of starters/contactors, disconnects, and temperature controls shall be combined in a single package using these starters. Coordination with Automatic Temperature Controls supplier and installer is required to reduce total project costs.
 - 1. 3-phase starter features include:
 - a. Multi-tap control power transformer (CPT) for universal control voltage.
 - b. Motor circuit protector disconnect (MCP) with high interrupt rating and lockable operator handle.

- c. Contactors rated as high as 2.5 million electrical operations and 25 million mechanical operations.
 - d. Anti-cycling feature.
 - e. Solid-state electronic overloads with wide adjustment range and highly accurate digital motor protection, including protection for phase loss, phase unbalance, stall and locked rotor conditions. Class 1-30.
 - f. Digital keypad, featuring an H-O-A (Hand, Off, Auto) panel with large, clearly labeled push buttons including a front panel reset function and high-intensity LED indicators for settings.
 - g. Damper and valve actuator control, to open the actuator before starting the fan or pump motor.
 - h. Permissive auto control to disable auto inputs. Commonly used with a high pressure limit switch.
 - i. Universal control inputs, including auto dry input, and wet input for voltages from 20 to 138 VAC or VDC.
 - j. Power failure reset.
 - k. Fireman's override.
 - l. NEMA 1 enclosure with prepunched knockouts. NEMA 3R, 4, 4X, and 12 as required.
 - m. BACnet embedded communications option available.
 - n. UL Listed assembly.
 - o. 5-year warranty.
 - p. Factory printed label or engraved nameplate, designating the equipment served.
2. Single-phase starter (Cerus BAS-IP series) features include:
- a. Manually operated quick-make toggle mechanism lockable in the "Off" position, which shall also function as the motor disconnect.
 - b. Hand/Auto switch, concealed behind sliding cover to discourage tampering.
 - c. Capability to operate in both manual and automatic control modes. In automatic mode, the starter shall have the capability to integrate with a building automation system by providing terminals for run input, run status output, and fault output.
 - d. Control terminals integrated in the starter.
 - e. Power, run status, and fault LED pilot lights.
 - f. Interposing run relay and current sensing status output relay.
 - g. Voltage and dry inputs for auto run command.
 - h. System override mode (fireman's, occupancy, or manual).
 - i. Solid-state electronic overload with wide adjustment range and highly accurate digital motor protection, including protection for stall and locked rotor conditions. Class 10. Concealed adjustment behind sliding cover.
 - j. Surface mount enclosure, UL Type 1, single gang box installation, with sliding covers for concealed items.
 - k. Power Input: 1-phase, 110-240 VAC, 1-16 Amps, 0.1-1 HP (75 to 745 W).
 - l. Universal Control Inputs: Voltage auto-run 10-130 VAC/DC to energize. Dry auto-run normally-open dry contact closure.
 - m. Control Outputs: Proof of run and fault, normally-open 0.3 Amps at 125 VAC, 1 Amp at 24 VAC.
 - n. Ambient operating temperature -5 to 140 degrees F (-20 to 60 degrees C).
 - o. UL 508A Listed.
 - p. 5-year warranty.

D. Feature Descriptions:

1. Fireman's Override Input: Causes the starter to run the motor in any mode (Hand, Off or Auto) regardless of other inputs or lack of inputs either manual or auto. The purpose of the Fireman's Override input is to act as a smoke purge function. Fireman's Override has priority over the Emergency Shutdown input.
2. Emergency Shutdown Input: Disables the starter from operating in either Hand or Auto mode regardless of other inputs either manual or auto.
3. Phase Failure Protection: Initiates when phase loss is greater than 70 percent for 3 seconds or phase unbalance is greater than 50 percent for more than 5 seconds.
4. Cycling Fault Protection: Activates whenever the starter is cycled at a rate of more than 1000 cycles in a one hour period. This feature shall be selectable to be disabled. Cycling fault shall cause overload LED to blink rapidly.

E. Contactors in starters shall be general purpose NEMA rated for connected H.P. (definite purpose starters not acceptable). Coordinate control voltage with Controls Contractor. Provide auxiliary contacts where required for interlocking of electrical equipment. Provide 2-speed motor starters where indicated or required.

F. Single phase motors shall have one of the following factory wired methods of motor protection:

1. Integral thermal overload protection in motor and cord with plug and receptacle in unit casing.
2. Integral thermal overload protection in motor and disconnecting switch mounted in or on casing as specified with equipment.
3. Switch with thermal overload protection for unprotected motors with switch serving as disconnect device.

G. For starters associated with equipment that is required to be shut down upon a fire alarm condition, provide input contacts within the starter enclosure to interface with the building's fire alarm system. Upon receipt of a signal from the building's fire alarm system, power to load side of the starter shall be turned off. Circuitry shall be provided to ensure that power is off whether the starter is in the "AUTO", "HAND" or "BYPASS" mode. If this feature is not available from the starter manufacturer, provide a contactor on the line side of the starter to accomplish the same function. The contactor shall meet the requirements of Division 26.

2.4 VARIABLE FREQUENCY DRIVES

A. Acceptable Manufacturers:

1. ABB (ACH550 Series) (basis of design).
2. Cerus Industrial, Inc. (P-Series).
3. Danfoss (VLT FC-100 Series).
4. Rockwell Automation (Allen-Bradley).
5. Toshiba (Q7 Series).
6. Yaskawa (E7 Series).
7. Schneider Electric (S-Flex)
8. Substitutions: Not permitted.

B. The variable frequency drives (VFDs) with options shall be UL listed as a complete assembly and shall be built in compliance with the latest standards of ANSI, IEEE, NEMA and the National Electric Code.

- C. The VFDs shall be designed to meet the requirements of the following standards: IEC801-2, IEC801-4, IEC255-4.
- D. Quality Assurance:
1. Manufacturer: Shall specialize in manufacture, assembly, and field performance of VFDs with minimum 5 years' experience.
 2. The VFD manufacturer shall have an existing representative, exclusively for HVAC applications, an independent service and start-up organization, and a parts stocking depot local to the installation.
- E. Warranty and Start-Up Service:
1. Start-Up Service: The VFD manufacturer shall provide a start-up service package. Service shall include inspection, final adjustment, operational checks, coordination with interface to building's ATC system (coordinate with Division 23 Section "Instrumentation and Controls for HVAC") and a final report for record purpose. Start-up service shall be performed by a factory approved and certified technician.
 2. Report: Submit a report of start-up and initial settings and readings.
 3. Owner Training: Provide a session of at least 4 hours, to train 2 or more of the Owner's representatives in the operation and maintenance of the drives. Schedule the training at the Owner's convenience within normal working hours, within 2 months after Substantial Completion.
 4. Warranty: For a period of 2 years after factory start-up, the VFD manufacturer shall include a full parts and labor on-site warranty at no additional cost.
- F. Construction:
1. Pulse Width Modulated design converting the fixed utility voltage and frequency to a variable voltage and frequency output. The VFD shall employ a full wave bridge rectifier, DC bus choke, DC bus filter capacitors, and Insulated Gate Bipolar Transistors (IGBTs) as the output switching device. SCRs, GTOs and Darlington transistors are not acceptable. The drive efficiency shall be 97 percent or better at full speed and full load. Fundamental power factor shall be 0.98 at all speeds and loads.
 2. 6-pulse (minimum) converter section.
 3. NEMA 1 ABS plastic or metal enclosure.
 4. Standard operating conditions are:
 - a. Incoming AC power at building power system design's phase and voltage (see Contract Drawings) ± 10 percent, 60 Hz. Output voltage, phase and frequencies compatible with equipment served (see Contract Drawings).
 - b. Humidity 0 to 95 percent (noncondensing and noncorrosive).
 - c. Altitude 0 to 3,300 feet above sea level, without derating.
 - d. Ambient temperature 0 to 40 degrees C.
 - e. Verify actual operating conditions, and derate drive capacity as required.
 5. VFDs shall include the following features:
 - a. Customer interface, including digital display in plain English (code numbers are not acceptable), keypad and customer connections.
 - b. Carrier (Switching) Frequency: Optimized for a 3 kHz or 4 kHz carrier frequency to reduce motor noise. The carrier frequency shall be adjustable by the start-up technician, in a range at least as low as 1 kHz and as high as 8 kHz. Provide at least the following settings to allow fine tuning: 1 kHz, 4 kHz, and 8 kHz.

- c. Built-in program to automatically vary the carrier (switching) frequency.
Acceptable types of control include:
 - 1) ABB's switching frequency foldback control, reduces heat generated by the IGBTs by reducing the carrier frequency if the heatsink temperature rises above 176-194 degrees F (80-90 degrees C).
 - 2) Danfoss automatic switching frequency modulation, reduces noise at low loads (below 60 percent) by adjusting the carrier frequency up to a selected maximum, and provides maximum power and efficiency at higher loads by adjusting the carrier frequency downward to a more efficient setting.
 - d. The option of either (1) displaying a fault, (2) running at a preset speed, or (3) running at the last known speed (average of last 10 seconds) if the input reference (4-20mA or 2-10V) is lost.
 - e. Automatic restart after an overcurrent, overvoltage, or undervoltage, or loss of input signal protective trip. The number of restart attempts and trial time shall be programmable.
 - f. The ability to start into a rotating load (forward or reverse) and accelerate or decelerate without safety tripping or component damage (flying start).
 - g. Automatic power loss ride through circuit that will utilize the inertia of the load to keep the drive powered. Minimum power loss ride through shall be 1 cycle based on full load and no inertia.
 - h. Isolated power for control circuits.
 - i. Input line fuses.
 - j. Acceptable start/stop commands shall include closure of a contact or switch, application and removal of input power and optional application and removal of 115 VAC on-off signal.
 - k. Load loss detection. Each VFD shall provide a dry contact closure at a field adjustable load threshold to indicate a loss of motor load (for example, broken fan belt or pump cavitation).
 - l. Pilot light cluster to provide visual indication of protective functions and circuit status, including the following LEDs:
 - 1) Power on (Red): Illuminates when main power is applied to the controller.
 - 2) AFC Run (Green): Illuminates to annunciate a drive run condition.
 - 3) AFC Fault (Yellow): Illuminates to annunciate a fault condition.
 - m. Five programmable critical frequency lockout ranges to prevent the VFD from continuously operating at an unstable speed.
 - n. PI setpoint controller integral to the drive, allowing a pressure or flow signal to be connected to the VFD, using the VFD for the closed loop control, eliminating the need for external controllers.
 - o. Three programmable digital relay outputs, rated for maximum switching current 8 amps at 24 VDC and 0.4 amps at 250 VAC; Maximum voltage 300 VDC and 250 VAC; continuous current rating 2 amps RMS.
 - p. Seven programmable preset speeds.
 - q. Six programmable digital inputs for interface with energy management system.
 - r. Two independently adjustable acceleration and deceleration ramps, adjustable from 1 to 1800 seconds.
 - s. Ramp or coast to a stop.
 - t. Two programmable analog outputs to provide 4-20 ma signals linear to output frequency, motor speed, output current, motor torque, motor power, DC bus voltage, and motor voltage.
6. VFD door mounted operator digital display shall include:
- a. Output Frequency

- b. Motor Speed (RPM)
 - c. Motor Current
 - d. Calculated Motor Torque
 - e. Calculated Motor Power
 - f. DC Bus Voltage
 - g. Output Voltage
 - h. Heat Sink Temperature
 - i. Analog Input Values
 - j. Keypad Reference Values
 - k. Elapsed Time Meter
7. VFD speed command input shall include:
- a. Keypad.
 - b. Two analog inputs, each capable of accepting a 0-20 mA, 4-20mA, 0-10V, and 2-10V signal inputs isolated from ground, and programmable via the keypad for different uses. Inputs shall have a programmable filter to remove any oscillation of the reference signal. The filter shall be adjustable from 0.01 to 10 seconds. The input shall be able to be inverted, so that minimum reference corresponds to maximum speed, and maximum reference corresponds to minimum speed.
 - c. Floating point input to accept a three wire input from a Dwyer Photohelic gauge or equivalent type instrument.
 - d. RS-485 communications.
8. The VFD shall include the following protection circuits. In the case of a protective trip, the drive shall stop, and announce the fault condition in plain words.
- a. Overcurrent trip, 200 percent of the VFD's variable torque current rating.
 - b. Overvoltage trip, 130 percent of the VFD's rated voltage.
 - c. Undervoltage trip, 60 percent of the VFD's rated voltage.
 - d. Over temperature, + 70 degrees C.
 - e. Ground fault.
 - f. Adaptable Electronic Motor Overload Protection: Shall protect the motor based on speed, load curve, and external fan parameter. Circuits that protect the motor only at full speed are unacceptable.
 - g. Power line surge protection by means of a metal oxide varistor (m.o.v.).
9. Accessories to be furnished and mounted by the drive manufacturer and contained in a single enclosure (the use of more than one enclosure is not acceptable):
- a. Protection From Harmonics and Voltage Spikes: Provide one of the following:
 - 1) Line Reactors: 3-percent AC input line reactors to reduce harmonic current distortion to the incoming power line, and to provide some protection to the drive from incoming voltage spikes. Provide reactors in each phase of incoming power to each VFD. Install between the input power and the drive's input bridge rectifier (so they protect the rectifier). The line reactor shall provide attenuation of line side voltage transients, thus preventing overvoltage trips or other unnecessary VFD shutdowns and providing a reduction in harmonic current distortion. Line reactors shall be manufactured by TCI of Milwaukee, WI and must meet the following requirements: provide a minimum of 2-1/2 percent line impedance, have a saturation rating of no less than 2.5 times the continuous current rating, and be UL recognized.

- 2) ABB Design: Integral 5 percent swinging chokes in the AC input lines, configured between the input power and the drive's input bridge rectifier (so they protect the rectifier from spikes in input power).
 - a) The swinging choke is an inductor with an inductance value inversely proportional to its operating current. Over a substantial portion of the normal operating current range, the inductance decreases as the current in the choke increases. A conventional or linear choke has a fixed inductance value that changes very little as the operating current varies in the normal operating range.
 - b) The harmonic limiting effectiveness of the swinging choke increases when the operating point is less than maximum power.
 - c) Compared to a standard linear choke, the swinging choke provides superior line harmonic current reduction when the drive's output power is less than or equal to rated output.
 - d) The effective inductance value of a swinging choke at full load is higher than the value of a linear choke of the same physical size.
 - e) The efficiency of a swinging choke is higher than the efficiency of a linear choke of the same inductance value.
 - f) Since the design point BHP is nearly always less than the nameplate horsepower of the selected motor, with swinging chokes the harmonic contribution of the drive will nearly always be less than that at maximum rated output power.
 - g) See U.S. Patent No. 6,774,758, "Low harmonic rectifier circuit" using non-linear inductor(s).
- 3) Danfoss Design: Harmonic suppression and surge suppression integral to the drive using separate components.
 - a) Harmonic Suppression: DC link chokes (inductors) installed between the drive's input bridge rectifier and the inverter bus capacitor, consisting of a dual, 5 percent DC-link reactor on the positive and negative rails of the DC bus. This reactor reduces the level of harmonics reflected back into the building power system without causing a voltage loss at the drive's input, and improves input power factor. The reactor is non-saturating (linear) to provide full harmonic filtering throughout the entire load range. In performance, the harmonic suppression of the DC-link reactor is equivalent to a 5 percent AC line reactor.
 - b) Incoming Power-Line Surge Suppression: Fast-acting Metal Oxide Varistor (or (MOV) installed between the input power and the drive's input bridge rectifier, Zener diodes and oversized DC bus capacitors to provide protection against high potential spikes. When the voltage exceeds 2.3 times the expected incoming voltage for 1.3 milliseconds, the MOV shorts, protecting the internal parts of the drive including the 3-phase full-wave diode bridge. The reactor also acts to reduce input current caused by power line disturbances. Provide 4 MOVs, one on each of the 3 inputs and one attached to the DC Link. Comply with the German specification for surge suppression (VDE 0160).
- 4) Linear chokes or DC link chokes used alone without surge suppression on the incoming power are NOT acceptable as alternatives to line reactors. If they are standard and integral to the VFD, they may be provided in addition to line reactors.

- b. **Bypass: Manual transfer to line power via contactors and including class 20 bimetal motor thermal overload relays and fuse or circuit breaker protection while in bypass operation, with automatic bypass capability.**
 - 1) Provide bypass on drives which serve single non-redundant motors, such as fan motors in air handling units and air conditioning units.
 - 2) Bypass is not required on drives which serve one of a pair of matching and fully-redundant motors with individual drive per motor (such as a pair of pumps where one is the lead pump and one is a 100 percent backup, and each pump has its own VFD).
 - c. Service switch which provides the ability to service the controller (electrically isolated while in bypass operation) without having to remove power to motor.
 - d. Hand-off automatic switch (HOA), prewired. The HOA switch shall be operable in both the Normal and Bypass (if provided) modes of operation. The switch may be dial type, or momentary-contact pushbutton type with LED indicator lights. The switch may be integral to the standard VFD keypad, if it is a dedicated physical switch that is always available, but it is not allowed to serve any other functions, and it may not be a virtual switch such as on a touchscreen.
 - 1) When Auto mode is selected, the external start command and external reference speed signal shall control the motor.
 - 2) When Hand mode is selected, the motor shall run and the manual potentiometer shall control the motor speed. Other controls and inputs/outputs shall function as in Auto mode.
 - e. Manual potentiometer, dial type with calibrated nameplate. Provide an analog (dial-type) or digital meter to indicate selected speed.
 - 1) If the HOA switch is a dedicated button integral to the VFD keypad, and the potentiometer function is immediately available without any further steps when the HOA is in "Hand" position (such as up-down pushbuttons on the face of the keypad), the potentiometer may be integral to the standard VFD keypad. The speed meter may be a display on the general display screen.
 - f. Customer Interlock Terminal Strip - provide a separate terminal strip for connection of fire, smoke, freeze contacts and external start command. External interlocks and start/stop contacts shall function with drive in hand, auto or bypass.
 - g. Door interlocked disconnect or circuit breaker, padlockable in off position.
 - h. For drives that control fans or pumps which are specified to operate in an automatic lead/lag arrangement, provide automatic alternation device in VFD enclosure. (coordinate with Division 23 Section "Instrumentation and Controls for Mechanical Systems").
 - i. **Damper Control Interlock shall:**
 - 1) **Provide 110 VAC output to the damper EP relay upon receipt of a start command to the VFD.**
 - 2) **Provide input terminals for connection to damper end switch. VFD shall not start until damper end switch is closed.**
 - 3) **Damper control circuit shall be operable in Hand, Auto, and Bypass.**
- 10. Energy Management System Interface
 - a. Drive shall have the capability to be controlled and monitored via analog and digital inputs and outputs.
 - b. In addition to analog and digital I/O the VFD shall be capable of communicating with the following controls companies' communication buses with no extra hardware:
 - 1) Johnson Controls
 - 2) Siemens Controls

- c. Drive shall have integral capability to be controlled and monitored through BACnet, LonWorks, Modbus, or other serial communication protocol compatible with the building automatic temperature control system. Provide adapter modules as required.
 - d. Coordinate with suppliers and installers of building automatic temperature control system to ensure compatibility and full functionality. See Division 23 Section "Instrumentation and Controls for Mechanical Systems."
 - 11. In the event of a power failure and upon restoration of power, the variable frequency drive shall remain responsive to its command signal from the building's energy management/temperature control system. The drive shall not require manual resetting after a power outage in order to respond to the energy management/temperature control system's command signal.
 - 12. For drives that are associated with equipment that is required to be shut down upon a fire alarm condition, provide input contacts within the VFD enclosure to interface with the building's fire alarm system. Upon receipt of a signal from the building's fire alarm system, power to load side of the VFD shall be turned off. Circuitry shall be provided to ensure that power is off whether the VFD is in the "AUTO", "HAND" or "BYPASS" mode. If this feature is not available from the VFD manufacturer, provide a contactor on the line side of the VFD to accomplish the same function. The contactor shall meet the requirements of the Electrical Division of the Specifications.
 - 13. Occasional input and output power circuit switching shall be able to be accomplished without interlocks or damage to the drive. If drive design cannot tolerate interruption of output, such as by a disconnect switch mounted between the drive and the motor, provide protective devices and coordinate with installers to protect the drive as specified in Part 3 – Execution in this Section.
- G. Compliance with IEEE-519:
- 1. Input Line Reactors: Provide as specified in "Construction" paragraph of this Section.
 - 2. The VFD manufacturer shall provide calculations, based on utility transformer impedance, KVA, and voltage data and electrical distribution wiring data supplied by the Owner/Engineer, specific to this installation demonstrating that the total harmonic distortion reflected into the electrical distribution system is limited to 70 percent of the level defined by IEEE-519 (latest edition) for general systems. Harmonic analysis shall be submitted prior to VFD start-up.
 - 3. VFD manufacturer shall conduct on-site harmonic measurements before and after start-up of the VFDs. Results of the measurements showing harmonic contribution of VFDs shall be submitted to the Architect one month after start up.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Manufacturer's instructions.
- B. Install securely on firm foundation. Mount ball bearing motors with shaft in any position.
- C. Coordinate with Division 26 "Electrical."
- D. Check line voltage and phase and direction of rotation, and ensure agreement with nameplate.

- E. Install guards in accordance with Codes and OSHA requirements.
- F. Adjust motor overload devices based on motor amperage ratings and field measurements of running amps, to ensure protection of the motor and eliminate nuisance trips.
- G. Disconnect Switch Mounting Height: Install at height above finished floor in accordance with NFPA 70.
 - 1. In most instances, the center of the grip of the disconnect switch operating handle in its highest position shall be no more than 79 inches (2.0 m) above finished floor or working platform.
 - 2. Switches and circuit breakers installed adjacent to the equipment served (and within 79 inches (2.0 m) above finished floor or working platform.
- H. Variable Frequency Drives:
 - 1. Mounting Height:
 - a. Install with the disconnect switch height in accordance with NFPA 70, as described in the paragraph “Disconnect Switch Mounting Height” in this Section.
 - b. The VFD shall be considered to be a piece of equipment served by its disconnect switch, for purposes of NFPA 70, unless otherwise indicated, or otherwise directed by the Authority Having Jurisdiction or by the Owner.
 - 1) If the motor served by the VFD is within sight of the VFD, and within 50 feet (15.2 m) measured in a straight line, this disconnect switch may also serve the motor unless otherwise indicated.
 - c. When possible, install VFDs with their operator-interface display at 79 inches (2.0 m) or less above finished floor, unless otherwise indicated or directed.
 - 1) To restrict unauthorized access, VFDs in locations accessible to the public (such as but not limited to classrooms, unrestricted storage rooms, and corridors) shall be mounted with the disconnect switch at 72 to 79 inches (1.8 to 2.0 m) above finished floor, with the VFD operator display and other accessories mounted above the disconnect switch, where ceiling height allows, unless otherwise indicated.
 - 2) In mechanical rooms and other restricted-access locations, mount VFDs at a height for greatest user convenience.
 - d. When possible, mount groups of adjacent VFDs with tops at uniform height above finished floor.
 - e. Because VFDs produce heat, do not install a VFD above another one, or above another heat-producing device. Do not install a VFD below or too near to any heat-sensitive device or room temperature sensor. Provide ventilation space and other means of cooling as required by the manufacturer.
 - f. Install with service and installation clearances as required by the manufacturer.
 - 2. Electrical Connections:
 - a. Provide separate metal conduits for drive input power, output power to the motor, and control wiring. Output motor cables from multiple drives shall be run separately.
 - b. Ground each drive separately.
 - c. Ensure that a fused disconnect switch is provided upstream between the transformer and the drive. Fuses are required because they are faster-acting than circuit breakers.
 - d. If drive design cannot tolerate interruption of output, such as by a disconnect switch mounted between the drive and the motor, provide protective devices and

coordinate with installers to protect the drive, and coordinate with installers to ensure that no unnecessary switching is installed.

- 1) When the VFD is out of sight from the equipment served, or is more than 50 feet (15.2 m) from the equipment served, a disconnect switch mounted on or adjacent to the equipment is generally required in Division 26 “Electrical” or by the Authority Having Jurisdiction. If such a disconnect or other switching device is indicated or required, provide protective devices as required by the VFD manufacturer. Such devices typically include an “early-break” auxiliary set of contacts or a “Stop” button on the disconnect switch, field-wired to the VFD’s external fault input or stop input, so that if the switch is opened while the VFD is running, the input will shut off the output of the VFD. The VFD stop method must be set to “Coast.” Provide field wiring in conduit.
 - 2) Provide engraved nameplates at disconnect switches and other devices, instructing users on the proper operation of these devices to prevent damage to the VFD.
3. Carrier Frequency: Adjust to minimize noise, but also to minimize the potential for motor bearing damage due to VFD-induced shaft voltage.
 - a. VFDs convert line AC voltage to a pulse width modulated (PWM) AC voltage of variable frequency. The switching frequency of these pulses is referred to as the “carrier frequency.” The switching induces a voltage on the rotor shaft, which, if it builds up to a sufficient level, can discharge as “bearing current” to ground through the bearings. This has an electric discharge machining (EDM) effect, causing pitting of the bearing’s rolling elements and raceways. This effect can be minimized by proper setup.
 - b. The higher the carrier frequency, the higher the rate of the current discharge pulses, and the more likely EDM will occur. At higher carrier frequencies the VFD will generally run quieter; however, it becomes more destructive on the motor insulation and bearings.
 - c. Adjust the carrier frequency as low as possible without creating unacceptable audible noise levels, and to avoid frequencies above 6 kHz altogether if possible.
 4. Coordinate with building controls systems as specified in Part 2 of this Section.
 5. Perform startup service, and submit report.
 6. Provide warranty service.
 7. Provide Owner training.

END OF SECTION 230513

SECTION 230517 – SLEEVES AND ESCUTCHEONS FOR HVAC PIPING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Pipe Sleeves.
- B. Escutcheons.
- C. Floor Plates.

1.2 RELATED SECTIONS

- A. Division 23 Section “Common Work Results for HVAC” – Firestopping.
- B. Division 23 Section “Hydronic Piping.”
- C. Division 23 Section “Refrigerant Piping.”

1.3 REFERENCES

- A. ASTM A53 - Pipe, Steel, Black and Hot-Dipped, Zinc Coated Welded and Seamless.
- B. ASTM C1107 - 11 Standard Specification for Packaged Dry, Hydraulic-Cement Grout (Nonshrink).

1.4 PERFORMANCE REQUIREMENTS

- A. Provide sleeves for piping penetrations of building construction such as interior partitions, interior and exterior walls, floors, and roofs.
- B. Provide watertight pipe sleeves for piping penetrations of basement and foundation walls below grade, on-grade floor slabs, floors in potentially wet locations, roof slabs, and at other locations as specified or indicated on the Drawings.
- C. Provide escutcheons and floor plates at piping penetrations of building construction.
- D. Coordinate

1.5 SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Manufacturer's Installation Instructions: Indicate special procedures, and external controls.

1.6 PROJECT RECORD DOCUMENTS

- A. Record actual locations of watertight sleeve-seal fittings.

1.7 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the products specified in this Section with minimum 3 years' experience.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect and handle products to site under provisions of documents.
- B. Protect materials from exposure by leaving factory coverings and packaging in place until installation.

1.9 WARRANTY

- A. Provide warranty under provisions of documents.

PART 2 - PRODUCTS

2.1 PIPE SLEEVES

- A. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.
- B. Galvanized-Steel Wall Pipes: ASTM A53, Schedule 40, with plain ends and welded steel collar; zinc coated.
- C. Galvanized-Steel-Pipe Sleeves: ASTM A53, Type E, Grade B, Schedule 40, zinc coated, with plain ends.
- D. PVC-Pipe Sleeves: ASTM D1785, Schedule 40.
- E. Galvanized-Steel-Sheet Sleeves: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.
- F. Molded-Polyethylene (PE) or molded-polypropylene (PP) Sleeves: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.
- G. Molded-PVC Sleeves: With nailing flange for attaching to wooden forms.

2.2 ESCUTCHEONS

- A. Material: Brass at floors and in potentially damp or wet locations. Brass or steel in other locations.
- B. Finish: Except as indicated below, polished chrome plated in exposed locations, prime painted steel or rough brass in mechanical rooms and similar spaces.
- C. One-Piece, Cast-Brass Type: With finish and setscrew fastener.
- D. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and

spring-clip fasteners.

- E. One-Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.
- F. Split-Casting Brass Type: With concealed hinge and setscrew.
- G. Split-Plate, Stamped-Steel Type: With chrome-plated finish, hinge, and spring-clip fasteners.

2.3 FLOOR PLATES

- A. Material: Brass in exposed locations. Brass or cast iron in other locations including mechanical equipment spaces.
- B. Finish: Except as indicated below, polished chrome plated in exposed locations, prime painted steel or rough brass in mechanical rooms and similar spaces.
- C. One-Piece Floor Plates: Cast-iron flange.
- D. Split-Casting Floor Plates: Cast brass with concealed hinge.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Provide sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
- C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as the slabs and walls are constructed.
- D. Size sleeves to allow firestopping.
- E. Size holes and sleeves to allow the required clear annular space for insulation, and a minimum of 1/4 in. (6.4 mm) clear outside the pipe and insulation for movement due to and expansion and contraction.
- F. Cut sleeves flush with both surfaces, except at floors.
- G. Extend sleeves through floors as follows: In locations not otherwise indicated, 2 inch (50 mm) above finished floor level. In normally-dry locations such as finished office spaces under fintube and baseboard radiation, 1 inch (25 mm) above finished floor level. Finished floor level includes the thickness of floor finish materials such as carpet and tile. Caulk sleeves full depth and provide floor plate.
- H. Fasten sleeves permanently in place.
- I. Using grout, seal the space outside of sleeves in concrete slabs and walls which do not have watertight sleeve system.
- J. Provide escutcheons for piping penetrations of walls, ceilings, and finished floors.

- K. Provide floor plates for piping penetrations of equipment-room floors.
- L. Escutcheons and floor plates on bare piping shall be one-piece type where possible. Escutcheons and floor plates on insulated piping and on existing piping shall be split, hinged type.
- M. Size escutcheons and floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.

END OF SECTION 230517

SECTION 230519 – METERS AND GAUGES FOR HVAC PIPING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Pressure gauges and Pressure gauge taps.
- B. Static pressure gauges.
- C. Filter gauges.
- D. Test Plugs.
- E. Thermometers and thermometer wells.
- F. Thermowell heat transfer paste.

1.2 RELATED SECTIONS

- A. Division 23 Section “Hydronic Piping.”
- B. Division 23 Section “Instrumentation and Controls for Mechanical Systems.”

1.3 REFERENCES

- A. ASME
- B. ASTM.
- C. AWWA
- D. HCF_SPEC-13 - HART Communication Protocol Specification.
- E. MIL-HDBK-217F – Military Handbook – Reliability Prediction of Electronic Equipment.
- F. UL.

1.4 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Company specializing in manufacturing the Products specified in this Section with minimum 3 years’ experience.

1.5 SUBMITTALS

- A. Product Data: Provide manufacturers data and list which indicates use, operating range, total range, accuracy, and location for manufactured components.

1.6 PROJECT RECORD DOCUMENTS

- A. Project Record Documents: Record actual locations of components and instrumentation.

1.7 OPERATION AND MAINTENANCE DATA

- A. Include instructions for calibrating instruments.

1.8 ENVIRONMENTAL REQUIREMENTS

- A. Do not install instruments when areas are under construction, except for required rough-in, taps, supports and test plugs.
- B. Supply 2 bottles of red gauge oil for static pressure gauges.

PART 2 - PRODUCTS

2.1 PRESSURE GAUGES

- A. Manufacturers:
 - 1. Weiss Series 4CTS.
 - 2. Terice 600 Series.
 - 3. Marshalltown.
 - 4. Amtek.
 - 5. Dwyer.
 - 6. Miljoco
- B. Gauge: Non-filled type, with bourdon tube, rotary brass movement, brass socket, soft-soldered connections, front recalibration adjustment, black scale on white-finished metal background.
 - 1. Case: Cast aluminum or stainless steel.
 - 2. Lens: Push-in Lexan polycarbonate, or clear glass or acrylic with stainless steel ring, per manufacturer's standard.
 - 3. Bourdon Tube: Phosphor bronze.
 - 4. Dial Size: 4 to 4-1/2 inch (101 to 114 mm).
 - 5. Connection: Lower, 1/4" NPT.
 - 6. Accuracy: 1 percent of full scale range, per ANSI-ASME B40.1 Grade 1A.
 - 7. Scale: Psi.
 - 8. Range: 0-60 psig typical, select for application.
- C. Gauges, Hot Water Heating and Chilled Water Systems: Weiss Series 4PG-1 industrial pressure gauge, dry non-filled type, with phosphor bronze bourdon tube, silver brazed connecting joints, brass socket, bushed stainless rotary movement, 1/4 inch NPT connection, white aluminum dial with black markings, black aluminum pointer with front slotted adjustment..
 - 1. Case: Cast aluminum or stainless steel.
 - 2. Lens: Push-in Lexan polycarbonate, or clear glass or acrylic with stainless steel ring, per manufacturer's standard.
 - 3. Bourdon Tube: Phosphor bronze.
 - 4. Dial Size: 4 to 4-1/2 inch (101 to 114 mm).
 - 5. Connection: Lower or lower back, 1/4 inch or 1/2 inch NPT, as selected by Contractor.
 - 6. Accuracy: 1 percent of full scale range, per ANSI-ASME B40.1 Grade 1A.
 - 7. Scale: Psi.
 - 8. Range: 0-60 psig typical, select for application.

- D. Verify suitability of range for each application. Best selection is for typical reading to be close to mid-scale.

2.2 PRESSURE GAUGE TAPPINGS

- A. Ball Valve: Provide under Division 23 Section "Hydronic Specialties."

2.3 STATIC PRESSURE GAUGES

A. Dial Gauges:

1. Manufacturers:
 - a. Dwyer.
 - b. Trerice.
 - c. Marshalltown.
 - d. Amtek.
 - e. Substitutions: Approved equal. See Section 016000 - Product Requirements.
2. 3-1/2 inch (89 mm) diameter dial in metal case, diaphragm actuated, black figures on white background, front recalibration adjustment, 2 percent of full scale accuracy.

B. Inclined Manometer:

1. Manufacturers:
 - a. Dwyer.
 - b. Trerice.
 - c. Marshalltown.
 - d. Amtek.
 - e. Substitutions: Approved equal. See Section 016000 - Product Requirements.
2. Plastic with red liquid on white background with black figures, front recalibration adjustment, 3 percent of full scale accuracy.

- C. Accessories: Static pressure tips with compression fittings for bulkhead mounting, 1/4 inch (6 mm) diameter tubing.

2.4 TEMPERATURE TRANSMITTER - DIGITAL SELF-INDICATING

A. Manufacturers:

1. Weiss.
2. Substitutions: Approved equal. See Section 016000 - Product Requirements.

- B. Thermometer: Weiss Vari-angle Self-indicating Temperature Transmitter, high-impact black ABS plastic case, adjustable angle and swivel head. Light-powered, no batteries. Stem assembly shall be in full conformance with Fed. Spec GG-T-321D for industrial glass thermometers, or ASTM B40.3-1990 for bimetallic dial thermometers. Recalibration via potentiometer adjustment.

1. Sensor type: Glass passivated thermistor.
2. Size: 1/2 inch (12.5 mm) high LCD digits.
3. Bulb: Provide extended bulb for socket extension in insulated pipe.
4. Accuracy: 1 percent of reading or 1 degree, whichever is greater.
5. Calibration: Switchable for degrees F and degrees C.
6. Scale Range: -50 to 300 degrees F (-45 to 150 degrees C).
7. Graduations: 1/10 degree between -19.9 to 199.9 degrees F (-28 to 93 degrees C).
8. Ambient Operating Range: -30 to 140 degrees F (-35 to 60 degrees C).

9. Ambient Temperature Error: Zero.
10. Allowable Humidity: 0 to 100 percent RH.
11. Update: 10 seconds.
12. Light Requirement: 10 Lux (1 foot-candle).
13. Air Duct Flange: Provide for duct applications.

C. Transmitter:

1. Sensor Type: Platinum 100 ohm RTD.
2. Output: 4 to 20 mA.
3. Power Requirement: 8.5 to 35 VDC.
4. Accuracy: 0.5 percent of span.
5. Range: -58 to 302 degrees F (-50 to 150 degrees C).
6. Graduations: 1/10 degree between -19.9 to 199.9 degrees F (-28 to 93 degrees C).
7. Ambient Operating Range: -15 to 185 degrees F (-25 to 85 degrees C).
8. Ambient Temperature Error: 0.015 percent of span.

D. Provide conduit connector.

E. Provide outdoor waterproof cover for wet locations.

2.5 TEST PLUGS

A. Test Plug:

1. Manufacturers:
 - a. Peterson Equipment Co., Inc., "Pete's Plugs".
 - b. Weiss.
 - c. Flow Design, Inc.
 - d. Trerice.
 - e. Substitutions: Approved equal. See Section 016000 - Product Requirements.
2. 1/2 inch (13 mm) NPT brass fitting and cap for receiving 1/8 inch (3 mm) outside diameter pressure or temperature probe with self-closing valves as follows:
 - a. Nordel (EPDM) core for water and hydronic heating and cooling service, temperatures range 30 to 275 degrees F (-1 to 176 degrees C).
 - b. Neoprene core for natural gas or LP gas service, temperature range -40 to 150 degrees F (-40 to 65 degrees C).
 - c. Verify core suitability for other fluids and temperatures.
3. Working Pressure: 500 psig
4. Cap Retaining Strap: Color coded to indicate core material.
5. Construction with either dual self-closing valves (Pete's Plug standard design) or single valve are allowed.
6. For chilled water applications, provide "XL" plugs which include a 1-1/2 inch (38 mm) extension for insulated piping.

B. Pressure and Temperature Test Kit: Furnish 1 to the Owner.

1. Carrying case with inside foam padding.
2. Pressure gauge, liquid filled with 1/4 inch (6 mm) NPT connection, range 0 to 100 psig (0 to 700 kPa), with gauge adapter attached.
3. Additional gauge adapter with 1/8 inch (3 mm) diameter probe and protecting shield.
4. Bimetal thermometer, range 25 to 125 degrees F (-5 to 50 degrees C), 5 inch (127 mm) stem, 1-3/4 inch (44 mm) dial, external calibration.
5. Bimetal thermometer, range 0 to 220 degrees F (-17 to 104 degrees C), 5 inch

- (127 mm) stem, 1-3/4 inch (44 mm) dial, external calibration.
6. If extended "XL" plugs are used, provide the XL test kit which is suitable for any length of plug.

2.6 THERMOMETERS - DIAL

- A. Manufacturers:
 1. Weiss.
 2. Trerice.
 3. Amtek.
 4. Ernst.
 5. Miljoco
 6. Substitutions: Approved equal. See Section 016000 - Product Requirements.
- B. Thermometer: Weiss Model 45VA, ASTM E1, stainless steel or cast aluminum case, adjustable angle with front recalibration, vapor actuated, black scale on white-finished metal background, black pointer, sealed lens, brass stem.
 1. Size: 4 to 4-1/2 inch (101 to 114 mm) dial.
 2. Lens: Snap-in Lexan polycarbonate with o-ring, or clear glass with rubber ring.
 3. Bulb: Copper. Provide extended bulb for socket extension in insulated pipe.
 4. Extended Bulb: Where required, provide extended capillary tube with braided copper protection.
 5. Connection: Separable socket.
 6. Accuracy: 1 scale division throughout range.
 7. Calibration: Degrees F.
 8. Scale Range: 0 to 100 degrees F (-20 to 40 degrees C) for plumbing cold water,; 30 to 240 degrees F (0 to 115 degrees C) for plumbing hot water, hot water heating, and supply air systems.
 9. Graduations: 2 degrees F.
 10. Air Duct Flange: Provide for duct applications.
- C. Provide dial type except where digital type is indicated.

2.7 THERMOMETERS - DIGITAL

- A. Manufacturers:
 1. Weiss.
 2. Miljoco
 3. Substitutions: Approved equal. See Section 016000 - Product Requirements.
- B. Thermometer: Weiss Vari-angle Digital Thermometer, high-impact black ABS plastic case, adjustable angle and swivel head. Light-powered, no batteries. Stem assembly shall be in full conformance with Fed. Spec GG-T-321D for industrial glass thermometers, or ASTM B40.3-1990 for bimetallic dial thermometers. Recalibration via potentiometer adjustment.
 1. Sensor type: Glass passivated thermistor.
 2. Size: 1/2 inch (12.5 mm) high LCD digits.
 3. Bulb: Provide extended bulb for socket extension in insulated pipe.
 4. Accuracy: 1 percent of reading or 1 degree, whichever is greater.
 5. Calibration: Switchable for degrees F and degrees C.
 6. Scale Range: -50 to 300 degrees F (-45 to 150 degrees C).
 7. Graduations: 1/10 degree between -19.9 to 199.9 degrees F (-28 to 93 degrees C).

8. Ambient Operating Range: -30 to 140 degrees F (-35 to 60 degrees C).
9. Ambient Temperature Error: Zero.
10. Allowable Humidity: 0 to 100 percent RH.
11. Update: 10 seconds.
12. Light Requirement: 10 Lux (1 foot-candle).
13. Air Duct Flange: Provide for duct applications.

C. Provide outdoor waterproof cover for wet locations.

D. May be used as an alternative to dial thermometers.

E.

2.8 THERMOMETER SUPPORTS

- A. Socket (Thermometer Well) for Piping: Brass separable sockets for thermometer stems, with extensions for insulated piping. Provide with Honeywell viscous heat transfer paste.
- B. Flange for Duct: 3 inch (76 mm) outside diameter reversible flange, designed to fasten to sheet metal air ducts, with brass perforated stem.

2.9 THERMOWELL HEAT TRANSFER PASTE

- A. Manufacturers:
 1. MG Chemicals.
 2. Honeywell.
 3. Trerice.
 4. Substitutions: Approved equal. See Section 016000 - Product Requirements.
- B. Description:
 1. Formulation: Silicone or synthetic base, containing metal oxides.
 2. Thermal Conductivity: At least 4.5 Btu-in./(hr-ft²-°F) (0.65 W/(m-K).
 3. Temperature Range: To 392 degrees F (200 degrees C).
 4. Flash Point: 500 degrees F (260 degrees C).
 5. Dropping Point: ASTM D566, greater than 500 degrees F (260 degrees C).
 6. Specific Gravity: 2.3 minimum at 77 degrees F (25 degrees C).
 7. Consistency: ASTM D217, 310 to 320.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Use ball valves for water service; use needle valves for steam service.
- B. Quality Requirements: Manufacturer's instructions.
- C. Install 1 pressure gauge per pump, with taps on suction and discharge of pump; pipe to gauge.
- D. Install gauge taps in piping; refer to Division 23 Section "Hydronic Piping" and "Steam and Condensate Heating Piping."

- E. Install pressure gauges with pulsation dampers. Provide valve to isolate each gauge; see “Pressure Gauge Tappings” in this Section. Extend nipples to allow clearance from insulation.
- F. Install thermometers in piping systems in sockets in short couplings. Enlarge pipes smaller than 2-1/2 inches (64 mm) for installation of thermometer sockets. Ensure sockets allow clearance from insulation.
- G. Install thermometers in air duct systems on flanges.
- H. Fill thermometer sockets with heat transfer paste.
- I. Install thermometer sockets adjacent to controls systems thermostat, transmitter, or sensor sockets.
- J. Locate duct mounted thermometers minimum 10 feet (3 m) downstream of mixing dampers, coils, or other devices causing air turbulence.
- K. Coil and conceal excess capillary on remote element instruments.
- L. Install static pressure gauges to measure across filters and filter banks (inlet to outlet). On multiple banks, provide manifold and single gauge.
- M. Provide instruments with scale ranges selected according to service with largest appropriate scale.
- N. Install gauges and thermometers in locations where they are easily read from normal operating level. Install vertical to 45 degrees off vertical.
- O. Adjust gauges and thermometers to final angle, clean windows and lenses, and calibrate to zero.
- P. Locate test plugs where indicated.
- Q. Provide pressure gauge at high point of system for setting of cold water make-up pressure reducing valve.
- R. Provide pressure gauge at connection to bladder type expansion tank for setting of air side pre-charge pressure.

END OF SECTION 230519

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SECTION 230529 – HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Pipe and equipment hangers and supports.
- B. Equipment bases and supports.
- C. Sleeves and seals.
- D. Flashing and sealing equipment and pipe stacks.

1.2 RELATED SECTIONS

- A. Division 03 Section “Cast-In-Place Concrete”: Equipment bases.
- B. Division 07 Section “Through-Penetration Firestop Systems”: Joint seals for piping and duct penetration of fire rated assemblies.
- C. Division 09 Section “Painting.”
- D. Division 23 Section “Vibration and Seismic Controls for HVAC Piping and Equipment.”
- E. Division 23 Section “HVAC Piping Insulation.”
- F. Division 23 Section “HVAC Equipment Insulation.”
- G. Division 23 Section “Hydronic Piping.”
- H. Division 23 Section “Refrigerant Piping.”

1.3 REFERENCES

- A. ASME.
- B. ASTM
- C. MSS.
- D. NFPA 70 - National Electrical Code

1.4 SUBMITTALS

- A. Shop Drawings: Indicate system layout with location and detail of trapeze hangers.
- B. Product Data: Provide manufacturers catalog data including load capacity.
- C. Design Data: Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers.

- D. Manufacturer's Installation Instructions: Indicate special procedures and assembly of components.

1.5 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the products specified in this Section with minimum 3 years' experience.

1.6 REGULATORY REQUIREMENTS

- A. Conform to applicable Codes for support of piping.
- B. Supports for Electrical: In conformance with NFPA 70 and Division 26 of the Specifications.

PART 2 - PRODUCTS

2.1 HANGERS, SUPPORTS, & PIPE CLAMPS

- A. Manufacturers:
 - 1. Strut Hangers:
 - a. Unistrut (division of Tyco).
 - b. Anvil International.
 - c. Cooper B-Line.
 - d. Hydra-Zorb Company.
 - e. Thomas & Betts - Superstrut line.
 - f. Tolco (division of Cooper B-Line).
 - g. Substitutions: Not permitted.
 - 2. Adjustable Swivel Band Hangers:
 - a. Carpenter & Paterson.
 - b. Anvil International.
 - c. Cooper B-Line.
 - d. Tolco (division of Cooper B-Line).
 - e. Substitutions: Not permitted.
 - 3. Clevis Hangers:
 - a. Cooper B-Line.
 - b. Anvil International.
 - c. Carpenter & Paterson.
 - d. Tolco (division of Cooper B-Line).
 - e. Substitutions: Not permitted.
 - 4. J-Hangers:
 - a. Cooper B-Line.
 - b. Carpenter & Paterson.
 - c. Thomas & Betts - Superstrut line.
 - d. Tolco (division of Cooper B-Line).
 - e. Unistrut (division of Tyco).
 - f. Substitutions: Not permitted
 - 5. Cushion Clamps:
 - a. Hydra-Zorb Company.
 - b. Cooper B-Line.
 - c. Thomas & Betts - Superstrut line.

- d. Tolco (division of Cooper B-Line).
 - e. Unistrut (division of Tyco).
 - f. Substitutions: Not permitted
- 6. Insulated Pipe Couplings:
 - a. Cooper B-Line - Armafix line.
 - b. Klo-Shure Corporation.
 - c. Substitutions: Not permitted
- B. Horizontal Piping Supports: Provide struts for trapeze hangers for single or multiple pipes. Where individual piping runs are hung with individual hangers, adjustable swivel band hangers, clevis hangers, or j-hangers may be used.
- C. Strut hangers shall be standard 1-5/8 inches x 1-5/8 inches (41x41 mm) size.
- D. Hangers, clamps, and supports located outdoors or otherwise exposed to weather, or in wet or washdown areas, shall be hot-dipped galvanized steel or 300-series stainless steel. Struts may be extruded aluminum. Threaded rods, nuts, and washers may have standard galvanizing if hot-dipped galvanized is not available.
 - 1. Hot-dipped galvanized steel shall have a nominal zinc coating of 2.6 mil (0.066 mm) thickness and 1.5 oz./sq.ft (458 g/m²) coating weight.
 - 2. In lieu of galvanizing, strut systems and their accessories may have Unistrut Perma-Green III electrodeposited thermoset acrylic coating, or be epoxy-coated equal to B-Line's Dura-Green or Dura-Copper coatings.
 - 3. Lesser coatings for struts and clamps, such as pre-galvanizing (0.75 mil (0.019 mm) thickness), electroplated zinc (0.2 to 0.5 mil (0.005 to 0.013 mm) thickness), and yellow zinc dichromate coating, are not acceptable in these locations.
- E. Pipe hanger rods and nuts shall be plated to match the hangers. Nuts shall be self-locking type, or provide double nuts tightened to lock together. Rods shall be threaded one end, or continuous threaded. Provide washers at each nut.
- F. Cushion Clamps for Un-insulated Lines: Plastic cushion shall be Dupont Hytel plastic, 5555HS plastic elastomer, warranted from -40 to 275 degrees F (-40 to 135 degrees C).
- G. Copper-plated hangers are plated for identification only. Traditional thin copper plating on steel substrate does not provide adequate protection from galvanic corrosion due to contact between dissimilar metals.
 - 1. Where copper-plated supports are specified for use with copper piping, either copper plating or a copper-colored finish such as Cooper B-Line's Dura-Copper epoxy coating is acceptable. This is for identification, and does not protect dissimilar metals.
 - 2. Where copper piping is used with steel hangers and supports, provide protection from galvanic corrosion such as thick plastic or vinyl factory coating, or plastic-lined cushion clamps.
- H. For Insulated Lines Clamped to Strut: Insulated pipe coupling insert with the same thickness as the insulation. Protects insulation from crushing, and provides continuous insulation and vapor barrier thru the hanger or clamp. Klo-Shure product provides plastic pipe support and rigid outer band, for field insulation into the coupling. Armafix product provides insulation with rigid outer band, for field insulation glued to the ends of the insert.

2.2 PIPE SUPPORTS

A. Hydronic Piping:

1. Conform to ASME B31.9, ASTM F708, MSS SP58, MSS SP69 and MSS SP89.
2. Hangers for Pipe Sizes 1/2 to 1-1/2 inch (13 to 38 mm): Malleable iron, adjustable swivel, split ring.
3. Hangers for Cold Pipe Sizes 2 inches (50 mm) and Over: Carbon steel, adjustable, clevis.
4. Hangers for Hot Pipe Sizes 2 to 4 inches (50 to 100 mm): Carbon steel, adjustable, clevis.
5. Hangers for Hot Pipe Sizes 5 inches (125 mm) and Over: Adjustable steel yoke, cast iron roll, double hanger.
6. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
7. Multiple or Trapeze Hangers for Hot Pipe Sizes 6 inches (150 mm) and Over: Steel channels with welded spacers and hanger rods, cast iron roll.
8. Wall Support for Pipe Sizes to 3 inches (76 mm): Cast iron hook.
9. Wall Support for Cold Pipe Sizes 4 inches (100 mm) and Over: Welded steel bracket and wrought steel clamp.
10. Wall Support for Hot Pipe Sizes 4 inches (100 mm) and Over: Welded steel bracket and wrought steel clamp with adjustable steel yoke and cast iron roll.
11. Vertical Support: Steel riser clamp.
12. Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
13. Floor Support for Hot Pipe Sizes to 4 inches (100 mm): Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
14. Floor Support for Hot Pipe Sizes 5 inches (125 mm) and Over: Adjustable cast iron roll and stand, steel screws, and concrete pier or steel support.
15. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

B. Refrigerant Piping:

1. Conform to ASME B31.5, ASTM F708, MSS SP58, MSS SP69 and MSS SP89.
2. Hangers for Pipe Sizes 1/2 to 1-1/2 inch (13 to 38 mm): Malleable iron, adjustable swivel, split ring.
3. Hangers for Pipe Sizes 2 inches (50 mm) and Over: Carbon steel, adjustable, clevis.
4. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
5. Wall Support for Pipe Sizes to 3 inches (75 mm): Cast iron hook.
6. Wall Support for Pipe Sizes 4 inches (100 mm) and Over: Welded steel bracket and wrought steel clamp.
7. Vertical Support: Steel riser clamp.
8. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.
9. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

2.3 INSERTS

A. Manufacturers:

1. Cooper B-Line.
2. Grinnell.
3. Substitutions: Approved equal. See Section 016000 - Product Requirements

B. Inserts: Malleable iron case of steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit

threaded hanger rods.

2.4 FLASHING

- A. Metal Flashing: 26 ga (0.5 mm) thick galvanized steel.
- B. Metal Counterflashing: 22 ga (0.8 mm) thick galvanized steel.
- C. Lead Flashing:
 - 1. Waterproofing: 5 lb/sq ft (24.5 kg/sq m) sheet lead
 - 2. Soundproofing: 1 lb/sq ft (5 kg/sq m) sheet lead.
- D. Flexible Flashing: 47 mil (1.2 mm) thick sheet butyl; compatible with roofing.
- E. Caps: Steel, 22 ga (0.8 mm) minimum; 16 ga (1.5 mm) at fire resistant elements.

2.5 SLEEVES

- A. Sleeves for Pipes Through Non-fire Rated Floors: 18 ga (1.2 mm) thick galvanized steel.
- B. Sleeves for Pipes Through Non-fire Rated Beams, Walls, Footings, and Potentially Wet Floors: Steel pipe or 18 ga (1.2 mm) thick galvanized steel.
- C. Sleeves for Pipes Through Fire Rated and Fire Resistive Floors and Walls, and Fire Proofing: Prefabricated fire rated sleeves including seals, UL listed.
- D. Sleeves for Round Ductwork: Galvanized steel.
- E. Sleeves for Rectangular Ductwork: Galvanized steel.
- F. Stuffing or Firestopping Insulation: Glass fiber type, non-combustible.
- G. Sealant: Acrylic.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.

3.2 INSERTS

- A. Provide inserts for placement in concrete formwork.
- B. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
- C. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches (100 mm).
- D. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.

- E. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut recessed into and grouted flush with slab.
- F. Do not anchor supports to metal decking with or without a concreted slab.

3.3 PIPE HANGERS AND SUPPORTS

- A. Support horizontal piping as scheduled.
- B. Install hangers to provide minimum 1/2 inch (13 mm) space between finished covering and adjacent work.
- C. Place hangers within 12 inches (300 mm) of each horizontal elbow.
- D. Use hangers with 1-1/2 inch (38 mm) minimum vertical adjustment.
- E. Support horizontal cast iron pipe adjacent to each hub, with 5 feet (1.5 m) maximum spacing between hangers.
- F. Support vertical piping at every floor. Support vertical cast iron pipe at each floor at hub.
- G. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
- H. Support riser piping independently of connected horizontal piping.
- I. Provide copper plated hangers and supports for copper piping.
- J. Design hangers for pipe movement without disengagement of supported pipe.
- K. Prime coat exposed steel hangers and supports. Refer to Division 09 Section "Painting". Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.
- L. Do not support pipes from other pipes or equipment.
- M. Size pipe hangers to accommodate continuous piping insulation.

3.4 EQUIPMENT BASES AND SUPPORTS

- A. Housekeeping pads:
 1. Provide housekeeping pads of concrete, minimum 4 inches (100 mm) thick and extending 6 inches (150 mm) beyond supported equipment, with 1 inch (25 mm) chamfered edges. Unless otherwise shown or specified, floor-mounted major equipment shall be set on housekeeping pads and anchored to housekeeping pads. This shall include but not be limited to, air handling units, utility set fans, compressors, base mounted pumps, boilers, converters, heat exchangers, storage tanks and expansion tanks.
 2. Unless otherwise indicated, provide #3 rebar dowel rods on 18-inch (450-mm) centers around full perimeter of base. Drill and epoxy bolts 3" into concrete slab.
 3. Provide templates and accessories for mounting and anchoring equipment.
 4. Apply bonding agent to the slab surface to receive housekeeping pad. Do not roughen by mechanical means.

5. Refer to Division 03 Section "Cast-in-Place Concrete".

- B. Construct supports of steel members. Brace and fasten with flanges bolted to structure.
- C. Provide rigid anchors for pipes after vibration isolation components are installed.
- D. Do not support equipment from pipes or from other equipment.

3.5 FLASHING

- A. Provide flexible flashing and metal counterflashing where piping and ductwork penetrate weatherproofed or waterproofed walls, floors, and roofs.
- B. Flash pipes projecting 3 inches (75 mm) minimum above finished roof surface with lead, 8 inches (200 mm) minimum clear on sides with 24 x 24 inches (600 x 600 mm) sheet size. For pipes through outside walls, turn flanges back into wall and caulk, counterflash with metal, and seal.
- C. Provide acoustical lead flashing around ducts and pipes penetrating equipment rooms, installed in accordance with manufacturer's instructions for sound control.
- D. Provide curbs for mechanical roof installations 14 inches (350 mm) minimum high above roofing surface. Flash and counterflash with sheet metal; seal watertight. Attach counterflashing mechanical equipment and lap base flashing on roof curbs. Flatten and solder joints.
- E. Adjust storm collars tight to pipe with bolts; caulk around top edge. Use storm collars above roof jacks. Screw vertical flange section to face of curb.

3.6 SLEEVES

- A. Set sleeves in position in formwork. Provide reinforcing around sleeves.
- B. Size sleeves large enough to allow for movement due to expansion and contraction. Provide for continuous insulation wrapping.
- C. Extend sleeves through floors 1 inch (25 mm) above finished floor level. Caulk sleeves.
- D. Where piping or ductwork penetrates floor, ceiling, or wall, close off space between pipe or duct and adjacent work with fire stopping insulation and caulk air tight. Provide close fitting metal collar or escutcheon covers at both sides of penetration.
- E. Install chrome plated steel escutcheons at finished surfaces.

3.7 SUPPORTS ABOVE ROOF

- A. Where possible, support piping and equipment from building structural steel and grillage.
- B. Where necessary, use non-penetrating roof-mounted pipe support system.

3.8 SCHEDULES

PIPE SIZE		HANGER ROD MAX. HANGER SPACING		DIAMETER	
Inches	(mm)	Feet	(m)	Inches	(mm)
Steel and Copper Piping					
1/2 to 1-1/4	12 to 32	6.5	2	3/8	9
1-1/2 to 2	38 to 50	10	3	3/8	9
2-1/2 to 3	62 to 75	10	3	1/2	13
4 to 6	100 to 150	10	3	5/8	15
8 to 12	200 to 300	14	4.25	7/8	22
14 and Over	350 and Over	20	6	1	25
1/2 to 2-1/2					
3 and over					

END OF SECTION 230529

SECTION 230553 – IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Nameplates.
- B. Tags.
- C. Labels.
- D. Stencils.
- E. Pipe Markers.
- F. Lockout Devices.

1.2 RELATED SECTIONS

- A. Division 09 Section “Painting”: Identification painting.

1.3 REFERENCES

- A. ASME A13.1 - Scheme for the Identification of Piping Systems (2007 edition or newer).
- B. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems.
- C. NFPA 99 - Standard for Health Care Facilities.

1.4 SUBMITTALS

- A. Submit list of wording, symbols, letter size, and color coding for mechanical identification.
- B. Submit valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.
- C. Product Data: Provide manufacturers catalog literature for each product required.
- D. Samples: Submit 2 tags, 1-1/2 inches (38 mm) in size.
- E. Samples: Submit 2 labels, 1.9 x 0.75 inches (48 x 19 mm) in size.

1.5 PROJECT RECORD DOCUMENTS

- A. Record actual locations of tagged valves; include valve tag numbers.

1.6 OPERATION AND MAINTENANCE DATA

- A. Submit under provisions of Division 01 Section “Operation and Maintenance Data.”

- B. Include valve tag chart.

1.7 REGULATORY REQUIREMENTS

- A. Conform to NFPA 99 requirements for labeling and identification of medical gas piping systems and accessories.

PART 2 - PRODUCTS

2.1 NAMEPLATES

- A. Manufacturers:
 - 1. Seton Identification Products.
 - 2. E.R. Perry Signs & Engraving.
 - 3. Brimar Industries, Inc., PipeMarker division.
 - 4. Substitutions: Not permitted
- B. Plastic Nameplates: Laminated 3-layer plastic with beveled edges and engraved letters on contrasting background color, 1/16 inch (1.58 mm) thick. Letters shall be black on light backgrounds, or white on dark backgrounds, as applicable. Service temperature range -40 to 175 degrees F (-40 to 79 degrees C); minimum application temperature for adhesive 50 degrees F (10 degrees C). Suitable for average outdoor lifespan of at least 2-3 years.
- C. Aluminum Nameplates: For higher temperature applications, and for outdoor applications when manufacturer does not recommend their plastic nameplates for use outdoors, provide aluminum nameplates, with integral anodized or painted surface color coating and natural aluminum engraved letters, 1/32-inch (0.78 mm) thick. Service temperature range -40 to 350 degrees F (-40 to 177 degrees C); minimum application temperature for adhesive 50 degrees F (10 degrees C). Suitable for average outdoor lifespan of at least 2-3 years.
- D. Colors: Select background color as appropriate for the application. Color for general applications shall be white (except that aluminum nameplate standard color shall be black). Color for general warnings shall be red or yellow. Colors for fluid services shall comply with ASME A13.1-2007. Comply with ASME/ANSI standards and other regulations as applicable.
- E. Provide with factory adhesive, and with side holes for fastener attachment as applicable. Mechanical fasteners are required for applications which are outdoors or otherwise exposed to weather or sunlight, or in moist areas such as kitchens and locker rooms, or on cooled surfaces subject to condensation, or on surfaces with operating temperatures above 150 degrees F (65 degrees C). Where nameplate is on an irregular surface and cannot make complete contact, provide mechanical fasteners or ties in addition to adhesive.

2.2 TAGS

- A. Plastic Tags:
 - 1. Manufacturers:
 - a. Seton Identification Products.
 - b. E.R. Perry Signs & Engraving.
 - c. Brimar Industries, Inc., PipeMarker division.
 - d. Substitutions: Not permitted.

2. Laminated three-layer plastic with engraved black letters on light contrasting background color. Tag size minimum 1-1/2 inches (38 mm) diameter.

B. Metal Tags:

1. Manufacturers:
 - a. Seton Identification Products.
 - b. Brady Worldwide, Inc.
 - c. Brimar Industries, Inc., PipeMarker division.
 - d. Substitutions: Not permitted.
2. Brass with stamped letters; tag size minimum 1-1/2 inches (38 mm) diameter with smooth edges.

C. Information Tags:

1. Manufacturer: Seton Identification Products.
2. Clear plastic with printed "Danger," "Caution," or "Warning" and message; size 3-1/4 x 5-5/8 inches (83 x 143 mm) with grommet and self-locking nylon ties.

D. Tag Chains and Hooks: Brass or stainless steel compatible with tag material for general applications. Brass where in contact with copper piping or other copper-alloy materials.

E. Tag Chart: Typewritten letter size list in anodized aluminum frame with plexiglass cover.

2.3 CEILING DOTS WITH LABEL-MAKER LABELS

A. Ceiling Dots:

1. Manufacturer: Avery – Division of Avery Dennison Corporation.
2. Description: Self-adhesive 1/2 inch (12.7 mm) diameter color coded label.

B. Label-Maker Labels:

1. Label Maker:
 - a. Manufacturer:
 - 1) Brother.
 - 2) Brady.
 - 3) Dymo.
 - 4) Substitutions: Approved equal. See Section 016000 - Product Requirements
 - b. Label width capacity: Maximum tape width at least 3/4 inch (19 mm).
 - c. Technology: Thermal transfer.
2. Labels:
 - a. Color:
 - 1) Clear with black lettering for white or off-white ceiling grids.
 - 2) White with black lettering for dark-colored or metallic-colored ceiling grids.
 - b. Width:
 - 1) 3/4 inch (18 mm) for standard 15/16 inch (23.8 mm) wide ceiling grids.
 - 2) 1/2 inch (12 mm) for narrow 9/16 inch (14.3 mm) wide ceiling grids.
 - c. Lettering Height: Maximum size available, for ease of viewing from floor.
Typical sizes as follows:
 - 1) 36 point (1/2 in. (12 mm)) on 3/4 inch (18 mm) wide labels.
 - 2) 24 point (1/3 in. (8 mm)) on 1/2 inch (12 mm) wide labels.

C. Color code as follows:

1. HVAC Equipment: Yellow.

2. Fire Dampers/Smoke Dampers: Red.
3. Plumbing Valves: Green.
4. Heating/Cooling Valves: Blue.]

2.4 LABELS

- A. Manufacturer:
 1. Seton Identification Products.
 2. Substitutions: Approved equal. See Section 016000 - Product Requirements
- B. Description: Polyester, size 1.9 x 0.75 inches (48 x 19 mm), adhesive backed with printed identification.

2.5 STENCILS

- A. Manufacturers:
 1. Seton Identification Products.
 2. Brimar Industries, Inc., PipeMarker division.
 3. Substitutions: Approved equal. See Section 016000 - Product Requirements
- B. Stencils: With clean cut symbols and letters of following size:
 1. Up to 2 inch (51 mm) Outside Diameter of Insulation or Pipe: 1/2 inch (13 mm) high letters.
 2. 2-1/2 to 6 inches (64-150 mm) Outside Diameter of Insulation or Pipe: 1 inch (25 mm) high letters.
 3. Over 6 inches (150 mm) Outside Diameter of Insulation or Pipe: 1-3/4 inches (44 mm) high letters.
 4. Ductwork and Equipment: 1-3/4 inches (44 mm) high letters.
- C. Stencil Paint: As specified in Division 09 Section "Painting", semi-gloss enamel, colors and lettering size conforming to ASME A13.1.

2.6 PIPE MARKERS

- A. Color and Lettering: Conform to ASME A13.1.
- B. Plastic Pipe Markers:
 1. Manufacturers:
 - a. Seton Identification Products.
 - b. Brady Worldwide, Inc.
 - c. Brimar Industries, Inc., PipeMarker division.
 - d. Substitutions: Not permitted
 2. Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering. Larger sizes may have maximum sheet size with spring fastener.
- C. Plastic Underground Pipe Markers:
 1. Manufacturers:
 - a. Seton Identification Products.
 - b. Brady Worldwide, Inc.
 - c. Brimar Industries, Inc., PipeMarker division.
 - d. Substitutions: Not permitted.

2. Bright colored continuously printed plastic ribbon tape, minimum 6 inches (150 mm) wide by 4 mil (0.10 mm) thick, manufactured for direct burial service.

2.7 LOCKOUT DEVICES

- A. Lockout Hasps:
 1. Manufacturers:
 - a. Seton Identification Products.
 - b. Brady Worldwide, Inc.
 - c. Master Lock.
 - d. Substitutions: Approved equal. See Section 016000 - Product Requirements
 2. Anodized aluminum hasp with erasable label surface; size minimum 7-1/4 x 3 inches (184 x 76 mm).
- B. Valve Lockout Devices:
 1. Manufacturers:
 - a. Seton Identification Products.
 - b. Brady Worldwide, Inc.
 - c. Master Lock.
 - d. Substitutions: Approved equal. See Section 016000 - Product Requirements
 2. Nylon device preventing access to valve operator, accepting lock shackle.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Degrease and clean surfaces to receive adhesive for identification materials.
- B. Prepare surfaces in accordance with Division 09 Section "Painting" for stencil painting.

3.2 INSTALLATION

- A. Manufacturer's instructions.
- B. Install identifying devices after completion of coverings and painting.
- C. Install plastic or aluminum engraved nameplates with corrosion-resistant mechanical fasteners, or adhesive, as specified. In outdoor locations, where lifetime of nameplates is limited, fasteners shall be removable screws or bolts for ease of nameplate replacement.
- D. Install labels with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer. For unfinished canvas covering, apply paint primer before applying labels.
- E. Install tags using corrosion resistant chain. Number tags consecutively by location.
- F. Apply stencil painting in accordance with Division 09 Section "Painting."
- G. Install underground plastic pipe markers 6 to 8 inches (150 to 200 mm) below finished grade, directly above buried pipe.
- H. Identify items of mechanical equipment such as chillers, fans, terminal units, air handling units,

pumps, heat transfer equipment, tanks, and water treatment devices with plastic nameplates. Small devices, such as in-line pumps, may be identified with tags.

- I. Identify control panels and major control components outside panels with plastic nameplates.
- J. Identify valves in main and branch piping with metal tags.
- K. Tag automatic controls, instruments, and relays. Key to control schematic.
- L. Identify piping, concealed or exposed, with plastic pipe markers. Use tags on piping 3/4 inch (20 mm) diameter and smaller. Identify service, flow direction, and pressure. Install in clear view and align with axis of piping. Locate identification not to exceed 20 feet (6 m) on straight runs including risers and drops, at each branch and riser take-off, adjacent to each valve and tee, at each side of penetration of structure or enclosure, and at each obstruction.
- M. Identify ductwork with stenciled painting. Identify with air handling unit identification number and area served. Locate identification at air handling unit, at each side of penetration of structure or enclosure, and at each obstruction.
- N. Identify duct access doors at fire dampers, smoke dampers, and smoke detectors with 1/2 inch (12.7 mm) lettering to indicate the fire protection device(s) within, in accordance with NFPA 90A.
- O. Provide ceiling dots with label-maker labels to locate valves, dampers and equipment above T-bar type panel ceilings. Locate in corner of panel closest to equipment.
- P. Secure valve tag chart on an easily accessible wall in the mechanical room or in a location as otherwise directed by the Architect.

3.3 COORDINATION WITH EXISTING EQUIPMENT

- A. Where an existing equipment identification system is involved, the new system shall be coordinated and compatible with the existing system.

END OF SECTION 230553

SECTION 230593 – TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 FOR INFORMATION ONLY

- A. The testing, adjusting and balancing (TAB) Agent shall be contracted directly with the Owner. This Specification section has been included for information only, to inform the Contractor that testing, adjusting and balancing will be performed on the mechanical systems and that the Contractor is responsible for assisting and coordinating with the TAB Agency as described in this section.

1.2 SECTION INCLUDES

- A. Testing, Adjustment, and Balancing of Air Systems.
- B. Testing, Adjustment, and Balancing of Hydronic, Refrigeration, Piping Systems.
- C. Measurement of Final Operating Condition of HVAC Systems.

1.3 RELATED SECTIONS

- A. Testing laboratory services: Employment of testing agency and payment for services.

1.4 REFERENCES

- A. AABC - National Standards for Total System Balance.
- B. ADC - Test Code for Grilles, Registers, and Diffusers.
- C. ASHRAE 111 - Practices for Measurement, Testing, Adjusting, and Balancing of Building Heating, Ventilation, Air-conditioning, and Refrigeration Systems.
- D. NEBB - Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems.
- E. SMACNA - HVAC Systems Testing, Adjusting, and Balancing.

1.5 DEFINITIONS

- A. AABC: Associated Air Balance Council.
- B. ASHRAE: American Society of Heating, Refrigerating and Air Conditioning Engineers.
- C. NEBB: National Environmental Balancing Bureau.
- D. SMACNA: Sheet Metal and Air Conditioning Contractors' National Association.
- E. TAB: Testing, Adjusting, and Balancing.

1.6 SUBMITTALS

- A. Submit name of TAB Agency for approval within 14 days after award of Contract.
- B. Design Review Reports:
 - 1. Submit prior to commencement of construction.
 - 2. Review the Contract Documents, and indicate deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.
- C. Preliminary Report Submittals:
 - 1. Prior to commencing work of this Section, and no more than 14 days after approval of TAB Agency submittals, submit report forms or outlines indicating adjusting, balancing, and equipment data required, with columns of design data filled in. By means of plan views, equipment profiles, and similar graphical descriptions, indicate where measurements will be taken.
 - 2. Submit the procedures to be used.
- D. Field Reports: Submit draft copies of report for review prior to final acceptance of Project. Provide final copies for Architect/Engineer and for inclusion in operating and maintenance manuals.
- E. Provide reports in letter size, 3-ring binder manuals, complete with index page and indexing tabs, with cover identification at front and side. Include set of reduced drawings with air outlets and equipment identified to correspond with data sheets, and indicating thermostat locations.
- F. Include detailed procedures, agenda, sample report forms and copy of AABC National Project Performance Guaranty prior to commencing system balance.
- G. Test Reports: Indicate data on AABC National Standards for Total System Balance forms, or forms prepared following ASHRAE 111, or NEBB forms, or forms containing information indicated in Schedules. Indicate data on AABC National Standards for Total System Balance forms, or forms prepared following ASHRAE 111, or NEBB forms.

1.7 QUALITY ASSURANCE

- A. Perform total system balance in accordance with AABC National Standards for Field Measurement and Instrumentation, Total System Balance; or ASHRAE 111; or NEBB Procedural Standards for Testing, Balancing and Adjusting of Environmental Systems.

1.8 QUALIFICATIONS

Agency: Company specializing in the testing, adjusting, and balancing of systems specified in this Section with minimum 3 years' experience and certified by AABC or NEBB, or equivalent experience which would qualify for membership in these testing organizations. Agency shall be one of those listed under article 3.1 AGENCIES in this Section

- A. Perform Work under supervision of AABC Certified Test and Balance Engineer, NEBB Certified Testing, Balancing and Adjusting Supervisor, or registered Professional Engineer experienced in performance of this Work and licensed at the place where the Project is located.

- B. Certification by the National Balancing Council (NBC) (an affiliate of the National Comfort Institute (NCI)) will not be allowed as a substitute for the specified qualifications.
- C. The approved Agency shall be in no way affiliated with the installing Subcontractor.

1.9 SEQUENCING

- A. Sequence work to commence after completion of systems or portions of work, and schedule completion of work before Substantial Completion of Project.

1.10 SCHEDULING

- A. Schedule and provide assistance in final adjustment and test of life safety system with Fire Authority.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 AGENCIES

- A. Tekon Technical Consultants, Portsmouth, NH. Contact: Charles Corlin, (603) 335-3080.
- B. Central Air Balance, Lisbon, Maine 04250; C (207) 754-2023; Contact Glenn Hill.
- C. Hood T.A.B. LLC, Andover, MA. Contact: Michael Hood, (978) 474-7595.
- D. NETB Associates LLC, East Kingston, NH. Contact: Frank Collamore, (978) 270-7547.
- E. Advantage Engineering, 19 Technology Way, Nashua, NH. Contact: Dan LaPlante 603-731-3880
- F. Substitutions: Not permitted.

3.2 EXAMINATION

- A. Verify that systems are complete and operating correctly in accordance with sequence of operations before commencing work. Ensure the following conditions:
 - 1. Systems are started and operating in a safe and normal condition.
 - 2. Temperature control systems are installed complete and operable.
 - 3. Proper thermal overload protection is in place for electrical equipment.
 - 4. Final filters are clean and in place. If required, install temporary media in addition to final filters.
 - 5. Duct systems are clean of debris.
 - 6. Fans are rotating correctly.
 - 7. Fire and volume dampers are in place and open.
 - 8. Air coil fins are cleaned and combed.
 - 9. Access doors are closed and duct end caps are in place.
 - 10. Air outlets are installed and connected.
 - 11. Duct system leakage is minimized.

12. Hydronic systems are flushed, filled, and vented.
13. Pumps are rotating correctly.
14. Proper strainer baskets are clean and in place.
15. Service and balance valves are open.

- B. Submit field reports. Report to the responsible Subcontractors, defects and deficiencies noted during performance of services which prevent system balance. Submit list of locations where the Contractor needs to provide additional balancing devices.
- C. Beginning of work means acceptance of existing conditions.

3.3 PREPARATION

- A. Provide instruments required for testing, adjusting, and balancing operations. Make instruments available to Architect/Engineer to facilitate spot checks during testing.

3.4 INSTALLATION TOLERANCES

- A. Air Handling Systems: Adjust to within plus or minus 5 percent of design for supply systems and plus or minus 10 percent of design for return and exhaust systems.
- B. Air Outlets and Inlets: Adjust total to within plus 10 percent and minus 5 percent of design to space. Adjust outlets and inlets in space to within plus or minus 10 percent of design.
- C. Hydronic Systems: Adjust to within plus or minus 10 percent of design.

3.5 ADJUSTING

- A. Ensure recorded data represents actual measured or observed conditions.
- B. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.
- C. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.
- D. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.
- E. For belt driven equipment, provide sheave and belt modifications and/or replacements as required to ensure design flow rates as specified.
- F. Variable-frequency drives shall generally be set near full speed, between 60 Hz and 55 Hz output frequency, to preserve as much frequency range as possible for controllability.

3.6 AIR SYSTEM PROCEDURE

- A. Adjust air handling and distribution systems to provide design supply, return, and exhaust air quantities.
- B. Make air quantity measurements in ducts by Pitot tube traverse of entire cross sectional area of duct.

- C. Measure air quantities at air inlets and outlets.
- D. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts and noise.
- E. Use volume control devices to regulate air quantities only to extent that adjustments do not create objectionable air motion or sound levels. Effect volume control by duct internal devices such as dampers and splitters.
- F. Vary total system air quantities by adjustment of fan speeds. Vary branch air quantities by damper regulation.
- G. Provide system schematic (in floor-plan or line-diagram view) with outlets and inlets numbered with the reference numbers used in the TAB Agent's tabular data, and with required and actual air quantities recorded at each outlet or inlet.
 - 1. Indicate locations of duct traverses.
 - 2. Indicate locations of duct pressure sensors, airflow monitoring stations, and other devices which require measurements for control settings.
- H. Measure static air pressure conditions on air supply units, air return units, exhaust units, and heat recovery units, including pressure drops across filters, coils, dampers, mixing boxes, and heat recovery devices, and total pressure across the fan. Make allowances for 50 percent loading of filters, and indicate actual filter drop as well as the allowances. Provide equipment diagram indicating internal components and measurement points.
- I. Provide duct traverse diagrams with measurement points indicated, with readings recorded at each point, and with calculated velocity and airflow.
- J. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions. Adjust at minimum position and maximum position, and use manual dampers and actuator limit stops to minimize differences.
- K. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.
- L. Where modulating dampers are provided, take measurements and balance at extreme conditions. Balance variable volume systems at maximum air flow rate, full cooling, and at minimum air flow rate, full heating.
- M. Coordinate with Division 23 Section "Instrumentation and Controls for Mechanical Systems" for calibration of air handling units' airflow monitoring stations. Calibrate airflow monitoring stations to ensure that airflow readings from airflow monitoring stations correspond with actual airflows.
- N. Coordinate with Division 23 Section "Instrumentation and Controls for Mechanical Systems" for calibration of air handling units' static pressure sensors and determination of pressure setpoints.
- O. Set pattern-control vanes and other devices in air inlets and outlets to provide the spread and throw patterns indicated, without objectionable noise or air motion to the occupants. Split the flow of linear slot diffusers in directions as required for good coverage. At completion, patterns

shall be uniform and pleasing to the eye.

3.7 WATER SYSTEM PROCEDURE

- A. Adjust water systems to provide required or design quantities.
- B. Use calibrated Venturi tubes, orifices, or other metered fittings and pressure gauges to determine flow rates for system balance. Where flow metering devices are not installed, base flow balance on temperature difference across various heat transfer elements in the system.
- C. 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.
- D. Effect system balance with automatic control valves fully open to heat transfer elements.
- E. Effect adjustment of water distribution systems by means of balancing cocks, valves, and fittings. Do not use service or shut-off valves for balancing.
- F. Where available pump capacity is less than total flow requirements of individual system parts (due to system diversity), full flow in one part may be simulated by temporary restriction of flow to other parts.
- G. Coordinate with Division 23 Section "Instrumentation and Controls for Mechanical Systems" for calibration of pump static pressure sensors and determination of pressure setpoints.
- H. When the available pump head is more than 15 percent above the required head to meet the design flow, trim the pump impeller to bring the head within 100 to 110 percent of the required head to meet the design flow. At least one balancing valve in the system, and one balancing valve per each multi-circuit sub-main branch served by a branch balancing valve, shall be fully open when balancing is complete.

3.8 REFRIGERATION TESTING PROCEDURES

- A. Obtain information from the refrigeration unit startup technician, including refrigerant and oil types and quantities used, and saturated suction temperature at full-load operation. Record this information for each refrigeration circuit.
- B. Record condenser inlet and outlet air temperatures at full load for each refrigeration circuit individually, and for unit full load with all circuits running. Provide heat at the cooling coil, and adjust operating room or air temperature setpoints, as required to simulate full load conditions.

3.9 VERIFICATION OF DUCT LEAKAGE TESTING

- A. The TAB Agent shall witness the duct leakage tests performed under Division 23 Section "Metal Ducts." At a minimum, the first duct leakage test shall be witnessed and approved by the TAB Agent and the Engineer. At a minimum, subsequent duct leakage tests shall be witnessed and approved by the TAB Agent. The TAB Agent shall confirm proper testing procedures and shall give written approval to leakage tests. If deficiencies are discovered, the TAB Agent shall document these deficiencies to the Contractor and the Engineer. Once deficiencies are corrected, the TAB Agent shall witness follow-up leakage tests.

3.10 COORDINATION OF SERVICES

- A. The General Contractor and his Subcontractors shall be responsible for providing the following assistance to the TAB Agent:
 - 1. Provide access to the Contractor's on site ladders and man-lifts as required to allow access to required equipment by the TAB Agent.
 - 2. Keep the TAB Agent informed of the project schedule and ensure that adequate notice is given to the TAB Agent to allow for the proper testing, adjusting and balancing of mechanical systems before ceilings are flooded or access to systems is otherwise obstructed.
 - 3. Ensure that adequate time is allotted in the project schedule to allow for the proper testing, adjusting and balancing of the mechanical systems.
 - 4. Coordinate with the TAB Agent to correct system deficiencies that are discovered by the TAB Agent. Notify the TAB Agent once system deficiencies are corrected.

3.11 PROJECT CLOSEOUT

- A. At final inspection, recheck random selections of data recorded in report. Recheck points or areas as selected and witnessed by the Architect
- B. Check and adjust systems approximately 6 months after final acceptance and submit report.
- C. Retests: If random tests elicit a measured flow deviation of 10 percent or more from, that recorded in the certified report listings, at 10 percent or more of the rechecked selections, the report shall be automatically rejected. In the event the report is rejected, systems shall be readjusted and tested, new data recorded, new certified reports submitted, and new inspection tests made.

3.12 SCHEDULES

- A. Equipment Requiring Testing, Adjusting, and Balancing:
 - 1. HVAC Pumps
 - 2. Air Cooled Refrigerant Condensers
 - 3. Gas-Fired Makeup Air Units
 - 4. Computer Room Air Conditioning Units
 - 5. Air Coils
 - 6. Air Handling Units
 - 7. Fans
 - 8. Air Filters
 - 9. Air Inlets and Outlets
- B. Report Forms:
 - 1. Title Page:
 - a. Name of Testing, Adjusting, and Balancing Agency
 - b. Address of Testing, Adjusting, and Balancing Agency
 - c. Telephone number of Testing, Adjusting, and Balancing Agency
 - d. Project name
 - e. Project location
 - f. Project Architect
 - g. Project Engineer

- h. Project Contractor
- i. Project altitude
- j. Report date
- 2. Summary Comments:
 - a. Design versus final performance
 - b. Notable characteristics of system
 - c. Description of systems operation sequence
 - d. Summary of outdoor and exhaust flows to indicate amount of building pressurization
 - e. Nomenclature used throughout report
 - f. Test conditions
- 3. Instrument List:
 - a. Instrument
 - b. Manufacturer
 - c. Model number
 - d. Serial number
 - e. Range
 - f. Calibration date
- 4. Electric Motors:
 - a. Manufacturer
 - b. Model/Frame
 - c. HP/BHP
 - d. Phase, voltage, amperage; nameplate, actual, no load
 - e. RPM
 - f. Service factor
 - g. Starter size, rating, heater elements
 - h. Sheave Make/Size/Bore
- 5. Variable Frequency Drive (VFD):
 - a. Motor(s) served
 - b. Manufacturer
 - c. Model/Frame
 - d. HP/BHP ratings
 - e. Phase, voltage, amperage; nameplate, actual, no load
 - f. Input and output frequency (Hz)
 - g. Reference speed command from control system
 - h. Carrier frequency setting
 - i. Speeds programmed out for vibration
 - j. Speed adjustment for motor balancing (if allowed)
- 6. Pump Data:
 - a. Identification/number
 - b. Manufacturer
 - c. Size/model
 - d. Impeller
 - e. Service
 - f. Design flow rate, pressure drop, BHP
 - g. Actual flow rate, pressure drop, BHP
 - h. Discharge pressure
 - i. Suction pressure
 - j. Total operating head pressure
 - k. Shut off, discharge and suction pressures
 - l. Shut off, total head pressure

7. Combustion Test:
 - a. Boiler manufacturer
 - b. Model number
 - c. Serial number
 - d. Fuel type
 - e. Firing rate
 - f. Fuel tank fill level
 - g. Oil pump inlet pressure/vacuum
 - h. Overfire draft
 - i. Gas meter timing dial size
 - j. Gas meter time per revolution
 - k. Gas pressure at meter outlet
 - l. Gas flow rate
 - m. Heat input
 - n. Burner manifold gas pressure
 - o. Percent carbon monoxide (CO₂)
 - p. Percent carbon dioxide (CO₂)
 - q. Percent oxygen (O₂)
 - r. Percent excess air
 - s. Flue gas temperature at outlet
 - t. Ambient temperature
 - u. Net stack temperature
 - v. Percent stack loss
 - w. Percent combustion efficiency
 - x. Heat output
8. Air Cooled Condensing Unit:
 - a. Identification/number
 - b. Location
 - c. Manufacturer and Model number
 - d. Serial number
 - e. Entering DB air temperature, design and actual
 - f. Leaving DB air temperature, design and actual
 - g. Number of compressors
 - h. Refrigerant and oil types and quantities
9. Cooling Coil Data:
 - a. Identification/number
 - b. Location
 - c. Service
 - d. Manufacturer
 - e. Rows, and fins per inch
 - f. Air flow, design and actual
 - g. Entering air DB temperature, design and actual
 - h. Entering air WB temperature, design and actual
 - i. Leaving air DB temperature, design and actual
 - j. Leaving air WB temperature, design and actual
 - k. Water flow, design and actual
 - l. Water pressure drop, design and actual
 - m. Entering water temperature, design and actual
 - n. Leaving water temperature, design and actual
 - o. Refrigerant saturated suction temperature, design and actual
 - p. Refrigerant superheat temperature

- q. Air pressure drop, design and actual
- 10. Heating Coil Data:
 - a. Identification/number
 - b. Location
 - c. Service
 - d. Manufacturer
 - e. Rows, and fins per inch
 - f. Air flow, design and actual
 - g. Water flow, design and actual
 - h. Water pressure drop, design and actual
 - i. Entering water temperature, design and actual
 - j. Leaving water temperature, design and actual
 - k. Entering air temperature, design and actual
 - l. Leaving air temperature, design and actual
 - m. Air pressure drop, design and actual
- 11. Return Air/Outside Air Data:
 - a. Identification/location
 - b. Design air flow
 - c. Actual air flow
 - d. Design return air flow
 - e. Actual return air flow
 - f. Design outside air flow
 - g. Actual outside air flow
 - h. Return air temperature
 - i. Outside air temperature
 - j. Required mixed air temperature
 - k. Actual mixed air temperature
 - l. Design outside/return air ratio
 - m. Actual outside/return air ratio
- 12. Exhaust Fan Data:
 - a. Location
 - b. Manufacturer
 - c. Model number
 - d. Serial number
 - e. Air flow, specified and actual
 - f. Total static pressure (total external), specified and actual
 - g. Inlet pressure
 - h. Discharge pressure
 - i. Sheave Make/Size/Bore
 - j. Number of Belts/Make/Size
 - k. Fan RPM
- 13. Duct Traverse:
 - a. System zone/branch
 - b. Duct size
 - c. Area
 - d. Design velocity
 - e. Design air flow
 - f. Test velocity
 - g. Test air flow
 - h. Duct static pressure
 - i. Air temperature

- j. Air correction factor
- 14. Air Monitoring Station Data:
 - a. Identification/location
 - b. System
 - c. Size
 - d. Area
 - e. Design velocity
 - f. Design air flow
 - g. Test velocity
 - h. Test air flow
- 15. Air Distribution Test Sheet:
 - a. Air terminal number
 - b. Room number/location
 - c. Terminal type
 - d. Terminal size
 - e. Area factor
 - f. Design velocity
 - g. Design air flow
 - h. Test (final) velocity
 - i. Test (final) air flow
 - j. Percent of design air flow

END OF SECTION 230593

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SECTION 230713 – DUCT INSULATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Ductwork Insulation.
- B. Duct Liner.
- C. Fire Resistive Duct Wrap for Kitchen Grease Exhaust.
- D. Insulation jackets.

1.2 RELATED SECTIONS

- A. Division 09 Section “Painting”: Painting insulation jackets.
- B. Division 23 Section “Identification for HVAC Piping and Equipment.”
- C. Division 23 Section “Metal Ducts”: Factory-insulated flexible ductwork.
- D. Division 23 Section “Metal Ducts”: Ductwork.

1.3 REFERENCES

- A. ASTM
- B. ISO 6944 - 1985 - Fire Resistance Tests - Ventilation Ducts.
- C. NAIMA - National Insulation Standards.
- D. NFPA 255 - Standard Method of Test of Surface Burning Characteristics of Building Materials.
- E. SMACNA - HVAC Duct Construction Standards - Metal and Flexible.
- F. UL 94 - Tests for Flammability of Plastic Materials for Parts in Devices and Appliances.
- G. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials.

1.4 SUBMITTALS

- A. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this Section with minimum 3 years’ experience.
- B. Applicator Qualifications: Company specializing in performing the work of this Section with

minimum 3 years' experience.

1.6 REGULATORY REQUIREMENTS

- A. Materials: Flame spread/smoke developed rating of 25/50 in accordance with ASTM E84, NFPA 255 and UL 723. For elastomeric foam insulation, rating shall apply for thicknesses up to 2 inches (50 mm).
- B. Insulation materials shall be asbestos free. No fibers with dimensions similar to asbestos fibers shall be released from any material.

1.7 DELIVERY, STORAGE, AND PROTECTION

- A. Transport, handle, store, and protect products.
- B. Accept materials on site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.
- C. Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original wrapping.

1.8 ENVIRONMENTAL REQUIREMENTS

- A. Environmental conditions affecting products on site.
- B. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.
- C. Maintain temperature during and after installation for minimum period of 24 hours.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Glass and Mineral Fiber Products:
 - 1. Knauf Insulation.
 - 2. Certainteed Corporation.
 - 3. Johns Manville.
 - 4. Owens Corning.
 - 5. Substitutions: Not permitted.
- B. Elastomeric Foam Products:
 - 1. Armacell LLC.
 - 2. K-Flex USA.
 - 3. Substitutions: Not permitted.
- C. Fire-resistive Duct Blankets for Kitchen Grease Exhaust:
 - 1. 3M Company – Fire Barrier Duct Wrap 615+.
 - 2. Thermal Ceramics Inc. – FireMaster FastWrap XL.
 - 3. Unifrax Corporation – FyreWrap Elite 1.5.
 - 4. Substitutions: Not permittedNo substitutions.

5.

D. Accessories:

1. Ceel-Co division of Johns Manville (product: plastic jacket systems).
2. Foster Products, division of Specialty Construction Brands, Inc., a subsidiary of H.B. Fuller (mastics, sealants, reinforcing membranes, and accessories).
3. Johns Manville (products: Super-Seal acrylic polymer coatings, Zeston plastic jacket systems).
4. Substitutions: Approved equal. See Section 016000 - Product Requirements.

2.2 GLASS FIBER, FLEXIBLE

A. Insulation: ASTM C553; flexible, noncombustible blanket.

1. 'K' ('Ksi') value: ASTM C518, 0.25 at 75 degrees F (0.039 at 24 degrees C).
2. Maximum service temperature: 250 degrees F (121 degrees C) faced and 350 degrees F (176 degrees C) unfaced.
3. Maximum moisture absorption: 0.20 percent by volume.
4. Minimum density: 1.0 lb/cu. ft. (16 kg/m³).

B. Vapor Barrier Jacket:

1. ASTM C1136, Kraft paper reinforced with glass fiber yarn and bonded to vapor barrier film. Facing as required for the application. Integral staple flap on one edge.
 - a. Aluminum Faced: FSK (aluminum foil-scrim-kraft) construction.
 - b. White Faced: PSK (polypropylene-scrim-kraft) construction.
2. Moisture vapor transmission: ASTM E96; 0.02 perm.
3. Suitable for insulation surface temperatures up to 150 degrees F (66 degrees C).
4. Overlap longitudinal laps and butt strips.
5. Secure with outward clinch expanding staples and vapor barrier mastic and pressure sensitive tape.

C. Vapor Barrier Tape: See article "Glass Fiber Insulation Sealing Tape" in this Section.

D. Tie Wire: Annealed steel, 16 ga (1.5 mm).

2.3 GLASS FIBER, RIGID

A. Insulation: ASTM C612; rigid, noncombustible blanket. Supplied in board form.

1. 'K' ('Ksi') value: ASTM C518, 0.24 at 75 degrees F (0.036 at 24 degrees C).
2. Maximum service temperature: 450 degrees F (232 degrees C).
3. Maximum moisture absorption: 1.0 percent by volume.
4. Density: 3.0 lb/cu. ft. (48 kg/cu m).

B. Vapor Barrier Jacket:

1. ASTM C1136, kraft paper reinforced with glass fiber yarn and bonded to aluminized film. Facing as required for the application.
 - a. Aluminum Faced: FSK (foil-scrim-kraft) construction
 - b. White Faced: ASJ (all-service jacket) construction.
2. Moisture vapor transmission: ASTM E96; 0.02 perm.
3. Suitable for insulation surface temperatures up to 150 degrees F (66 degrees C).
4. Overlap longitudinal laps and butt strips.
5. Secure insulation with mechanical fasteners to substrate, and seal jacket with pressure

sensitive tape.

- C. Vapor Barrier Tape: See article “Glass Fiber Insulation Sealing Tape” in this Section.
- D. Indoor Vapor Barrier Finish:
 - 1. Cloth: Untreated; 9 oz/sq yd (305 g/sq m) weight, glass fabric.
 - 2. Vinyl emulsion type acrylic, compatible with insulation, white color.

2.4 GLASS FIBER, SEMI-RIGID

- A. Insulation: ASTM C612; semi-rigid, noncombustible blanket, with fibers oriented perpendicular to insulation surface to provide compressive strength while maintaining flexibility. Supplied in roll form, suitable for application on rounded shapes such as pipes, tanks, ducts, vessels, and other similar round and irregular shapes.
 - 1. 'K' ('Ksi') value: ASTM C518, 0.24 at 75 degrees F (0.036 at 24 degrees C).
 - 2. Maximum service temperature: 450 degrees F (232 degrees C).
 - 3. Maximum moisture absorption: 1.0 percent by volume.
 - 4. Density: 2.5 lb/cu. ft. (40 kg/cu m).
- B. Vapor Barrier Jacket:
 - 1. ASTM C1136, kraft paper with glass fiber yarn and bonded to aluminized film. Facing as required for the application.
 - a. Aluminum Faced: FSK (foil-scrim-kraft) construction
 - b. White Faced: ASJ (all-service jacket) construction.
 - 2. Moisture vapor transmission: ASTM E96; 0.02 perm.
 - 3. Suitable for insulation surface temperatures up to 150 degrees F (66 degrees C).
 - 4. Overlap longitudinal laps and butt strips.
 - 5. Secure with outward clinch expanding staples and vapor barrier mastic and pressure sensitive tape.
- C. Vapor Barrier Tape: See article “Glass Fiber Insulation Sealing Tape” in this Section.
- D. Indoor Vapor Barrier Finish:
 - 1. Cloth: Untreated; 9 oz/sq yd (305 g/sq m) weight, glass fabric.
 - 2. Vinyl emulsion type acrylic, compatible with insulation, white color.

2.5 GLASS FIBER, PREFORMED PIPE COVERING

- A. Insulation: ASTM C547; rigid molded, noncombustible.
 - 1. 'K' ('Ksi') value: ASTM C177, 0.24 Btu-in/(hr-sq.ft-°F) at 75 degrees F (0.035 W/m-K at 24 degrees C).
 - 2. Maximum service temperature: 850 degrees F (454 degrees C).
 - 3. Maximum moisture absorption: 0.2 percent by volume.
- B. Vapor Barrier Jacket:
 - 1. ASTM C1136, White kraft paper with glass fiber yarn, bonded to aluminized film.
 - 2. Moisture vapor transmission: ASTM E96; 0.02 perm-inches.
- C. Tie Wire: 0.048 inch (1.22 mm) stainless steel with twisted ends on maximum 12 inch (300 mm) centers.

- D. Vapor Barrier Lap Adhesive: Compatible with insulation.
- E. Vapor Barrier Tape:
 - 1. Provide self-adhesive butt strips furnished by the insulation manufacturer, with finish to match the insulation outer finish.
- F. Insulating Cement/Mastic: ASTM C195; hydraulic setting on mineral wool.
- G. Indoor Vapor Barrier Finish:
 - 1. Cloth: Untreated; 9 oz/sq yd (305 g/sq m) weight.
 - 2. Vinyl emulsion type acrylic, compatible with insulation, white color.
- H. Outdoor Vapor Barrier Mastic: Vinyl emulsion type acrylic or mastic, compatible with insulation, black color.
- I. Outdoor Breather Mastic: Vinyl emulsion type acrylic or mastic, compatible with insulation, black color.
- J. Insulating Cement: ASTM C449/C449M.

2.6 GLASS FIBER INSULATION SEALING TAPE

- A. Manufacturer:
 - 1. 3M VentureTape,
 - 2. Ideal Tape
 - 3. Insulation manufacturer
 - 4. Substitutions: Approved equal. See Section 016000 - Product Requirements
- B. Self-adhesive tape with integral vapor barrier, pressure sensitive acrylic-based or rubber-based adhesive, and release liner strip. Width 3 inch (76 mm) nominal.
- C. Types:
 - 1. For rigid and semi-rigid insulations, tape shall be reinforced type. For flexible “duct wrap” insulation, tape shall be either reinforced or non-reinforced.
 - 2. White or aluminum outer surface to match the insulation.
 - 3. Reinforced: Kraft paper reinforced with glass fiber yarn and bonded to vapor barrier layer.
 - a. Aluminum Finish with FSK: VentureTape 1525CW.
 - b. White Finish with ASJ: VentureTape 1540CW
 - c. White Finish with PSK: VentureTape 1531CW.
 - 4. Non-Reinforced: Foil insulation tape. Dead-soft temper 2 mil (0.05 mm) thick aluminum foil, without reinforcement. Hand-tearable.
 - 5. Performance:
 - a. Peel Adhesion: PSTC-101 with 20 minute dwell, 45 oz/in. (12.5 N / 25 mm).
 - b. Shear Adhesion: PSTC-107, 2.2 psi (15.2 kPa) after 24 hours.
 - c. Tensile Strength: PSTC-131:
 - 1) Reinforced Types: 40 lb/in. (180.8 N / 25 mm).
 - 2) Non-reinforced Types: 21 lb/in. (94.9 N / 25 mm).
 - d. Elongation: PSTC 131, 6 percent maximum.
 - e. Service Temperature: -40 to 240 degrees F (-40 to 116 degrees C).
 - f. UL 723 listed or classified (flame/smoke rating).

2.7 ELASTOMERIC FOAM

- A. Approved Products:
 - 1. Armacell: AP Armaflex and AP Armaflex FS sheet insulation.
 - 2. K-Flex USA: Insul-Sheet S2S and K-Flex LS sheet insulation.
 - 3. Substitutions: Not permitted
- B. Insulation: ASTM C534; flexible, cellular elastomeric, molded or sheet.
 - 1. 'K' ('Ksi') value: ASTM C177; 0.277 Btu-in/(h-ft²-degrees F) at 75 degrees F (0.04 W/m-K at 24 degrees C).
 - 2. Minimum service temperature: -70 degrees F (-57 degrees C) (flexible to -40 degrees F (-40 degrees C)).
 - 3. Maximum service temperature: 220 degrees F (104 degrees C).
 - 4. Maximum moisture absorption: ASTM C209, 0.2 percent by volume; or ASTM D1056, 5 percent by weight.
 - 5. Moisture vapor transmission: ASTM E96; 0.08 perm-inches (0.116 ng/(s-m-Pa)).
 - 6. Connection: Waterproof vapor barrier adhesive.
 - 7. Density: 3.0 to 6.0 lb/cu ft (48 to 96 kg/cu m).
- C. Elastomeric Foam Adhesive: Air dried, contact adhesive, compatible with insulation.

2.8 ELASTOMERIC FOAM DUCT LINER

- A. Products:
 - 1. Armacell, AP Armaflex and AP Armaflex FS black or gray sheet duct liner insulation.
 - 2. K-Flex USA: Insul-Sheet S2S and K-Flex LS sheet insulation.
 - 3. Substitutions: Not permitted.
- B. Insulation: ASTM C534; flexible cellular elastomeric foam, molded or sheet, factory-treated with antimicrobial agent.
 - 1. 'K' ('Ksi') value: ASTM C177; 0.25 Btu-in/(h-ft²-degrees F) at 75 degrees F (0.04 W/m-K at 24 degrees C).
 - 2. Minimum service temperature: -70 degrees F (-57 degrees C) (flexible to -40 degrees F (-40 degrees C)).
 - 3. Maximum service temperature: 180 degrees F (82 degrees C).
 - 4. Maximum moisture absorption: ASTM C209, 0.2 percent by volume; or ASTM D1056, 5 percent by weight.
 - 5. Moisture vapor transmission: ASTM E96; 0.20 perm-inches (1.16x10⁻¹⁰ Kg/(s-m-Pa)).
 - 6. Maximum velocity on airstream side: ASTM C1071; 6,000 fpm (30.5 m/sec).
 - 7. Connection: Waterproof vapor barrier adhesive.
 - 8. Density: 3.0 to 6.0 lb/cu. ft. (48 to 96 kg/cu m).
 - 9. Minimum sound absorption coefficients, ASTM C423, Type A mounting (sabins/sq. ft):
 - a. At 250 Hz center band frequency: 0.17 for 1 inch (25 mm) thickness.
 - b. At 500 Hz center band frequency: 0.80 for 1 inch (25 mm) thickness.
 - c. At 1000 Hz center band frequency: 0.32 for 1 inch (25 mm) thickness.
 - d. NRC: 0.50 for 1 inch (25 mm) thickness.
- C. Elastomeric Foam Adhesive: Air dried, contact adhesive, compatible with insulation.
- D. Self-Adhesive Coating: At the Contractor's option, the insulation may be provided with a factory-applied self-adhesive coating with peel-off release liner. If the Manufacturer

recommends installation of self-adhesive liner without mechanical pin fasteners at all velocities, the pins may be omitted. Provide suitable cleaner for the ductwork to ensure adhesion.

2.9 FIRE RESISTIVE DUCT WRAP

- A. General:
 - 1. Work includes labor, material, and equipment to provide 2 hour fire resistive rated grease or air duct enclosure as a shaft alternative and a method for providing zero-inch clearances around commercial kitchen grease duct exhaust systems to combustible materials.
 - 2. These Specifications are based on 3M Fire Barrier Duct Wrap 615+ materials. Where installation requirements of substituted products differ from these Specifications, the more stringent requirements shall apply.
- B. Listing Agency: Provide products that are listed by at least one the following:
 - 1. Underwriters Laboratories Inc. (UL), in "Fire Resistance Directory" category XHEZ or XHBN as appropriate.
 - 2. Omega Point Laboratories (OPL), in "Directory of Listed Products, Through Penetration Fire Resistance Directory."
 - 3. Any other qualified independent testing and inspection agency that conducts periodic follow-up inspections and is acceptable to authorities having jurisdiction.
- C. Furnish products identical to those tested for classification by listing agency.
- D. Mark product packing with classification marking of listing agency.
- E. Duct Wrap Exposed to View: Provide products with flame spread index of less than 25 and smoke developed index of less than 450, when tested in accordance with ASTM E84.
- F. Duct Wrap Exposed to View, Traffic, Moisture, or Physical Damage: Provide products that after curing do not deteriorate when exposed to those conditions during and after construction.
- G. Materials: Use only products specifically listed for use in Listed systems.
- H. Submittals: Submit test reports substantiating performance requirements and Code compliance along with manufacturer's installation instructions.
- I. Duct Wrap: 3M Fire Barrier Duct Wrap 615+: Lightweight, non-asbestos, high temperature, bio-soluble, calcium-magnesium-silicate (CMS) non-woven blanket, encapsulated in a scrim-reinforced foil, blanket thickness of 1.5 inches (38 mm) for ventilation and grease duct applications.
 - 1. Color: White blanket, aluminum foil encapsulated.
 - 2. Weight: 0.9 psf (4.38 kg/m²).
 - 3. Density: 6 pcf (96.1 kg/m³) nominal.
 - 4. Thermal Conductivity (k-value) at 500 degrees F (260 degrees C) (ASTM C411, ASTM C518): 0.48 Btu/(ft² x h x F) (0.07 W/(m x K)).
 - 5. R-Value per ASTM C518 at ambient 77 degrees F (25 degrees C): At least 6.3 F-ft²-hr/Btu (1.1 K-m²/W)..
 - 6. Service range up to 2000 degrees F (1093 degrees C)
 - 7. Fire Resistance: For use in 1 hour and 2 hour fire resistant systems.
 - 8. Product complies with ASTM E2336 test standard.

9. Product complies with ISO 6944 test standard.
10. Through-penetration per ASTM E814 (UL 1479).
11. Non-combustible per ASTM E136.

J. Accessory Materials:

1. Tapes:
 - a. High Performance Filament Tape: 3M tape No. 898, 1 inch (25 mm) wide.
 - b. FSK Facing Tape: 3M tape No. 3320, with aluminum foil, fiberglass scrim, and kraft paper backing. Nominal 3 inches (76 mm) wide or 4 inches (102 mm) wide. For sealing cut blanket edges and seams.
2. Banding Material: Stainless or carbon steel banding, 1/2 inch (13 mm) wide x 0.015 inch (0.4 mm) thick, as stated in duct wrap Design Listing.
3. Insulation Pins and Clips:
 - a. Copper-coated steel pins, 12 gauge with a minimum length of 4 inches (102 mm), with 2.5 inch (64 mm) square galvanized steel speed clips.
 - b. 12 ga insulated cup head steel pins.
4. Through-Penetration Fire Stop Materials:
 - a. Packing Material: Scrap pieces of fire resistive duct wrap, 1.5 inches (13 mm) thick, or 4 pcf (56 kg/m³) mineral wool.
 - b. Sealant: 3M 2000+ premium non-slump silicone sealant, or other sealant as stated in the duct wrap's Design Listing.
5. Access Doors: 3M Fire Barrier Grease Duct Access Doors.
 - a. Steel angle opening frame, with threaded holes for fasteners.
 - b. Access cover, minimum 16 ga, with loop handle, labeling, and fastener holes.
 - c. Thumb screws for initial fastening of access cover to frame.
 - d. 3M Fire Barrier Grease Duct Access Door Hardware Extension Kit, including threaded rods, wing nuts, nuts, and washers.
 - e. Outer plate, minimum 16 ga steel, field furnished.
 - f. Layers of fire-resistant duct wrap, sized per manufacturer's instructions, with edges sealed with aluminum foil tape.
 - g. Insulation pins and speed clips to fasten the layers of duct wrap to the inside face of outer steel plate.
 - h. Label for outer plate.

PART 3 - Execution: See Part 3 of this Section.EXECUTION

3.1 EXAMINATION

- A. Verification of existing conditions before starting work.
- B. Verify that ductwork has been tested before applying insulation materials.
- C. Verify that surfaces are clean, foreign material removed, and dry.
- D. Verify that insulation materials are clean and dry. Discard any materials that exhibit signs of moisture damage, contamination, mold, mildew, or other biological growth. Discard any materials used in the air handling airstream if they have been exposed to water.

3.2 INSTALLATION

- A. Manufacturer's instructions.
- B. Install in accordance with NAIMA National Insulation Standards.
- C. Provide insulation for surfaces of ductwork, as indicated and specified. Insulation values shall meet or exceed the requirements of ASHRAE 90.1-2010, State Energy Codes, and Table I, whichever is greater. In addition, comply with the other requirements of this Section.
- D. Insulated Ductwork Conveying Air below Ambient Temperature:
 - 1. Provide insulation with vapor barrier jackets.
 - 2. Finish with tape and vapor barrier jacket.
 - 3. Continue insulation through walls, sleeves, hangers, and other duct penetrations.
 - 4. Insulate entire system including fittings, joints, flanges, fire dampers, flexible connections, and expansion joints.
- E. Insulated Ductwork Conveying Air above Ambient Temperature:
 - 1. Provide with or without standard vapor barrier jacket.
 - 2. Insulate fittings and joints. Where service access is required, bevel and seal ends of insulation.
- F. Ductwork Exposed below 10 feet (3 meters) above finished floor in Mechanical Equipment Rooms or below 8 feet (2.4 meters) above finished floor in Finished Spaces: Provide glass fiber rigid insulation with vapor barrier jacket.
- G. Do not insulate exposed heating or cooling supply ductwork in the conditioned spaces which it serves, unless otherwise specified or indicated on the Drawings.
- H. Wherever exposed ductwork for air conditioned systems passes through non air conditioned spaces, insulate ductwork with glass fiber rigid insulation with vapor barrier, to prevent condensation.
- I. Where rigid glass fiber insulation is scheduled, semi-rigid glass fiber insulation may be used on round and flat oval ducts and irregular shapes, and preformed pipe insulation may be used on small diameter round ducts.
- J. Duct and Plenum Liner Application:
 - 1. Duct dimensions indicated are net inside dimensions required for air flow. Increase duct size to allow for insulation thickness.
 - 2. Provide duct liner where:
 - a. Indicated on the Drawings.
 - b. Specified.
 - 3. Install duct liner in accordance with SMACNA standards.
 - 4. Install elastomeric foam duct liner in accordance with manufacturer's recommendations.
 - 5. Adhesive: Apply to duct sheet metal for 90 percent coverage. Clean the duct before applying adhesive.
 - 6. Mechanical Fastening: In addition to adhesive, provide mechanical fastening devices meeting the following requirements:
 - a. Are spaced in accordance with SMACNA Standards and Manufacturer's recommendations.

- b. When installed, are as corrosion-resistant as G60 coated galvanized steel.
 - c. Will not adversely affect the fire-resistant classification of liner and adhesives.
 - d. Do not damage the liner when applied as recommended by the manufacturer.
 - e. Do not cause leakage in the duct.
 - f. Do not project more than nominally into the airstream.
 - g. Will indefinitely sustain a 50 lb (222 N) tensile dead load test perpendicular to the duct wall.
 - h. Have a permanent, waterproof bond to the duct wall.
 - i. Are the correct length for the specified liner thickness.
7. Self-Adhesive Elastomeric Foam Insulation: If manufacturer's instructions recommend omitting mechanical pin fasteners at all air velocities, they may be omitted. Clean the duct with recommended liquid cleaner before installing insulation.
 8. Seal and smooth liner airstream surface penetrations, cuts, tears, edges, and transverse and longitudinal joints with adhesive or acrylic polymer repair coating, compatible with liner surface coating.
 9. Corners: Cut and fit liner in the corners of rectangular duct sections to assure butted edge overlapping. Longitudinal joints in duct liner shall not occur except at the corners of ducts unless the size of the duct and standard liner product dimensions make joints necessary.
 10. Transverse Joints: Butt liner neatly without gaps.
 11. Provide securely-installed metal nosings that are either channel or zee profile or are integrally-formed from the duct wall over transversely oriented liner edges facing the airstream at fan discharge, at access doors, and at any interval of lined duct preceded by unlined duct. In addition, where velocities exceed 2,000 fpm (10.2 mps), provide metal nosing on upstream edges of liner at every transverse joint.
 12. Where dampers, turning vane assemblies or other devices are placed inside of lined duct or fittings, install to not damage the liner or cause erosion of the liner. The use of metal hat sections or other buildout means is optional; when used, secure buildouts to the duct wall with bolts, screws, rivets or welds.
 13. Do not install duct liner in fresh air intake ductwork between the outside intake opening and the fan or other air moving device, or within 10 feet (3 m) downstream of a cooling coil or humidifier.
- K. Inspection Plates and Test Holes: Provide, where required, in ductwork or casings for balance measurements. Test holes shall be factory fabricated, airtight, and noncorrosive with screw cap and gasket. Extend cap through insulation.
- L. Install insulation after ductwork and equipment have been tested and approved.
- M. Ensure that surface is clean and dry prior to installation. Ensure that insulation is dry before and during application. Finish with system at operating conditions.
- N. Ensure that insulation is continuous through inside walls. Pack around ducts with fireproof self-supporting insulation material, properly sealed.
- O. Finish insulation neatly at hangers, supports and other protrusions.
- P. Locate insulation or cover seams in least visible locations.
- Q. Repair separation of joints or cracking of insulation due to thermal movement or poor workmanship.

- R. Standing seams, supporting angles and flanges on insulated ductwork shall be insulated with thickness equal to the duct and edges shall be finished and vapor sealed.
- S. For supply or return ductwork which is required to be insulated, insulation shall be continuous and shall include the insulating of register, grille and diffuser connection plenums/boots.
- T. Mechanical fasteners shall not be riveted or screwed to the duct and shall not penetrate the metalwork.

3.3 FIRE RESISTIVE DUCT WRAP FOR KITCHEN GREASE EXHAUST

- A. Install duct wrap system in accordance with manufacturer's instructions and referenced standards.
- B. Install duct wrap in direct contact with the duct it encloses. Install in accordance with details of the product's Listing. Protect every portion of duct with no less than 2 layers. Overlap both perimeter and longitudinal joints minimum of 3 in. (76 mm) per layer of material. If required, tape seams using minimum 3 in. (76 mm) wide aluminum foil self-adhesive tape.
- C. Air Duct Enclosure Wrap: Follow same traditional wrap method with exception of utilizing a 3 in. (76 mm) perimeter overlap in conjunction with longitudinal butt joint wrap plus duct wrap collar over exterior layer joints.
- D. Filament tape may be used as a temporary securing measure on both layers until banding hardware is in place. Band exterior layer spaced no more than 10.5 in. (267 mm) on center, and within 1.5 in. (39 mm) of overlapped seams.
- E. For duct widths greater than 24 inches (610 mm), weld insulation pins to bottom of horizontal and outer vertical duct runs. Space on a grid in accordance with duct wrap manufacturer's instructions. Impale duct wrap over pins and secure with galvanized steel speed clips before banding is applied.
- F. Protect grease duct access doors with 3 layers of duct wrap, each layer overlapping previous by 1 inch (25 mm) on all sides and in accordance with manufacturer's instructions.
- G. Locate grease duct access doors at horizontal cleanouts as required by local Codes. Protect with 3 layers of duct wrap, each layer overlapping previous by 1 inch (25 mm) on all sides and in accordance with manufacturer's instructions.
- H. Install duct access doors and their insulation in accordance with manufacturer's instructions. Provide labeling in accordance with NFPA 96 and Code requirements.
- I. Where fire rated duct wrap is used as a shaft enclosure, firestop at fire separations in accordance with the duct wrap manufacturer's recommendations.
- J. Protect fire wrap from damage when installed in locations accessible to building occupants.
- K. Repair Procedure:
 - 1. Repair damaged duct wrap in accordance with manufacturer's instructions.
 - 2. Remove damaged section. Apply a new section of same dimension. Place and fit ensuring same overlap that existed previously. Place banding around new duct wrap

- material and tension to sufficiently hold in place.
3. If damage has penetrated to interior layer, remove affected sections and reinstall as specified in Installation.

3.4 PAINTING AND IDENTIFICATION

- A. Paint in accordance with Division 09 Section "Painting."

3.5 FIELD INSPECTION

- A. Visually inspect to ensure that materials used conform to Specifications. Inspect installations progressively for compliance with requirements.

TABLE I
DUCTWORK INSULATION MATERIAL AND WALL THICKNESS

DUCTWORK TYPE	INSULATION MATERIAL	VAPOR BARRIER REQUIRED	INSULATION WALL THICKNESS
Supply ductwork (unless exposed in a conditioned space)	Glass Fiber, Flexible	Yes	1 ½ inches (38.1 mm)
	Glass Fiber, Rigid	Yes	1 ½ inches (38.1 mm)
Exposed supply ductwork in mechanical or equipment rooms	Glass Fiber, Rigid	Yes	1 ½ inches (38.1 mm)
Ductwork located outdoors, including above roofs	Polyisocyanurate Foam Board, Rigid, with Waterproof Jacket	Yes	2 layers of 1 ½ inch (38.1 mm) with staggered joints
Supply, return and exhaust ductwork in cold attic spaces, crawl spaces or any space outside of the building insulation envelope but within the building shell and protected from weather	Glass Fiber, Flexible	Yes	2 layers of 1 ½ inches (38.1 mm) with staggered joints
	Glass Fiber, Rigid	Yes	2 layers of 1 ½ inches (38.1 mm) with staggered joints
Exhaust ductwork from exterior building openings (such as louvers and roof hoods) to 4 feet (1.2 m) interior of motorized damper or backdraft damper.	Glass Fiber, Flexible (only if ductwork is concealed)	Yes	1 ½ inches (38.1 mm)
	Glass Fiber, Rigid	Yes	1 ½ inch (38.1 mm)
Outside air intake ductwork	Glass Fiber, Flexible (only if ductwork is concealed)	Yes	2 layers of 1 ½ inch (38.1 mm) with staggered joints
	Glass Fiber, Rigid	Yes	2 layers of 1 ½ inch (38.1 mm) with staggered joints
Mixed air ductwork	Glass Fiber, Flexible (only if ductwork is concealed)	Yes	2 layers of 1 ½ inches (38.1 mm) with staggered joints
	Glass Fiber, Rigid	Yes	2 layers of 1 ½ inches (38.1 mm) with staggered joints
Combustion air ductwork	Glass Fiber, Rigid	Yes	2 layers of 1 ½ inch (38.1 mm) with staggered joints

DUCTWORK TYPE	INSULATION MATERIAL	VAPOR BARRIER REQUIRED	INSULATION WALL THICKNESS
Evaporative condenser intake and exhaust ducts	Glass Fiber, Rigid	Yes	1 ½ inch (38.1 mm)
Transfer ducts	Elastomeric Foam Duct Liner	--	1 inch (25.4 mm)
Ductwork 5 feet downstream from a VAV box, or through the first elbow or take-off, whichever is longer.	Elastomeric Foam Duct Liner	--	1 inch (25.4 mm)
Ductwork 10 feet upstream and downstream from a supply or return fan, or through the first elbow, whichever is longer (excluding fresh air intake ductwork)	Elastomeric Foam Duct Liner	--	1 inch (25.4 mm)
Ductwork indicated on Drawings to be acoustically lined	Elastomeric Foam Duct Liner	--	1 inch (25.4 mm)
Kitchen Hood Grease Exhaust Ductwork near combustible materials and where indicated	Fire Resistive Duct Wrap	---	2 layers of 1-1/2 inches (38.1 mm) with staggered joints per Manufacturer's Recommendations to achieve zero clearance to combustibles
Kitchen Hood Grease Exhaust Ductwork where indicated to provide an alternative to a rated shaft enclosure	Fire Resistive Duct Wrap	---	2 layers of 1-1/2 inches (38.1 mm) with staggered joints per Manufacturer's Recommendations to achieve equivalence to a 2-hour rated shaft enclosure.
Fume Hood Exhaust Duct First 10 feet of exhaust duct outside of a vertical chase	Fire Resistive Duct Wrap	---	2 layers of 1-1/2 inches (38.1 mm) with staggered joints per Manufacturer's Recommendations to achieve equivalence to a 2-hour rated shaft enclosure.

END OF SECTION 230713

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SECTION 230719 – HVAC PIPING INSULATION

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Piping insulation.
- B. Jackets and accessories.
- C. Shields, Inserts, and Saddles.

1.2 RELATED SECTIONS

- A. Division 07 Section “Through Penetration Firestop Systems.”
- B. Division 09 Section “Painting”: Painting insulation jacket.
- C. Division 23 Section “Identification for HVAC Piping and Equipment.”
- D. Division 23 Section “Hangers and Supports for HVAC Piping and Equipment”: Placement of hangers and hanger inserts.
- E. Division 23 Section “HVAC Equipment Insulation”: Removable, reusable insulation covers.
- F. Division 23 Section “Hydronic Piping”: Placement of hangers and hanger inserts.
- G. Division 23 Section “Refrigerant Piping.”: Placement of inserts.

1.3 REFERENCES

- A. Division 01 Section “References”: Requirements for references and standards.
- B. ASTM
- C. NAIMA National Insulation Standards.
- D. NFPA 255 - Standard Method of Test of Surface Burning Characteristics of Building Materials.
- E. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials.

1.4 SUBMITTALS

- A. Submit under provisions of Division 01 Section “Submittal Procedures”.
- B. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.

1.5 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in

this Section with minimum 3 years' experience.

- B. Applicator Qualifications: Company specializing in performing the work of this Section with minimum 3 years' experience.

1.6 REGULATORY REQUIREMENTS

- A. Conform to maximum flame spread/smoke developed rating of 25/50 in accordance with ASTM E84, NFPA 255 and UL 723. For elastomeric foam insulation, rating shall apply for thicknesses up to 2 inches (50 mm).
- B. Insulation materials and accessories shall be asbestos-free. No fibers with dimensions similar to asbestos fibers shall be released from any material.

1.7 DELIVERY, STORAGE, AND PROTECTION

- A. Transport, handle, store, and protect products.
- B. Accept materials on site, labeled with manufacturer's identification, product density, and thickness.

1.8 ENVIRONMENTAL REQUIREMENTS

- A. Environmental conditions affecting products on site.
- B. Maintain ambient conditions required by manufacturers of each product.
- C. Maintain temperature before, during, and after installation for minimum of 24 hours.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Elastomeric Foam Products:
 - 1. Armacell: AP Armaflex and AP Armaflex FS pipe and sheet insulation.
 - 2. K-Flex USA: Insul-Tube and K-Flex LS pipe insulation, and Insul-Sheet S2S and K-Flex LS sheet insulation.
 - 3. Substitutions: Not permitted.
- B. Glass and Mineral Fiber Products:
 - 1. Knauf Insulation.
 - 2. Certainteed Corporation.
 - 3. Johns Manville.
 - 4. Owens Corning.
 - 5. Substitutions: Not permitted.
- C. Accessories:
 - 1. Ceel-Co division of Johns Manville (product: plastic jacket systems).
 - 2. Foster Products, division of Specialty Construction Brands, Inc., a subsidiary of H.B. Fuller (mastics, sealants, reinforcing membranes, and accessories).
 - 3. Johns Manville (products: Super-Seal acrylic polymer coatings, Zeston plastic jacket

- systems).
- 4. Pabco/Childers Metals, division of ITW Insulation Systems (products: metal jacket systems, and accessories).
- 5. Proto Corporation (product: plastic jacket systems).
- 6. Speedline Corporation (product: plastic jacket systems).

2.2 ELASTOMERIC FOAM

- A. Insulation: ASTM C534; flexible, cellular elastomeric, molded or sheet.
 - 1. 'K' ('Ksi') value: ASTM C177; 0.277 Btu-in/(hr-sq.ft- degrees F) at 75 degrees F (0.04 W/m-K at 24 degrees C).
 - 2. Minimum service temperature: -70 degrees F (-57 degrees C) (flexible to -20 degrees F (-29 degrees C)).
 - 3. Maximum service temperature: 220 degrees F (104 degrees C).
 - 4. Maximum moisture absorption: ASTM C209, 0.2 percent by volume; or ASTM D1056, 5 percent by weight.
 - 5. Moisture vapor transmission: ASTM E96; 0.08 perm-inches (0.116 ng/(s-m-Pa)).
 - 6. Connection: Waterproof vapor barrier adhesive.
- B. White Insulation for Exposed Locations: Where exposed to the occupants' view, provide insulation in white or off-white color, Armacell's AP/Armaflex W or K-Flex USA's Insul-Tube White and Insul-Sheet White.
- C. Elastomeric Foam Adhesive: Air dried, contact adhesive, compatible with insulation.
- D. Insulated Hanger Inserts: EATON Armafix IPH insulated pipe hanger inserts or for strut mounting with two piece pipe clamps with pre-installed friction tape and elastic stop nuts shall be used at hanger locations.
 - 1. Engineered from Armaflex insulation, with inserts of CFC-free PPUR/PIR polyurethane foam insulation bearing segments.
 - 2. Outer shell of 30 mils (0.76 mm) -thick painted aluminum.
 - 3. Self-adhesive closure strip.
 - 4. Insulation material shall meet the requirements as defined in ASTM C534
 - 5. 'K' ('Ksi') value: ASTM C177; 0.27 Btu-in/(hr-sq.ft- degrees F) at 75 degrees F
 - 6. Moisture vapor transmission: ASTM E96; 0.08 perm-inches (0.116 ng/(s-m-Pa)).
 - 7. Connection: Armaflex 520 Waterproof vapor barrier adhesive
 - 8. Provide Armaflex friction tape, wrapped around the IPH prior to placing in the hanger.

2.3 GLASS FIBER

- A. Insulation: ASTM C547; rigid molded, noncombustible.
 - 1. 'K' ('Ksi') value: ASTM C177, 0.24 Btu-in/(hr-sq.ft- degrees F) at 75 degrees F (0.035 W/m-K at 24 degrees C).
 - 2. Maximum service temperature: 850 degrees F (454 degrees C).
 - 3. Maximum moisture absorption: 0.2 percent by volume.
- B. Vapor Barrier Jacket:
 - 1. ASTM C1136, White kraft paper with glass fiber yarn, bonded to aluminized film.
 - 2. Moisture vapor transmission: ASTM E96; 0.02 perm-inches.
- C. Tie Wire: 0.048 inch (1.22 mm) stainless steel with twisted ends on maximum 12 inch (300

mm) centers.

- D. Vapor Barrier Lap Adhesive: Compatible with insulation.
- E. Insulating Cement/Mastic: ASTM C195; hydraulic setting on mineral wool.
- F. Indoor Vapor Barrier Finish:
 - 1. Cloth: Untreated; 9 oz/sq yd (305 g/sq m) weight.
 - 2. Vinyl emulsion type acrylic, compatible with insulation, white color.
- G. Outdoor Vapor Barrier Mastic: Vinyl emulsion type acrylic or mastic, compatible with insulation, black color.
- H. Outdoor Breather Mastic: Vinyl emulsion type acrylic or mastic, compatible with insulation, black color.
- I. Insulating Cement: ASTM C449/C449M.

2.4 JACKETS

- A. PVC Plastic.
 - 1. Jacket: ASTM D1784, One piece molded type fitting covers and sheet material, off-white color.
 - a. Minimum service temperature: 0 degrees F (-18 degrees C).
 - b. Maximum service temperature: 150 degrees F (66 degrees C).
 - c. Moisture vapor transmission: ASTM E96; 0.002 perm-inches.
 - d. Thickness: 15 mil (0.38 mm) for indoor use, 30 mil (0.76 mm) for outdoor use and in high-abuse areas
 - e. Connections: Brush on welding adhesive, tacks (for heating systems only) or pressure sensitive color matching vinyl tape.
 - 2. Covering Adhesive Mastic: Compatible with insulation.
- B. Canvas Jacket: UL listed.
 - 1. Fabric: 6 oz/sq yd (220 g/sq m), plain weave cotton treated with dilute fire retardant lagging adhesive.
 - 2. Lagging Adhesive: Compatible with insulation.
- C. Fibrous Glass Fabric:
 - 1. Cloth: Heat treated to remove most organic binders. May be factory-impregnated with an inorganic fire-retardant rewettable adhesive, at Contractor's option.
 - 2. Weight: 9 oz/sq yd (305 g/sq m) minimum.
 - 3. Blanket: 1.0 lb/cu ft (16 kg/cu m) density.
 - 4. Weave: 10x20 per inch (390x780 per meter).
 - 5. Service Temperature: 1000 degrees F (538 degrees C).
- D. Aluminum Jacket: ASTM B209, ASTM B209M.
 - 1. Thickness: 0.016 inch (0.40 mm) sheet.
 - 2. Finish: Smooth.
 - 3. Joining: Longitudinal slip joints and 2 inch (50 mm) laps.
 - 4. Fittings: 0.016 inch (0.4 mm) thick die shaped fitting covers with factory attached protective liner.

5. Metal Jacket Bands: 3/8 inch (10 mm) wide; 0.015 inch (0.38 mm) thick aluminum.
- E. Stainless Steel Jacket: ASTM A167 Type 304 stainless steel.
 1. Thickness: 0.010 inch (0.25 mm).
 2. Finish: Smooth.
 3. Metal Jacket Bands: 3/8 inch (10 mm) wide; 0.010 inch (0.25 mm) thick stainless steel.

2.5 SHIELDS, INSERTS, AND SADDLES

- A. Shields:
 1. Carpenter and Paterson Figure 265GS, or equal.
 2. Galvanized or electro-galvanized steel, minimum 12 inch length, minimum 120-degree arc, minimum 18 ga.
 3. Provide contact adhesive to glue shields to the insulation.
- B. Snap-On Shields:
 1. Cooper B-Line "Snap-N Shield".
 2. Snap-N Shield is an acceptable substitute for metal shields when installed with strut trapeze hangers on horizontal piping.
 3. Paintable polypropylene plastic 12 inch long preformed shields, snap-on design for attachment to strut.
 4. Gluing is not required with Snap-N Shield.
 5. Provide black or white color to match the insulation in areas exposed to public view.
- C. Inserts:
 1. Configuration: Minimum 6 inches (150 mm) long, of same thickness and contour as adjoining insulation; may be factory fabricated.
 2. Insert Material: Hydrous calcium silicate insulation or other heavy density insulating material suitable for the planned temperature range.
- D. Saddles:
 1. Factory fabricated of curved carbon steel plate, of same overall thickness and contour as adjoining insulation. Sides designed for welding to pipe. Center support plate for pipe sizes 12 inches (300 mm) and larger.

2.6 MANUFACTURER'S STAMP OR LABEL

- A. Every package or standard container of insulation, jackets, cements, adhesives, and coatings delivered to the project site for use shall have the manufacturer's stamp or label attached giving name of manufacturer, brand, and description of material. Insulation packages and containers shall be asbestos-free.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that piping has been tested before applying insulation materials.
- B. Verify that surfaces are clean and dry, with foreign material removed.

3.2 INSTALLATION

- A. Division 01 Section “Quality Requirements”: Manufacturer's instructions.
- B. Install in accordance with NAIMA National Insulation Standards where applicable.
- C. Provide insulation for surfaces of new piping, as indicated and specified.
- D. Insulation values shall meet or exceed the requirements of ASHRAE 90.1-2010, applicable State Energy Codes, and Table I, whichever is greater. In addition, comply with the other requirements of this Section.
 - 1. International Energy Conservation Code (IECC): Chapter 5 of the Code allows the use of ASHRAE 90.1 insulation thicknesses instead of the Minimum Pipe Insulation table which is in Chapter 5 of the IECC. This Specification does not reference the table in IECC.
- E. Piping systems requiring insulation, types of insulation required, and insulation thickness shall be as listed in Table I herein. For piping not listed in Table I, insulate to meet Code requirements, using suitable specified materials, subject to Architect’s approval. Except for flexible unicellular insulation, insulation thicknesses as specified in Table I shall be one inch (25 mm) greater for insulated piping systems located outside the building and in unconditioned spaces. Unless otherwise specified, insulate fittings, flanges, and valves, except valve stems, hand wheels, and operators. Use factory pre-molded, precut, or field-fabricated insulation of the same thickness and conductivity as used on adjacent piping. Insulation exterior shall be factory cleanable, grease resistant, non-flaking, and non-peeling.
- F. Exposed Piping: Locate insulation and cover seams in least visible locations.
- G. Insulated Pipes Conveying Fluids Below Ambient Temperature: Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, and expansion joints.
- H. Glass Fiber Insulated Pipes Conveying Fluids below Ambient Temperature:
 - 1. Provide vapor barrier jackets, factory-applied or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure sensitive adhesive. Secure with outward clinch expanding staples and vapor barrier mastic.
 - 2. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe. Finish with glass cloth and vapor barrier adhesive or PVC fitting covers.
- I. For hot piping conveying fluids 140 degrees F (60 degrees C) or less, do not insulate flanges and unions at equipment, but bevel and seal ends of insulation.
- J. For hot piping conveying fluids over 140 degrees F (60 degrees C), insulate flanges and unions at equipment.
- K. Glass Fiber Insulated Pipes Conveying Fluids above Ambient Temperature:
 - 1. Provide standard jackets, with or without vapor barrier, factory-applied or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure sensitive adhesive. Secure with outward clinch expanding staples.
 - 2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Finish with glass cloth and adhesive or PVC fitting covers.

- L. For piping which may operate at a range of temperatures (for example, heat recovery and heat exchange piping), provide insulation and vapor barriers as are suitable for the entire range of operation.
- M. Large Valve Bodies and Other Fittings: Large valves and other fittings requiring service access may be insulated with removable, reusable equipment covers with “Velcro” closures. Refer to Division 23 Section “HVAC Equipment Insulation.”
- N. Branches to Expansion Tanks: For chilled water systems, insulate completely. For hot water systems, insulate from the connection at the main to at least 10 feet (3 m) toward the tank.
- O. Branches to Gauges, Sensors, Drains, and Vents: Insulate branches to gauges, sensors, drains, and vents as for active sections of piping. For piping with operating temperatures above ambient, insulate to at least 6 inches (150 mm) from the active main. For temperature devices, insulate to include the sensing bulb or other element. For pressure devices in hot piping with syphon loops, insulate from the active main to the syphon loop, but it is not necessary to insulate the syphon loop or the portion of the branch on the device side of the syphon loop.
- P. Shields, Inserts, and Saddles:
 - 1. Application: Provide shields at hangers. Provide inserts for piping 2 in. (50 mm) nominal size or larger. Provide saddles for piping 6 in. (150 mm) nominal size and larger and for generator exhaust piping and muffler.
 - 2. Shield location: Between insulation jacket and hanger.
 - 3. Insert location: Between support shield and piping and under the finish jacket.
 - 4. Saddle location: Between support shield and piping.
 - 5. Tack-weld saddles to the pipe or muffler. Fill air spaces within the saddle with insulation material.
 - 6. Glue shields to outside of insulation after system is filled and run at operating temperature.
 - 7. Align mid-length of shields, inserts, and saddles with the hanger centerline.
- Q. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations. Finish at supports, protrusions, and interruptions. At fire separations, refer to Division 07.
- R. Pipe Exposed in Mechanical Equipment Rooms 10 feet (3 meters) or Less Above Finished Floor:
 - 1. Steam and Steam Condensate Piping: Finish with aluminum or stainless steel jacket and fitting covers.
 - 2. Piping Which Crosses Walking and Service Access Paths 4 feet (1.2 m) or Less Above Finished Floor: Finish with aluminum or stainless steel jacket and fitting covers.
 - 3. Other Piping: Finish with PVC or ABS jacket and fitting covers.
- S. Pipe Exposed in Finished Spaces 10 feet (3 meters) or Less Above Finished Floor: Finish with PVC or ABS jacket and fitting covers.

3.3 UNIFORM INSTALLATION

- A. Systems shall use a single insulation type throughout the installation.

3.4 PREPARATION

- A. Insulate piping after system tests have been completed and surfaces to be insulated have been cleaned of dirt, rust, and scale and dried. Ensure full range of motion of equipment actuators. Modify insulation to avoid obstruction of valve handles, safety reliefs, and other components requiring movement. Allow adequate space for pipe expansion. Install insulation with jackets drawn tight and cement down on longitudinal and end laps. Do not use scrap pieces where a full length section will fit. Insulation shall be continuous through sleeves, wall and ceiling openings. Extend surface finishes to protect surfaces, ends, and raw edges of insulation. Apply coatings and adhesives at the manufacturer's recommended coverage per gallon. Individually insulate piping. Provide a moisture and vapor seal where insulation terminates against metal hangers, anchors and other projections through the insulation on surfaces for which a vapor seal is specified. Keep insulation dry during the application of any finish. Bevel and seal the edges of exposed insulation. Unless otherwise indicated, do not insulate the following:
1. Piping in radiation enclosures, or within cabinets of unit heaters.
 2. Valve hand wheels.
 3. Fire protection pipes.
 4. Vibration isolating connections.
 5. Adjacent insulation.
 6. ASME stamps.

3.5 PIPING INSULATION

- A. Pipe Insulation (Except Elastomeric and Hydrous Calcium Silicate Insulation): Place sections of insulation around the pipe and joints tightly butted into place. The jacket laps shall be drawn tight and smooth. Secure jacket with fire resistant adhesive, factory applied self sealing lap. Cover circumferential joints with butt strips, not less than 3-inches (76 mm) wide, of material identical to the jacket material. Overlap longitudinal laps of jacket material not less than 1-1/2 inches (38 mm). Adhesive used to secure the butt strip shall be the same as used to secure the jacket laps. When a vapor barrier jacket is required, as indicated in Table I, or on the ends of sections of insulation that butt against flanges, unions, valves, fittings, and joints, use a vapor-barrier coating conforming to manufacturer's weatherproof coating for outside service. Apply this vapor barrier coating at longitudinal and circumferential laps. Patch damaged jacket material by wrapping a strip of jacket material around the pipe and cementing, and coating as specified for butt strips. Extend the patch not less than 1-1/2 inches (38 mm) past the break in both directions. At penetrations by pressure gauges and thermometers, fill the voids with the vapor barrier coating for outside service. Seal with a brush coat of the same coating. Where penetrating roofs, insulate piping to a point flush with the top of the flashing and seal with the vapor barrier coating. Butt tightly the exterior insulation to the top of the flashing and interior insulation. Extend the exterior metal jacket 2 inches (51 mm) down beyond the end of the insulation. Seal the flashing and counterflashing underneath with the vapor barrier coating.
- B. Elastomeric Foam Insulation: Bond cuts, butt joints, ends, and longitudinal joints with adhesive. Miter 90-degree turns and elbows, tees, and valve insulation. Where pipes penetrate fire walls, provide mineral-fiber insulation inserts and sheetmetal sleeves. Insulate flanges, unions, valves, and fittings in accordance with manufacturer's published instructions. Apply two coats of vinyl lacquer finish to elastomeric foam insulation before applying PVC jacket in outside locations.
- C. Seal surfaces of fibrous insulation to prevent release of fibers.

- D. Sleeves and Wall Chases: Where penetrating interior walls, extend a metal jacket 2 inches (51 mm) out on either side of the wall and secure on each end with a band. Where penetrating floors, extend a metal jacket from a point below the back-up material to a point 10 inches (254 mm) above the floor with one band at the floor and one not more than one inch from end of metal jacket. Where penetrating exterior walls, extend the metal jackets through the sleeve to a point 2 inches (51 mm) beyond the interior surface of the wall.

3.6 PAINTING AND IDENTIFICATION

- A. Paint in accordance with Division 09 Section "Painting". Piping identification shall be as specified in other sections.

3.7 FIELD INSPECTION

- A. Visually inspect to ensure that materials used conform to specifications. Inspect installations progressively for compliance with requirements.

TABLE I
PIPING INSULATION MATERIAL AND WALL THICKNESS

SERVICE	INSULATION MATERIAL	VAPOR BARRIER REQUIRED	INSULATION WALL THICKNESS AT THE FOLLOWING PIPE DIAMETERS				
			<1 inch	1 inch to <1.5 inches	1.5 inches to <4 inches	4 inches to <8 inches	8 inches or Greater
Heating Systems (Steam, Steam Condensate, Hot Water Supply and Return)							
Above 350 degrees F	Glass Fiber	No	4.5 inches	5 inches	5 inches	5 inches	5 inches
251 degrees F to 350 deg. F	Glass Fiber	No	3 inches	4 inches	4.5 inches	4.5 inches	4.5 inches
201 degrees F to 250 deg. F	Glass Fiber	No	2.5 inches	2.5 inches	2.5 inches	3 inches	3 inches
141 degrees F to 200 deg. F	Glass Fiber	No	1.5 inches	1.5 inches	2 inches	2 inches	2 inches
105 degrees F to 140 deg. F	Glass Fiber	Yes	1 inch	1 inch	1.5 inches	1.5 inches	1.5 inches
Air Conditioning Condensate	Elastomeric Foam	N/A	0.5 inch	0.5 inch	1 inch	1 inches	1 inches

SERVICE	INSULATION MATERIAL	VAPOR BARRIER REQUIRED	INSULATION WALL THICKNESS AT THE FOLLOWING PIPE DIAMETERS				
			<1 inch	1 inch to <1.5 inches	1.5 inches to <4 inches	4 inches to <8 inches	8 inches or Greater
Drain Located Inside Building							
	Glass Fiber	Yes	0.5 inch	0.5 inch	1 inch	1 inches	1 inches
Cooling Systems (Chilled Water, Glycol, and Brine)							
40 degrees F to 60 deg. F	Elastomeric Foam	N/A	0.5 inch	0.5 inch	1 inch	1 inches	1 inches
	Glass Fiber	Yes	0.5 inch	0.5 inch	1 inch	1 inches	1 inches
Below 40 degrees F	Elastomeric Foam	N/A	0.5 inch	1 inch	1 inch	1.0 inches	1.5 inches
Heat Recovery Hydronic Systems (Water, Glycol, and Brine)							
Minimum 40 degrees F and Above	Elastomeric Foam	N/A	0.5 inch	0.5 inch	1 inch	1 inches	1 inches
	Glass Fiber	Yes	0.5 inch	0.5 inch	1 inch	1 inches	1 inches
Minimum Below 40 degrees F	Elastomeric Foam	N/A	0.5 inch	1 inch	1 inch	1.0 inches	1.5 inches
Refrigerant Suction and Liquid Piping							
40 degrees F to 60 deg. F	Elastomeric Foam	N/A	0.5 inch	0.5 inch	1 inch	1 inches	1 inches
Below 40 degrees F	Elastomeric Foam	N/A	0.5 inch	1 inch	1 inch	1.0 inches	1.5 inches
Refrigerant	Glass Fiber	Yes	1 inch	1 inch	1.5 inches	1.5 inches	1.5 inches

END OF SECTION 230719

SECTION 230900 – INSTRUMENTATION AND CONTROL FOR MECHANICAL SYSTEMS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Direct Digital Control (DDC) equipment.
- B. Software.
- C. Installation.
- D. Mechanical Commissioning.

1.2 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

- A. Piping:
 - 1. Control Valves – piping connections.
 - 2. Temperature Sensor Wells and Sockets.
 - 3. Pressure Sensors and Switches.
 - 4. Flow Switches.
- B. Ductwork:
 - 1. Access Doors.
 - 2. Airflow Measuring Stations.
 - 3. Dampers - ductwork connections.

1.3 PRODUCTS FURNISHED UNDER OTHER SECTIONS

- A. Controllers furnished with some Plumbing equipment (Division 22).
- B. Controllers furnished with some HVAC equipment (Division 23).
- C. Monitoring devices furnished with some Electrical equipment (Division 26).

1.4 RELATED SECTIONS

- A. Division 08 Section “Access Doors and Frames.”
- B. Division 23 Section “Common Work Results for HVAC.”
- C. Division 23 Section “Common Motor Requirements for HVAC Equipment.”

1.5 REFERENCES

- A. U.S. Department of Justice – 2010 ADA Standards for Accessible Design.
- B. ASME MC85.1 - Terminology for Automatic Control.
- C. NEMA EMC1 - Energy Management Systems Definitions.

- D. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
- E. NFPA 70 - National Electrical Code.
- F. NFPA 90A - Installation of Air Conditioning and Ventilation Systems.

1.6 SYSTEM DESCRIPTION

- A. A fully integrated Automatic Temperature Control (ATC) Building Management and Control System incorporating Direct Digital Control (DDC), energy management, equipment monitoring, and control consisting of the following:
 - 1. Microcomputer-based equipment controllers interfacing directly with sensors, actuators and environmental delivery systems.
 - 2. Electric controls and mechanical devices for items indicated on Drawings and described hereinafter including dampers, valves, and motor drives.
 - 3. Microcomputer-based terminal controllers interfacing with sensors, actuators, and terminal equipment control devices.
- B. Submittals, data entry, electrical installation, programming, start up, test and validation, instruction of Owner's representative on maintenance and operation, as built documentation, and system warranty.
- C. System Summary:
 - 1. The intent of this project is to provide an ATC system with electric actuators
 - 2. Items which according to the Sequence of Operations are designated to be controlled by a thermostat, such as Cabinet unit heaters, unit heaters, terminal heating units, and the like, shall have "stand-alone" control, and are not required to be interfaced with the DDC system. At the Contractor's option, they may have DDC control, but with local setpoint control.
 - 3. Equipment which is designated to be controlled by a temperature sensor shall be interfaced with the DDC system, such that monitoring and setpoint adjustment shall be accomplished through the graphical user interface at the operator workstation.
- D. Note: The terms "BMS", "ATC", and "DDC" are used somewhat interchangeably throughout this Section.

1.7 DEFINITIONS

- A. Note: The terms ATC, BAS, and DDC may be used interchangeably in this Section and on the Drawings, to indicate the overall control system.
- B. Definitions:
 - 1. ATC: Automatic temperature control.
 - 2. BACnet: A control network technology platform for designing and implementing interoperable control devices and networks.
 - 3. BAS: Building Automation System.
 - 4. DDC: Direct digital control.
 - 5. I/O: Input/output.
 - 6. MS/TP: Master slave/token passing.
 - 7. PC: Personal computer.
 - 8. PID: Proportional plus integral plus derivative.

9. RTD: Resistance temperature detector.

1.8 SYSTEM PERFORMANCE

- A. Comply with the following performance requirements:
 1. Graphic Display: Display graphic with minimum 20 dynamic points with current data within 10 seconds.
 2. Graphic Refresh: Update graphic with minimum 20 dynamic points with current data within 8 seconds.
 3. Object Command: Reaction time of less than two seconds between operator command of a binary object and device reaction.
 4. Object Scan: Transmit change of state and change of analog values to control units or workstation within six seconds.
 5. Alarm Response Time: Annunciate alarm at workstation within 45 seconds.
 6. Program Execution Frequency: Run capability of applications as often as five seconds, but selected consistent with mechanical process under control.
 7. Performance: Programmable controllers shall execute DDC PID control loops, and scan and update process values and outputs at least once per second.
 8. Reporting Accuracy and Stability of Control: Report values and maintain measured variables within tolerances as follows:
 - a. Water Temperature: Plus or minus 1 deg F (0.5 deg C).
 - b. Water Flow: Plus or minus 5 percent of full scale.
 - c. Water Pressure: Plus or minus 2 percent of full scale.
 - d. Space Temperature: Plus or minus 1 deg F (0.5 deg C).
 - e. Ducted Air Temperature: Plus or minus 1 deg F (0.5 deg C).
 - f. Outside Air Temperature: Plus or minus 2 deg F (1.0 deg C).
 - g. Dew Point Temperature: Plus or minus 3 deg F (1.5 deg C).
 - h. Temperature Differential: Plus or minus 0.25 deg F (0.15 deg C).
 - i. Relative Humidity: Plus or minus 5 percent.
 - j. Electrical: Plus or minus 5 percent of reading.

1.9 SUBMITTALS

- A. Submit in accordance with Division 01 Section "Submittal Procedures."
- B. Qualification Data: For Installer and manufacturer.
- C. Product Data: Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.
 1. Hardware: Bill of materials of equipment indicating quantity, manufacturer, and model number. Include technical data for control units, transducers/transmitters, sensors, actuators, valves, relays/switches, control panels, and operator interface equipment.
 2. Controlled Systems: Instrumentation list with element name, type of device, manufacturer, model number, and product data. Include written description of sequence of operation including schematic diagram.
- D. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 1. Bill of materials of equipment indicating quantity, manufacturer, and model number.

2. Schematic flow diagrams showing fans, coils, dampers, valves, and control devices.
 3. Wiring Diagrams: Power, signal, and control wiring.
 4. Details of control panel faces, including controls, instruments, and labeling.
 5. Written description of sequence of operation.
 6. Schedule of dampers including size, leakage, and flow characteristics.
 7. Schedule of valves including size and flow characteristics.
 8. DDC System Hardware:
 - a. Wiring diagrams for control units with termination numbers.
 - b. Schematic diagrams and floor plans for field sensors and control hardware.
 - c. Schematic diagrams for control, communication, and power wiring, showing trunk data conductors and wiring between operator workstation and control units.
 9. Control System Software: List of color graphics indicating monitored systems, data (connected and calculated) point addresses, output schedule, and operator notations.
 10. Controlled Systems:
 - a. Schematic diagrams of each controlled system with control points labeled and control elements graphically shown, with wiring.
 - b. Scaled drawings showing mounting, routing, and wiring of elements including bases and special construction.
 - c. Written description of sequence of operation including schematic diagram.
- E. Software and Firmware Operational Documentation: Include the following:
1. Software operating and upgrade manuals.
 2. Program Software Backup: On a magnetic media or CD, complete with data files.
 3. Device address list.
 4. Printout of software application and graphic screens.
- F. Field quality-control test reports.
- G. Operation and Maintenance Data.

1.10 OPERATION AND MAINTENANCE DATA

- A. For mechanical instrumentation and control system to include in emergency, operation, and maintenance manuals.
- B. In addition to items specified include the following:
1. Maintenance instructions and lists of spare parts for each type of control device.
 2. Exploded assembly views.
 3. Interconnection wiring diagrams with identified and numbered system components and devices.
 4. Inspection period, cleaning methods, cleaning materials recommended, and calibration tolerances.
 5. Calibration records and list of set points.
- C. Manuals: Provide the following:
1. An Operator's Manual with graphic explanations of keyboard use for operator functions specified under Operator Training.
 2. Computerized printouts of equipment controller's data file construction including point processing assignments, physical terminal relationships, scales and offsets, command and alarm limits, and others as applicable.
 3. A manual including revised as-built documents of materials required under the paragraph

"SUBMITTALS" in this Specification Section.

4. Provide the quantity of manuals specified and at least 2 Operator's Manuals and 2 As-Built Manuals to the Owner. Refer to other Sections of the Specifications for project requirements for quantities of documentation.

1.11 CODES AND APPROVALS

- A. The complete temperature control installation shall be in strict accordance to the national and local electrical codes and the electrical Division of these Specifications. Devices designed for or used in line voltage applications shall be UL listed. Microprocessor based remote and central devices shall be UL916 Listed.
- B. Electronic equipment shall conform to the requirements of FCC regulation Part 15, Section 15 governing radio frequency electromagnetic interference and be so labeled.

1.12 QUALITY ASSURANCE

- A. Installer Qualifications: Automatic control system manufacturer's authorized representative who is trained and approved for installation of system components required for this Project.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with ASHRAE Standard 135 (BACnet) for DDC system components.

1.13 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect and handle products to site under provisions.
- B. Factory-Mounted Components: Where control devices specified in this Section are indicated to be factory mounted on equipment, provide shipping of control devices to equipment manufacturer, in a timely manner coordinated with the equipment manufacturer.
- C. Components to be Installed under Other Sections: For components to be installed under other Sections of the Specifications, provide delivery of components to appropriate Subcontractors, provide installation instructions, and supervise their installation.

1.14 COORDINATION

- A. Coordinate location of thermostats and other exposed control sensors with Contract Drawings before installation.
- B. Coordinate equipment with Division 26 and existing fire alarm system to achieve compatibility with equipment that interfaces with that system.
- C. Coordinate line-voltage power supplies with Division 26.

1.15 WARRANTY

- A. Components, system software, parts, and assemblies furnished under this Section shall be

guaranteed against defects in materials and workmanship for 1 year from acceptance date.

- B. Labor to troubleshoot, repair, reprogram, or replace system components shall be provided at no charge to the Owner during the warranty period.
- C. Corrective software modifications made during warranty service periods shall be updated on user documentation and on user and manufacturer archived software disks.

PART 2 - PRODUCTS

2.1 ACCEPTABLE SUPPLIERS

- A. Acceptable Manufacturers and Installers:
 - 1. Maine Controls, 400 Presumpscot Street, Portland, ME 04103.
 - 2. Trident Controls Inc., 187 Gray Road, Unit A, Cumberland, ME 04021.
 - 3. ibcontrols, 3 Pope Rd, Windham, ME, 04062
 - 4. Siemens Building Technologies, Inc., 66 Mussey Road, Scarborough, ME 04074.
 - 5. Honeywell Controls, installed by Honeywell Inc., 68 Darin Drive, Augusta, ME 04330.
 - 6.
 - 7. Siemens Building Technologies, Inc., 11 Court St., Exeter, NH 03833.
 - 8. Control Technologies, New Hampshire Office, 111 Zachary Road, Manchester, NH 03109.
 - 9. Control Technologies, Massachusetts Office, 500 West Cummings Park, Suite 1050, Woburn, MA 01801.
 - 10. Control Technologies, New York Office, 3500 Sunrise Highway, Suite T209, Great River, NY 11739.
 - 11. Control Technologies, Vermont Office, 121 Park Avenue, Suite 10, Williston, VT 05495.
 - 12. Johnson Controls Inc., 915 Holt Ave, Manchester, NH 03109.
 - 13. Johnson Controls Inc., 30 Thomas Drive, Westbrook, ME 04092.
 - 14. Substitutions: Not permitted.
- B. The Temperature Control Contractor (or Subcontractor) shall hereinafter be referred to as the ATC Contractor.

2.2 SYSTEM REQUIREMENT

- A. Provide complete direct digital and electronic control system consisting of temperature sensors, thermostats, control valves, dampers, operators, indicating devices, interface equipment, and other apparatus required to operate mechanical system and to perform functions specified. Provide controls for the following:
 - 1. Air conditioning systems.
 - 2. Air moving and handling systems.
 - 3. Boilers and fuel-fired equipment.
 - 4. Control dampers and valves.
 - 5. Cooling and heating coils.
 - 6. Cooling and heating terminal units.
 - 7. Exhaust, return, and supply fans.
 - 8. Filter pressure drops.
 - 9. Heat recovery systems.

10. Kitchen ventilation systems.
11. Outside air and ventilation.
12. Radiant floor heating.
13. Temperature and humidity monitoring.
14. Hot water heating systems.
15. Fire alarm system interfaces.
16. Graphical workstation.
17. Variable frequency drives for pumps and fans.
18. Provide hardware and software required for remote monitoring of the ATC system through modem or ethernet interface.

2.3 DATA INPUTS AND OUTPUTS

- A. Input/output sensors and devices shall be closely matched to the requirements of the remote panel for accurate, responsive, noise-free signal input/output. Control input response shall be high-sensitivity and matched to the loop gain requirements for precise and responsive control.
- B. Duct temperature sensors shall be rigid stem or averaging type as required. Provide water sensors with a separable copper, monel or stainless-steel well.
- C. Control relays and analog output transducers shall be compatible with equipment controllers output signals. Relays shall be suitable for the loads encountered. Analog output transducers shall be designed for precision closed loop control with pneumatic repeatability error no greater than 1/2 percent.
- D. Data inputs and outputs shall be compatible with variable frequency drives; see Division 23 Section "Common Motor Requirements for HVAC Equipment."

2.4 TEMPERATURE CONTROL CENTRAL HARDWARE

- A. Equipment controllers shall be 16 bit microprocessor based with EPROM operating system (O.S.). ATC programs and data files shall be non-volatile EEPROM or flash memory to allow simple additions and changes. Each equipment controller shall have an on-board real-time clock with battery backup of a minimum of 30 days.
 1. Equipment controllers shall be provided where indicated or specified with capacity to accommodate input/output (I/O) points required for the application plus spare points specified. These panels shall be configured with analog and digital inputs and outputs, and pulse counting totalizers and such that the primary input, the output and control logic shall be resident in a single microprocessor to provide network independent stand-alone closed loop ATC.
 2. Panel electronics shall be installed in suitable enclosures. Equipment room panels shall have hinged doors and shall also contain the load relays, transducers, and associated equipment.
- B. Terminal Equipment Controllers shall be EEPROM based and modularity expandable to accommodate additional points if required for future functional changes or enhancements, and with I/O selected for the application plus specified spares. Terminal controllers shall be capable of processing sensor signals of the applications specified, and shall have capability to drive digital (on-off), pulse width modulation, and true analog (0-10V) outputs. Terminal Controller enclosures shall be compact, finished steel to fit within or on terminal equipment. Each terminal controller shall have complete standalone capability.

2.5 OPERATOR STATION SOFTWARE

- A. Operator Station (OS) software shall include as a minimum the Operating System, Data Base Manager, Communications Control, Operator Interface , Trend and History Files, Report Generator, and Support Utilities.
 - 1. Real time operating system shall be true multi-tasking providing concurrent execution of multiple real time programs and custom program development.
 - 2. Data Base manager is to manage data on an integrated and non-redundant basis. It shall allow additions and deletions to the data base without any detriment to the existing data.
- B. Operator Interface Software:
 - 1. Operator access to the system is to be under personal ID and password control for up to 100 unique operators.
 - 2. Up to 100 frequently addressed system points shall be definable as "quick access" points. Each points user address, descriptor, and value/status shall be displayed.
 - 3. Software capacity and user's license shall be unlimited in the quantity of points and tags it can accommodate. Owner shall be able to add points and tags without purchasing additional software or licensing.
 - 4. Points (physical and pseudo) shall be displayed with dynamic data provided by the system with appropriate text descriptors, status or value, and engineering unit. Points shall be dynamic and shall continuously update anytime their field status/value changes.
 - 5. An on-line context-sensitive help utility shall be provided to facilitate operator training and understanding.
 - 6. Electronic messaging facility shall be provided on the operator station for any operator to enter a message to another operator.
- C. Site Specific Customizing Software:
 - 1. Provide software which will allow the user to modify and tailor the temperature control to the specific and unique requirements of the equipment installed, the programs implemented, and to staffing and operational practices.
 - 2. Point alarms shall be user-classifiable as critical or non-critical. Critical alarms shall be displayed in a dialog box of the color monitor. Display shall include time and date of occurrence, indication of alarm condition, analog value or status, user address, and alarm message.
 - 3. A discrete per point detailed alarm-action taking message of up to 480 characters shall be available for each point.
 - 4. Alarms shall be directed to the user selected alarm printer.
 - 5. Non-critical alarms shall only output to the printer and OS disk in order of occurrence.
 - 6. Run time limit messages shall be presented and processed as alarm messages except the action message shall be of a maintenance directive nature.
- D. Dynamic trends shall provide for each OS of up to eight user selected points to show real time activity of the associated points. This information shall be printed and/or displayed in numeric, bar chart, curve plot, pie chart, and other formats, as selected by the operator.
- E. Standard Reports Shall Be Provided Which Shall Be Output onto the Selected Report Printer. The Following Standard Pre-formatted Reports Shall Be Provided:
 - 1. The user shall be provided with a command trace feature selectable on a per point basis allowing the archiving of commands issued to each point.
 - 2. A custom report capability shall be provided to allow the user to format reports of any mix of text, points with status/value and descriptors, and points with status/value only.

3. Alarm history. The last 4000 alarm events shall be disk archived. Viewing or printing shall be by entering a date range (from-to).
 4. Operator activity. Operator activity shall be archived. Viewing or printing shall be by entering a desired date range.
 5. Trend reports shall allow the operator to randomly select point archival. Equipment controllers trend points (hardware and software) shall be assignable to PC archive files for display at user selectable intervals of 10 seconds to 24 hours.
- F. Equipment controllers shall be up-line or down-line loadable to or from the OS disk for backup archival.
 - G. Provide software to execute and observe diagnostics of any remote device connected to the peer bus and the ability to deactivate and restart the device.
 - H. In addition, a word processing utility, graphics package, and spreadsheet shall be available for generic use. The base system software shall include a CRT "windowing" feature to allow the operator to monitor the real time system and use third party software simultaneously.

2.6 GRAPHIC PROGRAMMING

- A. Graphic Programming. Provide hardware and software required for complete equipment controllers ATC programming of plant programs including plant system schematic development, I/O hardware point definition, hardware and software text point descriptors, ATC algorithmic development, a controller software loading utility, and a live programming test facility. At a minimum, the following shall be provided in the graphics package:
 1. Boilers - control and status.
 2. Heating water pump - control and status.
 3. Fuel oil transfer pump set - status
 4. Heat recovery pump - control and status
 5. Exhaust fans EF-4,5,7 and 14 - control and status
 6. Floor plans showing temperature sensors - control and status.
 7. Air handling units, rooftop HVAC units and associated pumps, fans, dampers - control and status.
- B. Provide a Boolean logic switching table matrix module for building ON-OFF commands from combinations of and or functions.
- C. Provide a program testing utility which allows live and dynamic monitoring of the graphically displayed control programs provided.
- D. In addition to training specified elsewhere in this Specification, provide 4 days of additional programming training, at a minimum of 4 hours training per day. These 4 days of additional training shall be provided during the 1 year warranty period. They are intended for use by the Owner as questions regarding system operation arise. Coordinate with the Owner.
- E. Provide 2 sets of programmer's manuals.

2.7 CONTROLLER SOFTWARE

- A. Energy Management application programs and associated data files shall be in non-volatile

memory.

1. Optimum Start shall delay equipment start-up based on global outdoor temperature, space temperature, and system response to assure that comfort conditions are reached at scheduled occupancy. The optimum start program shall operate fully stand-alone in the local equipment controllers.
 2. A load reset program shall be provided to assure that only the minimum amount of heating, cooling, and electrical energy is supplied to satisfy zone temperature requirements.
- B. Control Software:
1. Each equipment controllers shall contain up to 20 unique user modifiable time programs.
 2. Control Application Software shall be customized strictly to meet the detailed requirements of the "Sequence of Operation" specified hereinafter. Equipment controllers and terminal controllers shall be fully programmable. Initial software shall be fully modifiable, and not restricted by vendor's specific configuration guidelines. Equipment controllers control software shall be designed via a graphic programming facility, the detailed graphic design of which shall be provided as system documentation. Control strategies shall be advanced as noted with stabilizing setpoint ramps and procedures to assure slow loading of variable load equipment and economizer modes to prevent unsafe overshoot of controlled pressure and unsafe undershoot of mixed air temperatures during start-up and transition periods.
- C. Management Software:
1. Each equipment controllers shall be provided with a trend archive of at least the last 200 events (digital transitions or analog value changes) of any user selected group of up to 20 points. A stored event shall include date and time, and value or status. Point events shall be displayable at local panels as trend logs for evaluation of control system performance.
 2. Each equipment controllers shall monitor analog input points and specified digital points for off-normal conditions. Each alarm shall have an "alarm delay" attribute which shall determine how long (in seconds) a point must be in an off-normal state prior to being considered in an alarm state.
- D. Communications Software: Each equipment controllers shall have a full master peer-to-peer communications module to support global data sharing, hierarchical control, and global control strategies specified.

2.8 DATA COMMUNICATIONS

- A. Equipment controllers shall be interconnected via a primary communications network. Terminal controllers shall also be connected together via secondary networks to provide data concentration and parallel processing. Networks shall support sensor sharing, global application programs, and bus-to-bus communications without the presence of a host PC.
- B. The equipment controller's communications network shall support true peer protocol such that loss of any single device will not cause total bus failure.
- C. Data connections for any control panels required in addition to those indicated on the Drawings

shall be the responsibility of this Section.

2.9 GENERAL

- A. ATC setpoints, reset schedules, time programs, historical trends shall be displayable at local ATC panels and on the system's operator workstations.
- B. I/O Interface: Hardwired inputs and outputs may tie into system through controllers. Protect points so that shorting will cause no damage to controllers.
 - 1. Binary Inputs: Allow monitoring of on-off signals without external power.
 - 2. Pulse Accumulation Inputs: Accept up to 10 pulses per second.
 - 3. Analog Inputs: Allow monitoring of low-voltage (0- to 10-V dc), current (4 to 20 mA), or resistance signals.
 - 4. Binary Outputs: Provide on-off or pulsed low-voltage signal, selectable for normally open or normally closed operation with 3-position (on-off-auto) override switches and status lights.
 - 5. Analog Outputs: Provide modulating signal, either low voltage (0- to 10-V dc) or current (4 to 20 mA).
 - 6. Tri-State Outputs: Provide two coordinated binary outputs for control of 3-point, floating-type electronic actuators.
 - 7. Universal I/Os: Provide software selectable binary or analog outputs.
- C. Power Supplies: Transformers with Class 2 current-limiting type or overcurrent protection; limit connected loads to 80 percent of rated capacity. DC power supply shall match output current and voltage requirements and be full-wave rectifier type with the following:
 - 1. Output ripple of 5.0 mV maximum peak to peak.
 - 2. Combined 1 percent line and load regulation with 100-microsecond response time for 50 percent load changes.
 - 3. Built-in overvoltage and overcurrent protection and be able to withstand 150 percent overload for at least 3 seconds without failure.
- D. Power Line Filtering: Internal or external transient voltage and surge suppression for workstations or controllers with the following:
 - 1. Minimum dielectric strength of 1000 V.
 - 2. Maximum response time of 10 nanoseconds.
 - 3. Minimum transverse-mode noise attenuation of 65 dB.
 - 4. Minimum common-mode noise attenuation of 150 dB at 40 to 100 Hz.

2.10 SPARE POINTS

- A. Provide a minimum of 10 percent spare points or 16 spare points, whichever is greater, in each ATC control panel for future use. Spare points shall be equally distributed among analog input, analog output, digital input and digital output. It is not intended that spare points be provided in unitary control panels which serve VAV boxes, unit ventilators, fan coil units and heat pumps. It is intended that spare points be provided in master control panels and in panels which serve boiler/mechanical rooms and major equipment such as air handling units.

2.11 CONTROL CABLE

- A. Provide electronic and fiber-optic cables for control wiring in accordance with Division 27.

2.12 ACTUATORS

- A. Electric Motors: Size to operate with sufficient reserve power to provide smooth modulating action or 2-position action.
 - 1. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
 - 2. Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.
- B. Electronic Actuators: Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.
 - 1. Manufacturers:
 - a. Belimo.
 - b. Schneider Electric DuraDrive
 - c. Schneider Electric Andover Continuum Infinet II i2866 (with integral VAV controller)
 - 2. Valves: Size for torque required for valve close-off at maximum pump differential pressure.
 - a. Nonspring-Return Motors for Valves Larger Than NPS 2-1/2 (DN 65): Size for running torque of at least 150 lbf-in. (16.9 N-m) and breakaway torque of at least 300 lbf-in. (33.9 N-m).
 - b. Spring-Return Motors for Valves Larger Than NPS 2-1/2 (DN 65): Size for running and breakaway torque of at least 150 lbf-in. (16.9 N-m).
 - 3. Dampers: Size for running torque as recommended by the damper manufacturer for tight sealing under design operating static pressures and velocities. Submit damper manufacturer's torque chart in same submittal as actuator selection table.
 - a. For dampers which do not list torque values, provide torque calculated as follows:
 - 1) Damper with Edge Seals: 7 inch-lb/sq. ft. (8.6 N-m/sq. m) of damper.
 - 2) Damper without Edge Seals: 5 inch-lb/sq. ft. (6.22 N-m/sq. m) of damper.
 - b. Nonspring-Return Motors for Dampers Larger Than 25 Sq. Ft (2.3 sq. m): Size for running torque of at least 150 lbf-in. (16.9 N-m) and breakaway torque of at least 300 lbf-in. (33.9 N-m).
 - c. Spring-Return Motors for Dampers Larger Than 25 Sq. Ft (2.3 sq. m): Size for running and breakaway torque of at least 150 lbf-in. (16.9 N-m).
 - d. Dampers with 2- to 3-Inch wg (500 to 750 Pa) of Pressure Drop or Face Velocities of 1000 to 2500 fpm (5 to 13 m/s): Increase running torque by a factor of 1.5.
 - e. Dampers with 3- to 4-Inch wg (750 to 1000 Pa) of Pressure Drop or Face Velocities of 2500 to 3000 fpm (13 to 15 m/s): Increase running torque by a factor of 2.0.
 - 4. Coupling: V-bolt and V-shaped, toothed cradle.
 - 5. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
 - 6. Fail-Safe Operation: Mechanical, spring-return mechanism. Provide external, manual gear release on nonspring-return actuators.
 - 7. Power Requirements (2-Position Spring Return): 24-V ac.
 - 8. Power Requirements (Modulating): Maximum 10 VA at 24-V ac or 8 W at 24-V dc.
 - 9. Proportional Signal: 2- to 10-V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.
 - 10. Temperature Rating: 40 to 104°F (5 to 40°C).

- a. In addition, valve actuators shall be suitable for the anticipated ambient temperature and fluid temperature. For example, actuators located within heating equipment terminal enclosures will experience higher temperatures.
- 11. Temperature Rating (Smoke Dampers): -22 to 250 degrees F (-30 to 121 degrees C).
- 12. Run Time: 30 seconds.
- 13. Actuator Housing: Molded or die-cast zinc or aluminum. Terminal unit actuators may be high-impact plastic with ambient temperature rating of 50 to 140 degrees F (10 to 60 degrees C) unless located in return-air plenums.
- 14. Damper actuators shall be provided with end switches.

2.13 CONTROL VALVES

- A. Control Valves: Factory fabricated, of type, body material, and pressure class based on maximum pressure and temperature rating of piping system, unless otherwise indicated.
 - 1. Globe-type valves are required except for those applications where terminal-unit control valves or butterfly valves are specified or detailed.
 - 2. Ball-type valves may be substituted for other types, and shall be manufactured by Belimo, with Belimo actuators (no substitutions).
 - 3. Valves shall be suitable for water with up to 50 percent inhibited ethylene or propylene glycol.
 - 4. 3-way valves shall be mixing pattern, except where diverting pattern is specified, or where manufacturer requires use of diverting pattern.
 - 5. Rubber-paddle or ball-plug type control valves such as, but not limited to, Belimo Zone Valve, Honeywell Fan-Coil Valves or the TAC Erie product line (division of Schneider Electric) are not allowed.
 - 6. Valves with thermal-wax motors are not allowed.
 - 7. Valves requiring cartridge replacement for service are not allowed.
 - 8. Valves requiring special water treatment such as 50-micron filtration are not allowed.
- B. Sizing: Maximum pressure drop determined with valve full-open at design flow rate and the following:
 - 1. 2 Position: Line size.
 - 2. 2-Way Modulating: Between one-half and one times the variable-flow load pressure drop, but not to exceed 3 psig (21 kPa).
 - 3. 3-Way Modulating: Between one-half and one times the variable-flow load pressure drop, but not to exceed 1.5 psig (10.5 kPa).
 - 4. Note: For modulating valves, the load pressure drop is that across the modulated portion of the system. For example, for a 3-way valve providing reset-water control at a boiler, the modulated flow is across the boiler and accessories, whereas the building loop to terminal equipment is considered constant-flow for the purposes of this valve's sizing. For a 3-way valve modulating the flow thru a coil, the coil and its pipe fittings comprise the variable-flow load. For a 3-way valve in a primary-secondary loop to a coil, where the flow thru the coil is a constant pumped flow, the variable load is in the primary-secondary bridge.
- C. Hydronic system globe valves shall have the following characteristics:
 - 1. NPS 2 (DN 50) and Smaller: Class 125 bronze (or red brass) body, bronze or brass seat, bronze trim, rising stainless steel stem, renewable brass or composition disc or plug, screwed ends, with backseating capacity, repackable under pressure. Valve may have integral union ends. Valves with ends other than threaded or factory-integral unions are not allowed.

2. NPS 2-1/2 (DN 65) and Larger: Class 125 iron body, bronze trim, rising stem, plug-type disc, flanged ends, and renewable seat and disc.
 3. Internal Construction: Replaceable plugs and stainless-steel or brass seats.
 - a. Single-Seated Valves: Cage trim provides seating and guiding surfaces for plug on top and bottom.
 - b. Double-Seated Valves: Balanced plug; cage trim provides seating and guiding surfaces for plugs on top and bottom.
 4. Flow Characteristics: 2-way valves shall have equal percentage characteristics; 3-way valves shall have linear characteristics through 1 of the ports, equal percentage through the other.
 5. Close-Off (Differential) Pressure Rating: Combination of actuator and trim shall provide minimum close-off pressure rating of 150 percent of total system (pump) head for 2-way valves, and 100 percent of pressure differential across valve or 100 percent of total system (pump) head for 3-way valves.
 6. Temperature Rating: 250°F (121°C).
- D. Butterfly Valves: 200-psig (1380-kPa), 150-psig (1034-kPa) maximum pressure differential, ASTM A 126 cast-iron or ASTM A 536 ductile-iron body and bonnet, extended neck, stainless-steel stem, field-replaceable EPDM or Buna N sleeve and stem seals.
1. Body Style: Wafer or lug.
 2. Disc Type: Nickel-plated ductile iron or aluminum bronze.
 3. Seat: EPDM resilient seat replaceable. Disc may be coated, but primary sealing surface shall be the resilient seat mounted in the body.
 4. Sizing: 1-psig (7-kPa) maximum pressure drop at design flow rate.
 5. Temperature Rating: 250°F (121°C).
- E. Terminal Unit Control Valves: Bronze body, bronze trim, 2 or 3 ports as indicated, replaceable plugs and seats, and union and threaded ends. Valves with ends other than threaded or factory-integral unions are not allowed.
1. Applications: Duct-mounted reheat coils, unit heaters, cabinet unit heaters,. For other applications, see globe valve specifications above.
 2. Honeywell "small linear control valves" with "linear valve actuators" (or equal) may be used only for VAV box coils and hot water duct coils; they may not be used for other coil or equipment types.
 3. Rating: Class 125 for service at 125 psig (860 kPa) and 250 deg F (121 deg C) operating conditions.
 4. Close-Off (Differential) Pressure Rating: Combination of actuator and trim shall provide minimum close-off pressure rating sufficient to close against pump shutoff head.
 5. Flow Characteristics: 2-way valves shall have equal percentage characteristics; 3-way valves shall have linear characteristics.

2.14 DAMPERS

- A. Manufacturers:
1. Non-Insulated Dampers:
 - a. Ruskin - Model CD60.
 - b. American Warming & Ventilating.
 - c. Arrow.
 - d. Greenheck.
 - e. Tamco (T.A. Morrison & Co., Inc.).
 2. Insulated-Blade Dampers:

- a. T.A. Morrison & Co., Inc.; Tamco Series 9000 SC “Severe Cold Option” dampers.
 - b. Ventex, Inc. - Series 3965 SC.
- B. Non-Insulated Dampers:
 - 1. AMCA-rated, parallel (2-position) or opposed-blade (modulating) design.
 - 2. Frames shall be 16 gauge (1.6 mm) thick galvanized steel, reinforced to equivalent strength of 11 gauge (3 mm) galvanized steel; or 0.125 inch (3.2 mm) minimum thickness extruded-aluminum.
 - 3. Blades shall be airfoil type of not less than 14 gauge (2 mm) equivalent thickness galvanized steel or heavy gauge extruded aluminum, with maximum blade width of 8 inches (200 mm) and length of 48 inches (1220 mm).
 - 4. Secure blades to 1/2 inch (13 mm) diameter, hex-profile, zinc-plated axles using zinc-plated hardware, with oil-impregnated sintered bronze or nylon blade bearings, blade-linkage hardware of zinc-plated steel and brass, ends sealed against spring-stainless-steel blade bearings, and thrust bearings at each end of every blade.
 - 5. Operating Temperature Range: From -40 to 200 degrees F (-40 to 9 degrees C).
 - 6. Edge Seals, Low-Leakage Applications: Replaceable, inflatable blade edging of Ruskiprene, neoprene, vinyl, or rubber, and spring-loaded stainless-steel side seals, rated for leakage at less than 10 cfm/sq. ft (50 l/s per sq. m) of damper area, at differential pressure of 4-inch wg (1 kPa) when damper is held by torque of 50 in.-l bf (5.6 N-m); when tested according to AMCA 500D-98.
- C. Insulated Dampers: Dampers which are located in or 4 ft. (1.2 m) or less from outside walls or roof lines, and are 8 sq. ft. (0.74 sq. m) or larger, shall be thermally insulated type.
 - 1. Frame: Extruded aluminum, externally insulated with polystyrene foam.
 - 2. Blades: Double wall extruded aluminum, with internal injected polyurethane foam, thermally broken. Extruded silicone frame and blade seals, secured in slots in the aluminum extrusions. R-value of complete blade shall be 2.29 hr-ft²-F/Btu (0.39 m²- K/W).
 - 3. Leakage shall not exceed 4.9 cfm/sq. ft (25 l/s per sq. m) against 4 in. wg (1 kPa) differential static pressure at -40 degrees F (-40 degrees C).
 - 4. Bearings: Celcon inner bearing fixed to a 7/16 inch (11.1 mm) aluminum hexagon blade pin, rotating within a polycarbonate outer bearing inserted in the frame, resulting in no metal-to-metal or metal-to-plastic contact.
 - 5. Linkage Hardware: Installed in the frame side, constructed of aluminum and corrosion-resistant, zinc-plated steel, with cup-point trunnion screws for a slip-proof grip.
 - 6. Operating Temperatures: -40 to 155 degrees F (-40 to 68 degrees C).
 - 7. For dampers less than 12 inches (305 mm) in 1 dimension, provide “flanged-to-duct” mounting style for maximum free area.
- D. Automatic dampers at exterior wall louvers shall be 4 inches (100 mm) shorter in vertical dimension (height) than the louver they serve, to allow sloping of bottom of duct to drain outward. Depending on the height of the louver’s integral waterstop, it may be necessary to slope the top of the duct as well as the bottom. Coordinate sizing and positioning of dampers and louvers with Division 23 Section “Air Inlets and Outlets” to ensure that base of damper frame is positioned higher than the lowest edge of the duct where it laps over the top edge of the louver’s waterstop or bottom blade. It shall be the responsibility of this Section to ensure proper installation to drain.

2.15 ELECTRONIC SENSORS

- A. Description: Vibration and corrosion resistant; for wall, immersion, or duct mounting as required.
- B. Thermistor Temperature Sensors and Transmitters:
 - 1. Accuracy: Plus or minus 0.5°F (0.3°C) at calibration point.
 - 2. Wire: Twisted, shielded-pair cable.
 - 3. Insertion Elements in Ducts: Single point, 8 inches (200 mm) long; use where not affected by temperature stratification or where ducts are smaller than 9 sq. ft. (0.84 sq. m).
 - 4. Averaging Elements in Ducts: 36 inches (915 mm) long, flexible; use where prone to temperature stratification or where ducts are larger than 10 sq. ft. (1 sq. m).
 - 5. Insertion Elements for Liquids: Brass or stainless-steel socket with minimum insertion length of 2-1/2 inches (64-mm).
 - 6. Room Sensor Cover Construction: See below.
 - 7. Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.
 - 8. Room Security Sensors: Stainless-steel cover plate with insulated back and security screws.
- C. Humidity Sensors: Bulk polymer sensing element.
 - 1. Accuracy: 2 percent full range with linear output.
 - 2. Room Sensor Range: 20 to 80 percent relative humidity.
 - 3. Room Sensor Cover Construction: See below.
- D. Pressure Transmitters/Transducers:
 - 1. Static-Pressure Transmitter: Nondirectional sensor with suitable range for expected input, and temperature compensated.
 - a. Accuracy: 2 percent of full scale with repeatability of 0.5 percent.
 - b. Output: 4 to 20 mA.
 - c. Duct Static-Pressure Range: 0- to 5-inch wg (0 to 1240-Pa).
 - 2. Water Differential-Pressure Transducers: Stainless-steel diaphragm construction, suitable for service; minimum 150-psig (1034-kPa) operating pressure and tested to 300-psig (2070-kPa); linear output 4 to 20 mA.
 - 3. Differential-Pressure Switch (Air or Water): Snap acting, with pilot-duty rating and with suitable scale range and differential.
- E. Room Sensor Cover Construction: Manufacturer's standard locking covers.
 - 1. Set-Point Adjustment: Concealed.
 - 2. Set-Point Indication: Concealed.
 - 3. Thermometer: Concealed.
 - 4. Communications Port: Standard phone-type jack for connection of portable laptop computer and other devices. Provide at each room sensor, no exceptions.
 - 5. Override Pushbutton: For timed override of occupied/unoccupied cycle. Provide in normally-occupied rooms such as shops, offices, cafeterias,. Do not provide in storage rooms, electrical rooms, Comm rooms, and mechanical rooms.
- F. Room sensor accessories include the following:
 - 1. Insulating Bases: For sensors located on exterior walls.
 - 2. Adjusting Key: As required for calibration and cover screws. Furnish to the Owner, at least 5 per sensor type.

3. Wall Mounting Box: Recessed, steel, securely fastened to wall framing. Equal to Steel City metallic switch boxes by Thomas & Betts Corp. Box may only be omitted where sensor attaches directly to masonry construction.

2.16 THERMOSTATS AND TEMPERATURE SENSORS

- A. Thermostats and Sensors in locations in regular view by the occupants shall have covers which are simple, aesthetically pleasing, neutral in color, with manufacturer's logo, if any, in black or neutral color, and shall fit flush to the surrounding wall surface.
- B. Freezestats:
 1. Freezestat safety low limits shall be duct-mounted manual-reset and automatic-reset (see control sequences) 20-foot limited fill capillary-tube type, responsive to the coolest section of its length.
 2. Air handling systems which handle outside air (or a mix of outside air and return air) or are located outdoors shall have freezestats at hydronic and steam coils. Where freezestats are required, provide both a manual-reset type set near freezing temperature for shutdown, and an automatic-reset type set at a warmer temperature for preventive action
- C. Thermostats
 1. Electric thermostats shall be line voltage or low voltage type, suitable for the application. They shall have exposed setpoint adjustment and setpoint indicator.
 2. Unit heater aquastats shall be strap-on type.
- D. Temperature Sensors:
 1. Temperature sensors shall provide a 2-wire connection to the controller that is polarity and wire type insensitive. Sensors shall have communications jacks for connection to the communication trunk to which the controller is connected. The temperature sensor, the connected controller, and other devices on the communications bus shall be accessible by the Graphical Programming tool.
 2. Provide with manual adjustment rotary or sliding dials, with a scale labeled as either temperature in degrees F, or "warmer/cooler". The input from this dial shall be programmable through the operator workstation to allow a maximum and minimum range for user adjustment. The min/max range shall initially be set at 4°F above/below the programmed setpoint. When the dial is adjusted, it shall shift both heating and cooling setpoints by the programmed amount, in proportion to the distance moved. This dial shall only affect the occupied setpoints; the unoccupied setpoints shall remain as programmed.
 3. Provide with override buttons which, when depressed during unoccupied time periods, will override the zone's temperature controls and setpoints to occupied conditions for a user adjustable period of time (initially set for 2 hours).

2.17 STATUS SENSORS

- A. Where differential pressure "sensor" is indicated or specified, they shall be analog-output type as specified herein. Where differential pressure "switch" is indicated, it may be digital-output type.
- B. Status Inputs for Fans: Unless otherwise specified: Differential-pressure switch with pilot-duty rating and with adjustable range of 0- to 5-inch wg (0 to 1240 Pa).

- C. Status Inputs for Pumps: Unless otherwise specified: Differential-pressure switch with pilot-duty rating and with adjustable pressure-differential range of 8 to 60 psig (55 to 414 kPa), piped across pump.
- D. Status Inputs for Electric Motors: Comply with ISA 50.00.01, current-sensing fixed- or split-core transformers with self-powered transmitter, adjustable and suitable for 175 percent of rated motor current.
- E. Voltage Transmitter (100- to 600-V ac): Comply with ISA 50.00.01, single-loop, self-powered transmitter, adjustable, with suitable range and 1 percent full-scale accuracy.
- F. Power Monitor: 3-phase type with disconnect/shorting switch assembly, listed voltage and current transformers, with pulse kilowatt hour output and 4-20 mA kW output, with maximum 2 percent error at 1.0 power factor and 2.5 percent error at 0.5 power factor.
- G. Current Switches: Self-powered, solid-state with adjustable trip current, selected to match current and system output requirements.
- H. Electronic Valve/Damper Position Indicator: Visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.
- I. Water-Flow Switches: Bellows-actuated mercury or snap-acting type with pilot-duty rating, stainless-steel or bronze paddle, with appropriate range and differential adjustment, in NEMA 250, Type 1 enclosure.

2.18 CURRENT TRANSFORMERS

- A. Current transformers (CTs) are not an acceptable substitute for pump or fan monitoring where flow switches or pressure switches are specified.
- B. Provide CTs as required for the sequences of operation specified.

2.19 DIFFERENTIAL WATER PRESSURE SENSORS

- A. Manufacturers:
 - 1. Setra - Model 230 Wet-to-Wet Pressure Transducer.
 - 2. Ashcroft.
 - 3. Honeywell.
 - 4. Johnson Controls.
- B. At Contractor's option, Setra Model 231RS wet-to-wet multi-range differential pressure transducer with remote-wired sensors may be used.
- C. Differential-pressure monitoring shall be analog-output type unless otherwise specified.
- D. High output, low differential pressure transducer designed for wet to wet differential pressure measurements of liquids or gases. A fast-response capacitance sensor and signal conditioned electronic circuitry provide a highly accurate, linear analog output proportional to pressure. Both unidirectional and bidirectional pressure ranges are available for applications with line pressure up to 250 psig.

- E. An isolation system transmits the motion of the differential pressure sensing diaphragm from the high line pressure environment (e.g. corrosive liquids) to the dry (air) enclosure where it moves one of a pair of capacitance plates proportionally to the diaphragm movement. Response to pressure changes is approximately 20 times faster than conventional fluid-filled transducers. The electronic circuit linearizes output vs. pressure and compensates for thermal effects of the sensor.
- F. NEMA 4/IP65 rated enclosure. Pipe-thread fittings.
- G. Accuracy RSS (of non-linearity, non-repeatability and hysteresis) (at constant temperature) +/- 0.25 percent of full scale (pressure range).
- H. Pressure Range: Selected by the Contractor for the anticipated or field-measured (actual) pressure differential. Lower ranges have greater accuracy.
- I. Ambient Operating Temperature for Electronics: 0 to 175°F (-18 to 79°C).

2.20 DIFFERENTIAL WATER PRESSURE SWITCHES

- A. Differential-pressure switches with on/off contact closure output may be used where specified.
- B. NEMA 2 minimum enclosure. Pipe-thread fittings. Brass or bronze wetted parts.
- C. Ambient Operating Temperature for Electronics: 30 to 158°F (-1 to 70°C).

2.21 ROOM OCCUPANCY DETECTION EQUIPMENT

- A. Carbon Dioxide Sensor and Transmitter: See "Carbon Dioxide Sensor" in this Section.
- B. Occupancy Sensor: Provided by Division 26.

2.22 REFRIGERANT LEAK DETECTORS

- A. Manufacturers:
 1. Bacharach, Inc. - HGM-MZ multizone.
 2. Parasense, Inc.
- B. Product Type: Multiple-area monitoring system for low level continuous monitoring of refrigerant gases used in most commercial systems including: CFC, HCFC, HFC and Ammonia. System design supports compliance with gas monitoring requirements of ANSI/BSR ASHRAE 15-1994.
 1. Detector shall be compatible with refrigerant type as scheduled.
- C. Front Panel: 3 indicator lights.
 1. Green: Monitor is powered on. LED glows during normal operation; flashes when unit is in warm-up mode.
 2. Red: Alarm. LED flashes when any point has exceeded the alarm setting.
 3. Yellow: Fault. LED flashes when there is a system fault.
- D. Performance:
 1. Sensitivity: 1 ppm (exception is R11: +/- 10 ppm +/- 15 percent of reading 0-1000)

- ppm).
 2. Measuring Range: 0 to 10,000 ppm.
 3. Accuracy: +/- 1 ppm from +/- 10 percent of reading from 1-1000 ppm (exception is R-11: +/- 10 ppm +/- 15 percent of reading 0-1000 ppm).
 4. Temperature Drift: +/- 0.3 percent of reading per degree C.
 5. Coverage: 4 point (zone) standard, expandable to 16 points in 4 point increments.
 6. Detector Type: Infrared Non-Dispersive.
 7. Sampling Mode: Automatic or Manual (hold).
 8. Re-Zero: Auto or on Zone Change.
 9. Response Time: 5 to 120 seconds - depending on air-line length and number of zones.
 10. System Noise: Less than 40 dB(A) at 10 feet (3 m).
 11. Monitoring Distance: 1,200 ft. maximum for combined length of sample + exhaust tubing (each zone).
 12. Conditional System: Dual optional 4-20 mAdc isolated outputs. Channel 1: zone area. Channel 2: PPM.
 13. Alarms:
 - a. 4 SPDT alarm contacts (rated 5 Amps at 250 volts). 3 assigned to PPM level alarms, 1 assigned to system faults.
 - b. Audible alarm at panel, with silencing feature.
 14. Communications: RS-232C communication port standard. Provide full 2-way communication with building management system via RS485 MODBUS-RTU serial interface.
 15. Power Safety Mode: Fully automatic system reset. Programmed parameters retained
 16. Operating Temp: 32 to 122°F (0 to 50°C).
 17. Ambient Humidity: 5 to 90 percent RH (non-condensing).
 18. AC Power: 100 to 240 VAC, 50/60 Hz, 20 W.
 19. Altitude Limit: 6,562 ft. (2,000 m).
 20. Fusing: F1, F2: 1.0 A, 250 VAC, Type "F".
 21. Sensor Life: 7-10 years.
- E. Certification: UL 61010-1, Can/CSA 22.2 No. 61010-1 & CE Mark.
- F. Warranty: 2 years from date of shipment.
- G. Accessories:
1. Surge protector.
 2. Tubing and supports for sample intake lines, purge line, and exhaust line.
 3. End-of-line filters.
 4. Charcoal filter for purge line.
 5. Splitter kits for multiple filters on a single zone.
 6. Water trap.
 7. Spare fuses.
 8. Annual maintenance kit, including line end filters in quantity to match installation, 1 charcoal filter, 1 hydrophobic filter, and 3 end-of-line water stop filters.
- H. For installation of relief valve end-of-line filter, provide end of relief copper piping turned downward to shed water and snow, and enlarge end of piping so that net area of piping with filter installed is not less than the area of the relief main.

2.23 AIRFLOW MEASURING STATIONS

- A. Manufacturers:
 - 1. EBTRON, Inc. Model GTx116 P and GTx116 F (basis of design).
 - 2. Air Monitor Corporation.
- B. Verify quantities, sizes, and locations of measuring stations to meet the intent of the specified control sequences, and provide as required, whether or not they are indicated on the Drawings. Coordinate with other Sections of the Specifications and other trades, to provide installation in ductwork, air handling units, and other locations as required.
- C. Warranty: Provide a manufacturer's parts warranty for 36 months from the date of unit shipment.
- D. Submittals:
 - 1. Submit product data sheets for airflow measuring devices indicating minimum placement requirements, sensor density, sensor distribution, and installed accuracy to the host control system.
 - 2. Devices whose accuracy is the combined accuracy of the transmitter and sensor probes must demonstrate that the total accuracy meets the performance requirements of this Specification throughout the measurement range.
 - 3. Submit a schedule of airflow measuring devices indicating compliance with specified accuracy at minimum and maximum airflow rates.
 - 4. Submit installation, operation and maintenance documentation.
- E. Each measurement device shall consist of one or more sensor probe assemblies and a single microprocessor based transmitter. Each sensor probe assembly shall contain one or more independently wired sensor housings. Multiple sensor housings shall be equally weighted and averaged by the transmitter prior to output. Pitot tubes and arrays are not acceptable. Vortex shedding flow meters are not acceptable.
- F. Air flow measuring assemblies shall be selected and arranged to minimize the number of probes and sensors required for the size of the duct.
- G. Sensor Probe Assemblies:
 - 1. Each sensor housing shall be manufactured of a U.L. listed engineered thermoplastic.
 - 2. Each sensor housing shall utilize two hermetically sealed, bead in glass thermistor probes to determine airflow rate and ambient temperature. Devices that use "chip" type thermistors are unacceptable. Devices that do not have 2 thermistors in each sensor housing are not acceptable.
 - 3. Each sensor housing shall be calibrated at a minimum of 16 airflow rates and have an accuracy of +/- 2 degrees F of reading over the entire operating airflow range. Each sensor assembly shall be calibrated to standards that are traceable to the National Institute of Standards and Technology (NIST).
 - a. Devices whose accuracy is the combined accuracy of the transmitter and sensor probes must demonstrate that the total accuracy meets the performance requirements of this Specification throughout the measurement range.
 - 4. The operating temperature range for the sensor probe assembly shall be 20 to 160 degrees F (-28 to 71 degrees C). The operating humidity range for the sensor probe assembly shall be 0 to 99 percent RH (non-condensing).

5. Each temperature sensor shall be calibrated at a minimum of 3 temperatures and have an accuracy of +/- 0.15 degrees F (0.08 degrees C) over the entire operating temperature range. Each temperature sensor shall be calibrated to standards that are traceable to the National Institute of Standards and Technology (NIST).
6. Each sensor probe assembly shall have an integral, U.L. listed, plenum rated cable and terminal plug for connection to a remotely mounted transmitter. Terminal plug interconnecting pins shall be gold plated.
7. Each sensor assembly shall not require matching to the transmitter in the field.
8. A single manufacturer shall provide both the airflow/temperature measuring probe(s) and transmitter at a given measurement location.

H. Duct and Plenum Sensor Probe Assemblies:

1. Sensor housings shall be mounted in an extruded, gold anodized, 6063 aluminum tube probe assembly.
2. The number of sensor housings provided for each location shall be as follows:

a.	Area (sq.ft.)	Area (sq.m)	Sensors
	≤1	(≤0.09)	2
	>1 to <4	(>0.09 to <0.37)	4
	4 to <8	(0.37 to <0.74)	6
	8 to <12	(0.74 to <1.11)	8
	12 to <16	(1.11 to <1.49)	12
	≥16	(≥1.49)	16
3. Probe assembly mounting brackets shall be constructed of Type 304 stainless steel. Probe assemblies shall be mounted using one of the following options:
 - a. Insertion mounted through the side or top of the duct.
 - b. Internally mounted inside the duct or plenum.
 - c. Standoff mounted inside the plenum.
 - d. The operating airflow range shall be 0 to 5,000 fpm (0 to 56 m/s) unless otherwise indicated on the Drawings.

I. Fan Inlet Sensor Probe Assemblies:

1. Sensor housings shall be mounted on 304 stainless steel blocks.
2. Mounting rods shall be field adjustable to fit the fan inlet and constructed of nickel plated steel.
3. Mounting feet shall be constructed of 304 stainless steel.
4. The operating airflow range shall be 0 to 10,000 fpm (0 to 113 m/s) unless otherwise indicated on the Drawings.

J. Transmitters:

1. The transmitter shall have an LCD display capable of displaying airflow and temperature. Airflow shall be field configurable to be displayed as a velocity or a volumetric rate.
2. The transmitter shall be capable of displaying the individual airflow and temperature readings of each sensor on the LCD display.
3. The transmitter shall operate on 24 VAC. The transmitter shall not require an isolated power source.
4. The operating temperature range for the transmitter shall be 20 to 120 degrees F (-28 to 48 degrees C). The transmitter shall be protected from weather and water.
5. The transmitter shall be capable of communicating with the host controls using one of the following interface options:
 - a. Linear analog output signal: Field selectable, fuse protected and isolated, 0 10VDC and 4 20mA (4 wire).

- b. RS 485: Field selectable BACnet MS/TP, ModBus RTU and Johnson Controls N2 Bus.
 - c. 10 Base T Ethernet: Field selectable BACnet Ethernet, BACnet IP, ModBus TCP and TCP/IP.
 - d. LonWorks Free Topology.
- K. The measuring device shall be UL listed as an entire assembly.
- L. The manufacturer's authorized representative shall review and approve placement and operating airflow rates for each measurement location indicated on the Drawings. Submit a written report to the Architect if any measurement locations do not meet the manufacturer's placement requirements.
- M. Airflow measuring stations shall be interfaced so that the building's ATC system shall monitor airflow. Coordinate output signal with the ATC system's requirements. Any controllers required for the proper operation of the airflow monitoring station shall be LonWorks compliant.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that power supply and data outlet is available to control units and operator workstation.

3.2 ELECTRICAL WIRING AND CONNECTION INSTALLATION

- A. The ATC Contractor shall be responsible for electrical installation, including any low voltage and line voltage wiring which is required for a fully functional control system and not indicated on the Electrical Drawings or required by the Electrical Specifications (Divisions 26 and 27).
- B. Wiring and conduits shall be properly supported and run in a neat and workmanlike manner. Wiring and conduits exposed and in equipment rooms shall run parallel to or at right angles to the building structure. Wiring and conduits within enclosures shall be neatly bundled and anchored to prevent obstruction to devices and terminals. Wiring, conduits, wall boxes, and accessories shall conform to Division 26 – Electrical, and Division 27 of the Contract Documents.
- C. Wiring shall be in accordance with local and national Codes and regulations.
- D. Provide electrical materials and installation under this Section. Requirements and standards shall be as specified in other Sections and Divisions of the Specifications, as indicated in paragraphs below.
 - 1. Install raceways, boxes, and cabinets in conformance to Division 26.
 - 2. Install building wire and cable in conformance to Division 26.
 - 3. Provide interface wiring (line and low voltage) as required to complete ATC system installation.
 - 4. Install signal and communication cable according to Division 27.
 - a. Conceal cable, except in mechanical rooms and areas where other conduit and piping are exposed.
 - b. Install exposed cable in raceway.

- c. Install concealed cable in raceway.
 - d. Bundle and harness multi-conductor instrument cable in place of single cables where several cables follow a common path.
 - e. Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.
 - f. Number-code or color-code conductors for future identification and service of control system, except local individual room control cables.
 - g. Install wire and cable with sufficient slack and flexible connections to allow for vibration of piping and equipment.
- E. Control wiring in boiler room, mechanical rooms, and equipment rooms shall be installed in conduit which shall comply with the requirements of the Electrical Specifications.
- F. Electronic low-voltage wiring shall be #18 AWG minimum THHN and shielded if required.
- G. Provide power for normally-open duct reheat coils, hot water valves. De-energize valves when hot water pumps are de-energized.
- H. Power for any temperature control panels required in addition to those indicated on the Drawings shall be the responsibility of this Section. Power to temperature control panels shall be through “stand-by” power circuits which are powered through the building’s emergency generator.
- 1. It is the design intent to have the entire temperature control system, including damper and valve actuators, powered by stand-by power circuits to ensure that the DDC system is fully functional when the building is operating on generator power.
 - 2. The following HVAC equipment will be powered by stand-by circuits and shall remain in control when the building is operating on generator power:
 - a. Boilers
 - b. Heating water pumps.
 - c. The entire automatic temperature control system.
 - 3. Air Handling Unit

3.3 INSTALLATION

- A. Wall mounted thermostats and temperature sensors shall be attached to an electrical wall box attached to a wall stud, masonry wall, or to blocking. Attaching to gypsum wallboard only shall not be allowed.
- B. Mounting heights of room sensors, thermostats, and other devices, which have features which occupants may adjust or set by touching, shall be installed in locations and heights conforming to U.S. Department of Justice – 2010 ADA Standards for Accessible Design.
- 1. Unobstructed Forward or Side Reach: Reaches, measured by distance above the finished floor or ground surface upon which the occupant shall be sitting or standing, shall be a high of 46 inches (1220 mm) maximum measured to the center of the device.
 - 2. Obstructed High Reach: Where the reach depth exceeds 20 inches (510 mm), the high forward reach shall be 42 inches (1120 mm) maximum to the center of the device and the reach depth shall be 25 inches (635 mm) maximum.
 - 3. Coordinate with Division 26 – Electrical to match heights for an aesthetically pleasing appearance.
- C. Verify location of room temperature sensors and other exposed control sensors with Drawings

and room details before installation.

1. Thermostats and temperature sensors are indicated on the Drawings for general location. Terminal heat transfer units and fans which control space temperature shall be provided with thermostatic control, whether or not a thermostat or temperature sensor has been indicated on the Drawings.
 2. Locate in the general location indicated, and coordinate to group together with room light switches and other devices of similar height, to minimize disruption of open wall space.
 3. Locate to not be above electrical dimmers.
 4. Locate to avoid heat-generating equipment such as computers, copiers, cooking equipment, coffee makers, vending machines, and refrigerators. Where electrical outlets are indicated near sensors, verify whether equipment is intended.
 5. Locate to avoid heating piping which may be concealed in partitions.
 6. Locate away from windows and exterior doors.
 7. Locate to avoid other false sources of heat such as strong sunlight.
- D. Provide guards on room sensors and thermostats in the following locations:
1. Locations vulnerable to traffic.
 2. Where indicated.
- E. At each wall-mounted temperature sensor, provide wiring for setpoint dial and override pushbutton, and for communications jacks, whether or not the specified sensor has these functions. This will allow the Owner to change sensors to add these functions in the future. Provide access to the associated controller and related control panels through each communication jack.
- F. Install averaging elements in ducts and plenums in crossing or zigzag pattern.
- G. Install freezestats serpentine across and clipped to the downstream face of coils. Entire length of capillary tube shall be within the unit airstream.
- H. Perform adjustment/relocation of freezestats as required to eliminate nuisance freezestat alarms.
- I. Aquastats installed on unit heaters and at any location above 60 inches (1525 mm) above finished floor shall be installed with adjustment knobs facing downward to facilitate adjustment.
- J. Outdoor air temperature sensor(s) shall be installed on the North side of the building.
- K. Connect manual-reset limit controls independent of manual-control switch positions. Automatic duct heater resets may be connected in interlock circuit of power controllers.
- L. Connect hand-off-auto selector switches to override automatic interlock controls when switch is in hand position.
- M. Connect lead-lag controls to lock out the failed or non-selected motor, to prevent simultaneous operation.
- N. Connect lead-lag controls so that only 1 motor can run in starter "hand" position.
- O. Connect fire alarm shutdown of motors on the load side of controls and hand-off-auto switches,

to prevent motor from running in any switch position during fire alarm.

- P. For components to be installed under other Sections of the Specifications, provide delivery of components to appropriate Subcontractors, provide installation instructions, and supervise their installation.
- Q. Install hydronic instrument wells, valves, and other accessories according to Division 23 Section "Hydronic Piping."
 - 1. Sensors shall be immersion type in wells unless otherwise specified or indicated.
 - 2. Enlarge piping at wells to prevent excess interference with flow.
 - 3. Locate wells to ensure insertion in active flowing section of piping or tank.
 - 4. Fill sensor wells with Honeywell thermal heat transfer paste to ensure good conduction.
 - 5. Locate sensors wells at or above the 90° level on piping systems to prevent sediment build up.
- R. Install refrigerant instrument wells, valves, and other accessories according to Division 23 Section "Refrigerant Piping and Specialties."
- S. Install automatic dampers in conformance to Division 23 Section "Air Duct Accessories."
- T. Install damper motors on outside of duct in warm areas, not in locations exposed to outdoor temperatures. Provide stand-off brackets of depth to meet or exceed specified thickness of duct insulation.
- U. Install duct volume-control dampers according to Division 23 Sections specifying air ducts.
- V. Provide labels and nameplates to identify control components according to Division 23 Section "Identification for HVAC Piping and Equipment."
- W. Install electronic and fiber-optic cables according to Division 27.
- X. Unless otherwise indicated, actuators shall be spring loaded and shall, upon a loss of power, actuate their device to an appropriate "fail safe" position.
 - 1. Hot water valves - fail safe to fully open.
 - 2. Outside and exhaust air dampers - fail safe to fully closed.
 - 3. Exhaust fan motorized dampers - fail safe to fully closed.
 - 4. Supply air dampers at rooftop units - fail safe to fully closed.
 - 5. Return air dampers - fail safe to fully open.
 - 6. Boiler isolation valves (each boiler) - fail safe to fully open.
- Y. For actuators that are required to "fail safe", provide spring return actuators. "Floating point" actuators shall not be allowed for these applications. "Floating point" actuators shall be allowed for actuators that are not required to "fail safe".
- Z. Enter computer programs and data files into the related computers including control programs, initial approved parameters and settings, and English descriptors.
- AA. Maintain CD copies of data file and application software for reload use in the event of a system crash or memory failure. 1 copy shall be delivered to the Owner during training session, and 1 copy shall be archived in the ATC Contractor's local software vault.

- BB. Install software in control units and operator workstation(s). Implement features of programs to specified requirements and as appropriate to sequence of operation.
- CC. Connect and configure equipment and software to achieve sequence of operation specified.

3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.
- B. Perform the following field tests and inspections and prepare test reports:
 - 1. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove and replace malfunctioning units and retest.
 - 2. Test and adjust controls and safeties.
- C. DDC Verification:
 - 1. Verify that instruments are installed before calibration, testing, and loop or leak checks.
 - 2. Check instruments for proper location and accessibility.
 - 3. Check instrument installation for direction of flow, elevation, orientation, insertion depth, and other applicable considerations.
 - 4. Check flow instruments. Inspect tag number and line and bore size, and verify that inlet side is identified and that meters are installed correctly.
 - 5. Check pressure instruments, piping slope, installation of valve manifold, and self-contained pressure regulators.
 - 6. Check temperature instruments and material and length of sensing elements.
 - 7. Check control valves. Verify that they are in correct direction.
 - 8. Check DDC system as follows:
 - a. Verify that DDC controller power supply is from emergency power supply, if applicable.
 - b. Verify that wires at control panels are tagged with their service designation and approved tagging system.
 - c. Verify that spare I/O capacity has been provided.
 - d. Verify that DDC controllers are protected from power supply surges.
- D. Replace damaged or malfunctioning controls and equipment and repeat testing procedures.

3.5 ADJUSTING

- A. Calibrating and Adjusting:
 - 1. Calibrate instruments.
 - 2. Make 3-point calibration test for both linearity and accuracy for each analog instrument.
 - 3. Calibrate equipment and procedures using manufacturer's written recommendations and instruction manuals. Use test equipment with accuracy at least double that of instrument being calibrated.
 - 4. Control System Inputs and Outputs:
 - a. Check analog inputs at 0, 50, and 100 percent of span.
 - b. Check analog outputs using milliamper meter at 0, 50, and 100 percent output.
 - c. Check digital inputs using jumper wire.
 - d. Check digital outputs using ohmmeter to test for contact making or breaking.
 - e. Check resistance temperature inputs at 0, 50, and 100 percent of span using a

- precision-resistant source.
 - 5. Flow:
 - a. Set differential pressure flow transmitters for 0 and 100 percent values with 3-point calibration accomplished at 50, 90, and 100 percent of span.
 - b. Manually operate flow switches to verify that they make or break contact.
 - 6. Pressure:
 - a. Calibrate pressure transmitters at 0, 50, and 100 percent of span.
 - b. Calibrate pressure switches to make or break contacts, with adjustable differential set at minimum.
 - 7. Temperature:
 - a. Calibrate resistance temperature transmitters at 0, 50, and 100 percent of span using a precision-resistance source.
 - b. Calibrate temperature switches to make or break contacts.
 - 8. Stroke and adjust control valves and dampers without positioners, following the manufacturer's recommended procedure, so that valve or damper is 100 percent open and closed.
 - 9. Stroke and adjust control valves and dampers with positioners, following manufacturer's recommended procedure, so that valve and damper is 0, 50, and 100 percent closed.
 - 10. Provide diagnostic and test instruments for calibration and adjustment of system.
 - 11. Provide written description of procedures and equipment for calibrating each type of instrument. Submit procedures review and approval before initiating startup procedures.
- B. Adjust initial temperature set points.
- C. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to 3 visits to Project during other than normal occupancy hours for this purpose.

3.6 VALIDATION

- A. The ATC Contractor shall completely check out, calibrate, and test connected hardware and software to insure that the system performs in accordance with the approved submittals for specifications and sequences of operations.
- B. Witnessed Validation Demonstration: Shall consist of:
 - 1. Display and demonstrate each type of data entry to show site specific customizing capability.
 - 2. Execute digital and analog commands.
 - 3. Demonstrate ATC loop precision and stability via trend logs of inputs and outputs.
 - 4. Demonstrate energy management performance via trend logs and command trace.
 - 5. Demonstrate that each control point, tag, or address is associated with the proper device, such as a room sensor input or an actuator output. This demonstration shall include visual confirmation that the measured values and the output actions match what is indicated in the control system.

3.7 DEMONSTRATION

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

3.8 TRAINING

- A. Training shall be by the ATC Subcontractor and shall utilize specified manuals and as-built documentation. Video record each training session, and turn the completed video over to the Owner when training has been completed.
- B. Operator training shall include 10 four-hour sessions encompassing:
 - 1. Modifying text.
 - 2. Sequence of Operation review.
 - 3. Selection of displays and reports.
 - 4. Use of the specified functions.
 - 5. Setting and adjusting of occupancy schedules.
 - 6. Troubleshooting of sensors.
 - 7. Owner questions/concerns.
- C. 2 training sessions shall be conducted at project substantial completion, and the others shall be conducted at the Owner's request and in accordance with the Owner's schedule within a period of 6 months after substantial completion of the project.
- D. At 6 months after substantial completion, unused training hours shall be, at the Owner's discretion, used for future training of new personnel or reimbursed to the Owner at the Subcontractor's current hourly service rate.

3.9 MECHANICAL COMMISSIONING

- A. Refer to Specification for requirements and responsibilities of the ATC Contractor.
- B. Prior to the commencement of mechanical commissioning, provide validation of the temperature control system as follows:
 - 1. Completely check out, calibrate, and test connected hardware and software to insure that the system performs in accordance with the approved products and sequences of operations submitted.
 - 2. Witnessed validation demonstration shall consist of:
 - a. Display and demonstrate each type of data entry to show site specific customizing capability.
 - b. Execute digital and analog commands.
 - c. Demonstrate DDC loop precision and stability via trend logs of inputs and outputs.
 - d. Demonstrate energy management performance via trend logs and command trace.
- C. To facilitate the commissioning process, provide the ability for the Commissioning Agent to, through the graphics screens, modify the outside air temperature analog input signal to the system. The intent is to allow the Commissioning Agent to adjust the outside air temperature so that the systems can be tested during their various modes of operation (for example, dehumidification, humidification, heating, cooling.)
- D. Provide support for the Commissioning Agent as required to facilitate the commissioning process. This shall include a minimum of 2 four-hour training sessions on the use of the system's graphics and associated software. The intent is to train the Commissioning Agent so that he can perform simple commands such as adjusting room temperature setpoints for commissioning of reheat coils, fin tube radiation, cabinet unit heaters, unit heaters and VAV boxes. This will allow the Commissioning Agent to perform a majority of his work without

assistance. For more complicated systems such as building pressure control, control of outdoor air dampers based on CO₂ levels, control of variable frequency drives and air handling unit damper response, provide assistance as required by the Commissioning Agent during the commissioning process.

PART 4 - SEQUENCE OF OPERATION

4.1 GENERAL

- A. Setpoints shall be adjustable by the building operator through the graphic interface on the operator's workstation desktop PC, and through a portable laptop computer plugged into the system at locations throughout the building.
- B. Provide the ability for the Commissioning Agent and the Testing and Balancing Agent to connect to the system and change setpoints, to temporarily override setpoints, and to override modes of operation, as may be required for their work.

4.2 ALARMS

- A. In addition to alarms specified in the following sequences, provide alarms as follows. Program alarms selected by the Owner to initiate a signal to the Owner's off-site building security company, and to designated agents such as company employees.
 - 1. Room low temperature alarm.
 - 2. Room high temperature alarm.
 - 3. Boiler failure alarm.
 - 4. Pump failure alarm (both pumps in lead-lag situations).

4.3 OCCUPIED/UNOCCUPIED MODE

- A. Provide as a minimum the following zones of occupied/unoccupied control, each with its own time-of-day and calendar sequences:
 - 1. Areas served by AHU-1 and AHU-2 and associated exhaust fans in toilet areas.
- B. When occupied/unoccupied override buttons on space sensors are pressed, the mode for that space and associated toilet rooms shall change to occupied mode for 2 hours (adjustable). System shall maintain a log of where and when the buttons are pressed during unoccupied times, but shall not log if button is pressed during occupied time.
- C. Operator Station Display: At a minimum, indicate the following on operator workstation display terminal:
 - 1. Identification of room where button was pressed.
 - 2. Identification of systems in override status.
 - 3. Override time remaining.

4.4 HEATING/COOLING MODE

- A. Heating Mode:
 - 1. Heating mode is automatically enabled when outside air temperature drops below setpoint (60°F, adjustable) or when there is a call for heating from any 2 (quantity adjustable) zones or more, or from the low-temperature alarm in any space. Heating

- mode is automatically disabled when the outside air temperature rises above setpoint.
 - 2. Heating control valves are powered from dedicated circuits. When the hot water pumps are disabled, control power to the valves is de-energized, allowing the valves to go to failsafe position. This is to prolong actuator life by turning them off in warm weather.
- B. Cooling Mode:
- 1. Cooling system is automatically enabled when outside air temperature rises above setpoint (10°F, adjustable) or when there is a call for cooling from the room sensor or the high-temperature alarm in any space. Cooling mode is automatically disabled when the outside air temperature drops below setpoint, if no space is calling for mechanical cooling.
 - 2. Cooling mode is enabled by the DDC system when there is a call for mechanical cooling. Economizer cooling is the first stage of cooling. For systems which have economizer cooling, mechanical cooling is locked out when outside air temperature is below 45°F (adjustable).
- C. Deadband (Zero-Energy Mode): In spaces and systems with both heating and cooling setpoints, there shall be a difference of at least 4°F between temperature setpoints, unless otherwise specified. When the sensed temperature or humidity is between the heating and cooling setpoints, the system shall operate with no heating hot water or cooling except as required to maintain the status quo.
- D. Provide manual override points on the graphics screen to allow the Owner to override the automatic heating and cooling modes.

4.5 HEATING SUPPLY WATER TEMPERATURE CONTROL

- A. Gas-fired hot water boilers are operated independently of any other system controls.
- 1. Boiler B-1:
 - a. The boiler is enabled on based on system demand.
 - b. When a boiler is energized, its gas burner fires (fully modulating) to maintain setpoint (140°F, adjustable).
 - c. When a boiler is energized and its temperature is within 15°F of setpoint, its return control valve opens.
 - d.
 - 2. The ATC monitors boiler safeties including low water cutoff and flame failure.
- B. Loop Temperature Control:
- 1. When a boiler is energized and its temperature is within 15°F of setpoint, its injection pump (BP-1) is enabled.
 - 2. The heating water supply setpoint is reset based on outdoor air temperature, in a supply temperature range of 120 to 140°F over an outdoor range of 0 to 55°F.
- C. The following points and associated control wiring are provided under this Section. Coordinate with boiler controller manufacturer. Provide control wiring required for interface between automatic temperature control system and boiler controllers. Coordinate control signal with boiler controller manufacturer.
- 1. Analog input to receive signal from lead/lag controller for calculated system target temperature. Use this signal for control of lead boiler burner.
 - 2. Analog input to receive signal from lead/lag controller for boiler temperature (each boiler).

3. Digital input to receive signal from lead/lag controller for burner command status (on/off).
 4. Digital input to receive signal from lead/lag controller for burner status (on/off /alarm).
 5. Digital input to receive signal from lead/lag controller for lag boiler status.
 6. Digital output to lead/lag controller to enable/disable boiler system.
- D. Operator Station Display: At a minimum, indicate the following on operator workstation display terminal:
1. Boilers:
 - a. Boiler command enable status.
 - b. Boiler burner call for heating.
 - c. Water temperature in each boiler (immersion sensor in the boiler adjacent to boiler's control aquastat).
 - d. Outdoor temperature.
 - e. Reset function setpoints.
 2. Building load side of system:
 - a. Hot water supply manifold temperature.
 - b. Hot water return manifold temperature.
 - c. Hot water return temperature to boilers.
 - d. VFD reference command speed.
 - e. VFD actual speed.
 - f. VFD alarms.
 - g. Room temperature.
 - h. Room cooling exhaust fan command.
 - i. Room cooling exhaust fan status.

4.6 HOT WATER CIRCULATING PUMPS (P-1)

- A. Pumps are started and stopped through the DDC system. The lead pump runs continuously in heating mode.
- B. The variable frequency drive modulates pump speed to maintain system differential pressures.
1. Provide differential pressure sensors at remote locations at least 3/4 of the total system distance from the pumps, and where indicated, including one set for each phased area as required.
 2. Differential pressure setpoints are determined by the Testing and Balancing (TAB) Agent and are the value at which design water flow is achieved at each sensor.
 3. The system has the capability to operate on a single sensor selected by the operator. It is also able to operate on 2 or more sensors selected by the operator, responding to the sensor which has the greatest deviation from setpoint.
 4. When the differential pressure sensor(s) call for increased pressure, the variable frequency drive for the lead pump modulates the pump motor speed from minimum to maximum to maintain the differential pressure setpoint.
 5. The ATC system monitors VFD status, and other data. If a VFD indicates trouble, an alarm is generated. If the lead-pump VFD indicates trouble, the lead pump and its VFD are locked out and the lag pump is energized.
- C. Differential pressure sensors at each pump monitor pump operation and generate an alarm if differential pressure falls below minimum set point, with time delay on start-up and lead pump

switch-over.

- D. Operator Station Display: At a minimum, indicate the following on operator workstation display terminal:

1. Circulating Pumps P-1:
 - a. Heating system and pump demand on/off.
 - b. pump selection status.
 - c. pump manual selection.
 - d. Pump status by differential pressure.
 - e. pump trouble (alarm).
 - f. pump failure (critical alarm).
 - g. Pump run time in hours.
 - h. VFD reference speed.
 - i. VFD actual speed output.
 - j. VFD power/amps.
 - k. VFD trouble alarm.
 - l. Alarm silencing.
2. Building piping loop:
 - a. Differential pressure setpoint at each remote sensor.
 - b. Differential pressure reading at each remote sensor.
 - c. Selection of one or more remote DP sensors to control pump speed.

4.7 AIR HANDLING UNIT

- A. The unit is DDC controlled using electric actuation.
- B. The air handling unit is scheduled for automatic operation on a time of day basis for Occupied and Unoccupied modes.
1. Within the Occupied mode, the system can enter:
 - a. Warm-Up mode:
 - 1) When zone space temperature is below set point.
 - 2) The system stays in the Warm-Up mode until the mode set point is satisfied.
 - b. Cool-Down mode:
 - 1) When zone space temperature is above set point.
 - 2) The system stays in the Cool-Down mode until the mode set point is satisfied.
 2. Within the Unoccupied mode, Night Heating is available when the space temperature drops below space unoccupied heating set point (3 degrees adjustable below radiant floor heat setpoint). The latest start time is the scheduled occupancy for the space.
- C. The air handling unit operates in Warm-Up, Cool-Down, Occupied, Unoccupied, Night Heating, Cooking (AHU-2 only) and Safety modes as follows (suggested set points and settings are Owner-adjustable)
1. Optimum Start
 - a. The warm-up mode begins at a time calculated by the DDC system based on trends of outdoor temperature, time required to warm up/cool down, and current outdoor temperature.
 2. Warm-Up Mode
 - a. The supply and return fans start. The return air mixed air dampers are positioned for 100 percent return air. The heating coil valve opens 100 percent and remains

open until the return air temperature reaches 70°F. If time reaches the latest start time during the Warm-up mode, the outdoor air damper opens to the minimum position. The system is prevented from entering the Warm-up mode more than once per day.

3. Cool-Down Mode
 - a. The supply and return fans start. The return and mixed air dampers are positioned for 100 percent return air. The associated condensing unit operates at 100 percent and until return air temperature reaches 74°F. If time reaches the latest start time during the Cool-Down mode, the outdoor air damper opens to its minimum position. The system is prevented from entering the Cool-Down mode more than once per day.
4. Occupied Mode
 - a. The fans start or continue to run. Position return air damper and the mixed air damper open and the relief damper and the outdoor air damper open to minimum position (225 cfm for AHU-1 & 300 cfm for AHU-2). The heating valve and condensing unit modulate to maintain space set point.
 - b. As the first stage of cooling, when outside air enthalpy is lower than return-air enthalpy, the differential-enthalpy economizer modulates the economizer outside air damper and the return damper for up to 100 percent outside air. The maximum amount of outside air and damper position are set in cooperation with the ARU manufacturer's representative and the TAB Agent; it may be beneficial to limit this to less than 100 percent to encourage rotation of the room air, and/or to help control room pressurization.
 - c. As the second stage of cooling, the condensing unit modulates to maintain setpoint.
 - d. Both economizer and mechanical cooling can operate simultaneously.
5. Unoccupied Mode (Normal Off)
 - a. The supply and return fans stop. The outside air and relief dampers close and the heating coil valve opens to 10 percent (Owner-adjustable) if outside air temperature is below 45°F. Heating coil valve shall close if outside air temperature is above 45°F.
6. Night Heating
 - a. The air handling unit shall operate when the space set point falls 5 degrees F below night setback temperature. If this should occur, the supply and return fans start with the heating coil valve modulating to maintain an 85°F discharge air temperature. The air handling unit shall remain on until the zone is satisfied. The outside air and relief dampers remain closed.
7. Cooking (AHU-2 only)
 - a. The air handling unit shall operate in cooking mode when the range hood is in use. The air handling unit runs in occupied mode except for the outdoor damper opens to 500 cfm. The damper remains in this position until the range hood turns off.
8. Night Cooling: cooling is de-energized during the unoccupied mode.

D. Supply and Return Fan Control

1. The supply fan variable frequency drive shall modulate the supply fan between minimum and maximum air flow.
2. The return fan variable frequency drive shall modulate the return fan to maintain an air flow, equal to 90 percent of the total supply air flow minus any exhaust in the associated AHU system. Return fan air flow shall be determined by the TAB Agent.
3. Upon initial startup of the air handling unit, the supply and return fans slowly ramp to the

desired static pressure set point. Upon shutdown of the air handling unit, the supply and return fans slowly stop and the speed reset signal goes to zero speed.

- E. Filter Pressure Drop Monitoring: A filter pressure switch monitors the pressure drop across the filters, with separate switches for prefilters and final filters, and generates a service message specific to each switch when the pressure drop exceeds setpoint. Setpoints shall be at the filter manufacturer's midrange of serviceable pressure drop, not at the maximum allowable drop.
- F. Safeties
 - 1. High limit static pressure sensor (set at 1 inch wc static pressure higher than scheduled external static pressure) in both supply and return mains shall de-energize the supply and return fans upon activation and shall activate an alarm.
 - 2. An automatic reset, capillary tube type freezestat is installed downstream of the heating coil. This freezestat is set to trip at a temperature which is 5 degrees F higher than the manual reset freezestat located downstream of the heating coil. When this freezestat is tripped, the air dampers are placed in 100% recirculation air mode for a period of 15 minutes (Owner-adjustable). After 15 minutes have elapsed, the outside/ mixed air dampers are allowed to modulate open to normal control.
 - 3. Air flow switches are installed in the ductwork for each supply and return fan. The DDC system uses the switches to confirm the fans are in the desired state (on or off) and generates an environmental alarm if status deviates from DDC start/stop control.

4.8 AIR HANDLER OPERATOR STATION DISPLAY:

- A. Application: AHU.
- B. At a minimum, indicate the following on operator workstation display terminal:
 - 1. Supply and return fan status.
 - 2. Supply and return fan air flow.
 - 3. Supply and return fan VFD status.
 - 4. Supply duct static pressure.
 - 5. Supply duct static pressure set point.
 - 6. High limit supply and return static status.
 - 7. 2 position outdoor air and exhaust air damper status.
 - 8. Modulating return, exhaust, and mixing air damper status.
 - 9. Supply and return smoke detector status.
 - 10. Outdoor, return, mixed, and supply air temperature.
 - 11. Supply air set point temperature.
 - 12. Heating valve position.
 - 13. Condensing unit status.
 - 14. Automatic and manual freeze stat status.
 - 15. VFD speed command.
 - 16. VFD actual speed.
 - 17. Hot water coil pump command.
 - 18. Hot water coil pump proof (differential pressure sensor).
 - 19. Occupied override status.
 - 20. Warm up status.
 - 21. Cool down status.
 - 22. Alarms.

4.9 CABINET UNIT HEATERS (CUH)

1. Space sensor: Wall-mounted, except where sensor is indicated on the Drawings to be mounted in unit return air. Blank cover, without setpoint dial or thermometer.
2. Setpoint: Provide occupied/unoccupied control. Initial setpoints (adjustable):
3. Cabinet Unit Heaters in spaces with exterior doors (most Stairs and , Entries, and Vestibules): 65°F occupied/55°F unoccupied.
4. Cabinet Unit Heaters in Vestibules:
5. 60°F occupied/50°F unoccupied.
6. Heating in Vestibules shall be disabled when outside air temperature rises above 55 deg F.
7. Cabinet Unit Heaters in spaces without exterior doors: 68°F occupied/60°F unoccupied.
8. Fan cycles on demand from space sensor. 2-way or 3-way (as indicated) control valve opens on demand from space sensor, and strap-on return aquastat cycles the fan. Provide strap-on aquastat (location: on return piping unless otherwise detailed) set at 100°F (adjustable) to prevent fan operation when hot water is not available.
9. Mount strap-on aquastat in orientation to be most readily visible from the floor. Insulate over the sensor bulb.
10. Operator Station Display: At a minimum, indicate the following on operator workstation display terminal:
11. Space temperature.
12. Unit on/off command.

4.10 DUCTLESS SPLIT SYSTEMS AND MINI-SPLIT SYSTEMS

- A. Space sensor: Wall-mounted, blank cover, without setpoint dial or thermometer.
- B. The factory-furnished hard-wired wall-mounted controller cycles the indoor fan on a call for cooling (setpoint 75°F, adjustable). The rooftop condensing unit compressor and its condenser fan cycle as required. The Mechanical Subcontractor is responsible for controller setup and programming.
- C. The wall-mounted sensor monitors space temperature.
- D. Operator Station Display: At a minimum, indicate the following on operator workstation display terminal:
 1. Space temperature.

4.11 EXHAUST FANS

- A. Space sensor: Wall-mounted, blank cover, without setpoint dial or thermometer.
- B. Fan status is monitored by current sensors.
- C. When a fan associated with an AHU is placed in the occupied mode of operation, the fan's motorized damper opens. The fan is commanded on upon closure of the damper auxiliary switch. When the air handler is in the unoccupied mode, the fan is commanded off and its respective motorized damper closes. Configure controls to allow control and override of these fans through the operator workstation graphics.
- D. General Exhaust Fans: General exhaust is on a time-of-day function. The motorized damper opens; when the damper auxiliary switch closes, the fan starts.

- E. Electrical Rooms, Boiler Room, and Chiller Room Cooling: As space temperature increases above setpoint (80°F, adjustable), the fan's motorized damper opens, and associated intake louver or hood dampers (if any) open. When the fan damper auxiliary switch closes, the fan starts. When space set point temperature is satisfied, the fan is commanded off and the dampers close.
- F. Operator Station Display: At a minimum, indicate the following on operator workstation display terminal:
 - 1. Exhaust fan on/off command.
 - 2. Exhaust fan airflow status.
 - 3. Damper auxiliary switch open/closed.
 - 4. Fan alarm status.
 - 5. Space temperature where required.
 - 6. Space set point where required.
 - 7. Leak detection warning and critical alarm status, and reset points.

4.12 RADIANT FLOOR

- A. Space sensor: Wall-mounted, blank cover, without setpoint dial or thermometer.
- B. Slab sensor: Remote sensing element embedded in the floor slab, ruggedized type, centered between rows of tubing, 6 to 12 feet from outside wall.
- C. When the building is in heating mode and the main hot water pumps are enabled, the radiant floor circulator pump is energized. When heating mode is disabled, the circulator is de-energized.
- D. When the slab or room temperature falls below setpoint (slab 80°F, room 70°F, adjustable) the 3-way mixing valve modulates to maintain the supply temperature, according to the following schedule (adjustable):

Outside Air Temp	Supply Temp
0 degrees F	100 degrees F
40 degrees F	80 degrees F
- E. When the slab and room temperature are satisfied, the 3-way valve modulates to maintain a neutral supply temperature (initial set point 70°F).
- F. Operator Station Display: At a minimum, indicate the following on operator workstation display terminal:
 - 1. Circulating pump enable.
 - 2. Radiant panel valve open/close command.
 - 3. Space temperature setpoint.
 - 4. Slab temperature setpoint.
 - 5. Space temperature.
 - 6. Slab temperature.
 - 7. Outdoor temperature.
 - 8. Occupied/unoccupied status.
- G. At Contractor's option, a dedicated controller and room, slab and outdoor sensors by Tekmar (no substitutions) may be used to control the radiant floor. This controller shall include an LCD display of setpoints, temperatures, and functions.

4.13 UNIT HEATERS (UH)

- A. Space sensor: Wall-mounted, except where sensor is indicated on the Drawings to be mounted on unit at return air inlet. Setpoint dial with limited range, no thermometer.
- B. Setpoint: Provide occupied/unoccupied control. Initial setpoints (adjustable):
 - 1. Unit heaters in mechanical rooms and other unoccupied spaces: 60°F occupied/55°F unoccupied.
 - 2. Unit heaters in potentially occupied spaces such as Tool Room storage rooms: 68°F occupied/60°F unoccupied.
- C. 2-position 2-way control valve cycles on demand from space sensor.
- D. Fan cycles on demand from space sensor. Provide strap-on aquastat (location: on return piping unless otherwise detailed) set at 100°F (adjustable) to prevent fan operation when hot water is not available.
- E. Mount strap-on aquastat in orientation to be most readily visible from the floor. Insulate over the sensor bulb.
- F. Operator Station Display: At a minimum, indicate the following on operator workstation display terminal:
 - 1. Space temperature.
 - 2. Unit on/off command.

4.14 FIRE ALARM SYSTEM SHUT-DOWN INTERFACE

- A. For starters that are associated with equipment that is required to be shut down upon a fire alarm condition, provide input contacts within the starter enclosure to interface with the building(s) fire alarm system. Upon receipt of a signal from the building(s) fire alarm system, power to load side of the starter is turned off. Circuitry is provided to ensure that power is off whether the starter is in the "AUTO", "HAND" or "BYPASS" mode. If this feature is not available from the starter manufacturer, provide a contactor on the line side of the starter to accomplish the same function. The contactor shall meet the requirements of Division 26.
- B. Every fan or air-moving system serving ducts which have fire dampers or fire/smoke dampers shall shut down upon a fire alarm condition.

4.15 RE-START PHASING AFTER POWER INTERRUPTION

- A. Upon a power interruption, a loss of power, or at morning start-up, equipment of electrical power greater than or equal to 1.0 HP is started in a staged manner which allows a time delay of 30 seconds between the start of each device.

END OF SECTION 230900

SECTION 232113 – HYDRONIC PIPING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Pipe and Pipe Fittings For:
 - 1. Heating water piping system.
 - 2. Equipment drains and overflows.

1.2 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

- A. Access Doors.

1.3 RELATED SECTIONS

- A. Division 08 Section “Access Doors and Frames.”
- B. Division 09 Section “Painting.”
- C. Division 23 Section “Sleeves and Escutcheons for HVAC Piping.”
- D. Division 23 Section “Hangers and Supports for HVAC Piping and Equipment.”
- E. Division 23 Section “Identification for HVAC Piping and Equipment.”
- F. Division 23 Section “Vibration and Seismic Controls for HVAC Piping and Equipment.”
- G. Division 23 Section “HVAC Piping Insulation.”
- H. Division 23 Section “Radiant-Heating Hydronic Piping.”
- I. Division 23 Section “Hydronic Specialties.”
- J. Division 23 Section “HVAC Water Treatment”: Pipe cleaning.

1.4 REFERENCES

- A. ASME - Boiler and Pressure Vessel Codes, SEC 9 - Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators.
- B. ASME B16.3 - Malleable Iron Threaded Fittings Class 50 and 300.
- C. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings.
- D. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
- E. ASME B31.5 - Refrigeration Piping.
- F. ASME B31.9 - Building Services Piping.

- G. ASME B36.10M - Welded and Seamless Wrought Steel Pipe.
- H. ASTM A53 - Pipe, Steel, Black and Hot-Dipped, Zinc Coated Welded and Seamless.
- I. ASTM A234 - Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures.
- J. ASTM A240 - Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.
- K. ASTM A312 - Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes.
- L. ASTM A403 - Standard Specification for Wrought Austenitic Stainless Steel Piping Fittings.
- M. ASTM B32 - Solder Metal.
- N. ASTM B88 - Seamless Copper Water Tube.
- O. ASTM D256 - Standard Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics.
- P. ASTM D1785 - Poly(Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.
- Q. ASTM D2235 - Solvent Cement for Acrylonitrile-Butadiene-Styrene (ABS) Plastic Pipe and Fittings.
- R. ASTM D2241 - Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR-Series).
- S. ASTM D2310 - Machine-Made Reinforced Thermosetting Resin Pipe.
- T. ASTM D2466 - Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40.
- U. ASTM D2467 - Socket-Type Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 80.
- V. ASTM D2680 - Acrylonitrile-Butadiene-Styrene (ABS) and Poly (Vinyl Chloride) (PVC) Composite-Sewer Piping.
- W. ASTM D2683 - Socket-Type Polyethylene Fittings for Outside Diameter-Controlled Polyethylene Pipe and Tubing.
- X. ASTM D2751 - Acrylonitrile-Butadiene-Styrene (ABS) Sewer Pipe and Fittings.
- Y. ASTM D2855 - Making Solvent-Cemented Joints with Poly (Vinyl Chloride) (PVC) Pipe and Fittings.
- Z. ASTM D3309 - Polybutylene (PB) Plastic Hot-and Cold-Water Distribution Systems.
- AA. ASTM D3965 - Standard Classification System and Basis for Specifications for Rigid Acrylonitrile-Butadiene-Styrene (ABS) Materials for Pipe and Fittings.
- BB. ASTM F441 - Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic

Pipe, Schedules 40 and 80.

- CC. ASTM F477 - Elastomeric Seals (Gaskets) for Joining Plastic Pipe.
- DD. ASTM F708 - Design and Installation of Rigid Pipe Hangers.
- EE. ASTM F2389 - Standard Specification for Pressure-rated Polypropylene (PP) Piping Systems
- FF. ASTM F845 - Plastic Insert Fittings for Polybutylene (PB) Tubing.
- GG. ASTM F876 - Crosslinked Polyethylene (PEX) Tubing.
- HH. ASTM F877 - Crosslinked Polyethylene (PEX) Plastic Hot - and Cold - Water Distribution Systems.
- II. AWS A5.8 - Brazing Filler Metal.
- JJ. AWS D1.1 - Structural Welding Code.
- KK. AWWA C105 - Polyethylene Encasement for Ductile Iron Piping for Water and Other Liquids.
- LL. AWWA C110 - Ductile - Iron and Grey -Iron Fittings 3 in. through 48 in. (75 mm through 1200 mm), for Water and Other Liquids.
- MM. AWWA C111 - Rubber-Gasket Joints for Ductile Iron and Grey-Iron Pressure Pipe and Fittings.
- NN. AWWA C151 - Ductile-Iron Pipe, Centrifugally Cast in Metal Molds or Sand-Lined Molds, for Water or Other Liquids.
- OO. CSA B137.11 - Polypropylene (PP-R) Pipe and Fittings for Pressure Applications.
- PP. MSS SP58 - Pipe Hangers and Supports - Materials, Design and Manufacture.
- QQ. MSS SP69 - Pipe Hangers and Supports - Selection and Application.
- RR. MSS SP89 - Pipe Hangers and Supports - Fabrication and Installation Practices.
- SS. NSF/ANSI 14 – Plastic Piping System Components and Related Materials.
- TT. NSF/ANSI 61 - Drinking Water System Components.

1.5 SUBMITTALS

- A. Product Data: Include data on pipe materials, pipe fittings, valves, and accessories. Provide Manufacturers catalogue information. Indicate valve data and ratings.
- B. Welders Certificate: Include welder's certification of compliance with ASME SEC 9 and AWS D1.1.
- C. Manufacturer's Installation Instructions: Indicate hanging and support methods, joining procedures.

1.6 PROJECT RECORD DOCUMENTS

- A. Record actual locations of valves.

1.7 OPERATION AND MAINTENANCE DATA

- A. Maintenance Data: Include installation instructions, spare parts lists, exploded assembly views.

1.8 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the products specified in this Section with minimum 3 years' experience.
- B. Installer: Company specializing in performing the work of this Section with minimum 3 years' experience.
- C. Welders: Certify in accordance with ASME SEC 9 and AWS D1.1.
- D. Pressed Pipe Fittings: Submit documentation of fitting-manufacturer training of installers or their on-site supervisors, with names of individuals.

1.9 REGULATORY REQUIREMENTS

- A. Conform to ASME B31.9 code for installation of piping system.
- B. Welding Materials and Procedures: Conform to ASME SEC 9 and applicable state labor regulations.
- C. Provide certificate of compliance from authority having jurisdiction indicating approval of welders.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect and handle products to site under provisions of Division 01 Section "Product Requirements."
- B. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- C. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.11 ENVIRONMENTAL REQUIREMENTS

- A. Do not install underground piping when bedding is wet or frozen.

PART 2 - PRODUCTS

2.1 HEATING WATER PIPING, ABOVE GROUND

- A. Steel Pipe: ASTM A53, Schedule 40 , black.
 - 1. Fittings: ASTM B16.3, malleable iron or ASTM A234, forged steel welding type fittings.
 - 2. Joints: Schedule 40 threaded for pipe sizes 2 inch (50.8 mm) and smaller, and AWS D1.1, welded for pipe sizes over 2 inch (50.8 mm).
 - 3. Grooved and Shouldered Pipe End Couplings: As specified in this Section, with grooved steel pipe, is an acceptable alternate to the above for water service operating at temperatures from -30 to 230 degrees F (-30 to 110 degrees C), utilizing grade E, EPDM gasket compound.
- B. Copper Tubing: ASTM B88, Type L hard drawn.
 - 1. Allowed only for pipe sizes 2 inch (50.8 mm) and smaller.
 - 2. Fittings: ASME B16.18, cast brass, or ASME B16.22, solder wrought copper.
 - 3. Joints: Solder or braze, or press fittings.

2.2 RADIANT HEATING PIPING

- A. Composite Polyethylene Pipe: Aluminum tube laminated between two layers of high density cross-linked polyethylene, 100 psig (690 kPa) operating pressure at maximum 180 degrees F (82 degrees C).
 - 1. Fittings: Brass flared compression.
 - 2. Joints: Fittings adapt to copper tubing or copper tube fittings, threaded pipe and fittings, and copper compression fittings.

2.3 EQUIPMENT DRAINS AND OVERFLOWS

- A. Steel Pipe: ASTM A53, Schedule 40 galvanized.
 - 1. Fittings: Galvanized cast iron, or ASTM B16.3 malleable iron.
 - 2. Joints: Threaded, or grooved mechanical couplings.
- B. Copper Tubing: ASTM B88, Type L, hard drawn.
 - 1. Fittings: ASME B16.18, cast brass, or ASME B16.22 solder wrought copper.
 - 2. Joints: Solder or braze, or press fittings.

2.4 BRAZING MATERIALS – 15 percent Silver for copper, brass, and bronze

- A. Manufacturers:
 - 1. Harris (Product: Stay-Silv 15).
 - 2. Lucas-Milhaupt (Product: Sil-Fos 15).
 - 3. Wolverine (Product: Silvaloy 15).
 - 4. Substitutions: Not permitted.
- B. Nominal Composition: 5.0 percent phosphorus, 15.0 percent silver, 0.15 percent other elements (total), remainder copper. Cadmium-free.
- C. Physical Properties:
 - 1. Color: Yellow/Gray

2. Solidus: 1190 degrees F (643 degrees C)
3. Liquidus: 1480 degrees F (802 degrees C)
4. Brazing Range: 1300 – 1500 degrees F (704-816 degrees C)
5. Electrical Conductivity: 9.9 percent IACS
6. Electrical Resistivity: 17.40 Microhm-cm

D. Specification Compliance:

1. ANSI/AWS A5.8, class BCuP-5
2. ASME SFA5.8, class BCuP-5
3. Optional:
 - a. QQB 650C, class BCuP-5
 - b. QQB 654A, class BCuP-5
 - c. QQB 654, class BCuP-5

E. Flux:

1. Harris (Stay-Silv For copper-to-brass joints. No flux required for copper-to-copper joints).

2.5 BRAZING MATERIALS – 35 percent Silver for brazing to ferrous metals (steel)

A. Manufacturers:

1. Harris (Product: Safety-Silv 35).
2. Lucas-Milhaupt (Product: Braze 351).
3. Wolverine (Product: Silvaloy A-35).
4. Substitutions: Not permitted.

B. Nominal Composition: 35.0 percent silver, 33 percent Zinc, 0.15 percent other elements (total), remainder copper. Cadmium-free.

C. Physical Properties:

1. Color: Yellow/Gray
2. Solidus: 1250 degrees F (677 degrees C)
3. Liquidus: 1410 degrees F (732 degrees C)
4. Electrical Conductivity: 19.8 percent IACS
5. Electrical Resistivity: 8.2 Microhm-cm

D. Specification Compliance:

1. ANSI/AWS A5.8, class BAg-5
2. ASME SFA5.8, class BCuP-5

E. Flux:

1. Harris (Stay-Silv white flux, or where heating cycles are extended, Stay-Silv black flux).

2.6 SOLDER MATERIALS:

A. Manufacturers:

1. Harris (Product: Stay-Brite).
2. Lucas-Milhaupt (Product: Clean 'n Brite).
3. Wolverine (Product: Silvabrite).
4. Substitutions: Not permitted.

- B. Nominal Composition: Alloy of silver and tin (3-6 percent Ag, remainder Sn). Antimony-free.
- C. Physical Properties:
1. Color: Bright Silver
 2. Solidus: 430 degrees F (221 degrees C)
 3. Liquidus: 430 degrees F (221 degrees C)
 4. Electrical Conductivity: 16.4 percent IACS
 5. Shear Strength: 10,600 psi (73 MPa)
 6. Tensile Strength: 14,000 psi (96 MPa)
 7. Elongation: 48 percent
- D. Specification Compliance:
1. NSF 51
 2. ASTM B32-89, Alloy Grade Sn96
 3. Federal Spec. QQ-S-571E, Class Sn 96 with exception to QPL paragraph 3.1
 4. J-STD-006, Sn96Ag04A
- E. Flux:
1. Harris (Product: Stay Clean Paste Flux, Stay Clean Liquid Flux (used with 4 inch or larger copper tubing also stainless steels), or Bridgit Water Soluble Paste Flux).
 2. Canfield (Product: Aqua-Brite or AB Cream Flux). Glycerin-based, water soluble.

2.7 UNIONS, FLANGES, AND COUPLINGS

- A. Unions for Pipe 2 inch (50 mm) and Under:
1. Ferrous Piping: 150 psig (1034 kPa) malleable iron, threaded.
 2. Copper Pipe: Bronze, soldered joints.
- B. Flanges for Pipe Over 2 Inch (50 mm):
1. Ferrous Piping: 150 psig (1034 kPa) forged steel, slip-on.
 2. Copper Piping: Bronze.
- C. Grooved and Shouldered Pipe End Couplings:
1. Approved Manufacturers:
 - a. Victaulic Company.
 - b. Anvil International (division of Mueller Water Products, Inc.) - Gruvlok product line.
 - c. Grinnell Mechanical Products (division of Tyco Fire Suppression & Building Products Co.).
 - d. Substitutions: Not permitted.
 2. Products:
 - a. Housing Clamps: Malleable iron to engage and lock, designed to permit some angular deflection, contraction, and expansion.
 - b. Sealing Gasket: C-shape EPDM elastomer composition for operating temperature range from -30 degrees F (-34 degrees C) to 230 degrees F (110 degrees C). This is the standard gasket material suitable for water and glycol service. For other services, verify material.
 - c. Accessories: Steel bolts, nuts, and washers with zinc plating.
 3. Note: Grooved couplings are not allowed where concealed above hard ceilings.
- D. Dielectric Connections: Union with galvanized or plated steel threaded end, copper solder end,

water impervious isolation barrier.

2.8 PRESS FITTINGS

- A. Approved Manufacturers:
 - 1. Viega LLC, Wichita, KS - ProPress System with Smart Connect feature.
 - 2. Grinnell, division of Tyco International – G-Press System with leak-before-press feature.
 - 3. Substitutions: Not permitted.
- B. Fitting and Valve Products:
 - 1. Wrought copper and cast copper alloy (brass or bronze) fittings and valves for copper piping.
 - 2. Adapter fittings for transition connections to threaded fittings and dissimilar materials.
 - 3. Available sizes: 1/2 inch to 4 inch (12.7 mm to 101 mm).
- C. Features:
 - 1. Seals: O-ring type, factory installed in a fitting bead. Seals in larger sizes shall include a separator ring and a stainless steel grip ring.
 - 2. Seal Materials: EPDM (color shiny black) in copper for hydronic and drain systems.
 - 3. Colored Identification Dots:
 - a. Copper Fittings:
 - 1) Green for EPDM seal.
 - 4. Smart Connect feature provides a leakage path to allow water and air to leak past any unpressed connection, for quick identification during pressure testing.
- D. Temperature/Pressure ratings (with appropriate type seals):
 - 1. Hydronic Systems: 0 to 250 degrees F (-17 to 121 degrees C) up to 200 psig (1723 kPa), at up to 100 percent maximum concentration of ethylene or propylene glycol.
- E. Accessories:
 - 1. Pressing: Use pressing tools, actuator jaws, and pressing rings, Ridgid brand manufactured by Ridge Tool Company, as recommended by the fitting manufacturer for each type of fitting.
 - 2. Lubricants: Do not use. Not recommended by fitting manufacturer.
 - 3. Cutting Tools: For copper or stainless steel pipe, use wheeled cutting tool, or cutting tool approved by the fitting manufacturer. Use deburring tool or reamer after cutting.

2.9 PIPE HANGERS AND SUPPORTS

- A. See Division 23 Section “Hangers and Supports for HVAC Piping and Equipment.”

2.10 SLEEVES

- A. See Division 23 Section “Sleeves and Escutcheons for HVAC Piping.”

PART 3 - EXECUTION

3.1 PREPARATION

- A. Ream pipe and tube ends. Remove burrs.

- B. Remove scale and dirt on inside and outside before assembly.
- C. Prepare piping connections to equipment with flanges or unions.
- D. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.
- E. After completion, fill, clean, and treat systems. Refer to Division 23 Section "HVAC Water Treatment."

3.2 INSTALLATION

- A. Install in accordance with Manufacturer's instructions.
- B. Install components furnished under other Section and Divisions of the Specifications. Such items may include but are not limited to: Sensors furnished under Division 23 Section "Instrumentation and Control for Mechanical Systems."
- C. Install heating water piping to ASME B31.9. Install chilled water piping to ASME B31.5.
- D. Pipe used shall be new material, and threads on piping shall be full length and clean cut with inside edges reamed smooth to full inside bore.
- E. Minimum pipe size allowed for hydronic piping shall be 3/4 inch (19 mm). Piping less than 3/4 inch (19 mm) shall not be allowed for these piping systems.
- F. Route piping in orderly manner, parallel to building structure, and maintain gradient.
- G. Install piping to conserve building space, and not interfere with use of space.
- H. Group piping whenever practical at common elevations.
- I. Erect piping to provide for the easy passage and noiseless circulation of water under working conditions.
- J. Slope piping and arrange systems to drain at low points. Use eccentric reducers to maintain top of pipe level. Slope water piping 1 inch in 40 feet (1:480) and arrange to drain at low points. Slope piping up in direction of water flow.
- K. On closed systems, equip low points with 3/4 inch (19 mm) drain valves and hose nipples. Provide, at high points of mains, collecting chambers and high capacity float operated automatic air vents, with ball valves on their inlets to valve off after initial system startup. Provide, at high points of branches, manual air vents with air chambers.
- L. Use main sized saddle type branch connections for directly connecting branch lines to mains in steel piping if main is at least 1 pipe size larger than the branch for up to 6 inch (152 mm) mains and if main is at least 2 pipe sizes larger than branch for 8 inch (203 mm) and larger mains. Do not project branch pipes inside the main pipe.
- M. Caulking of threads will not be allowed on any piping.

- N. Pipe joint compound shall be put on male threads only.
- O. Where more than one piping system material is specified, ensure system components are compatible and joined to ensure the integrity of the system is not jeopardized. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.
- P. Dissimilar Metals: Use non-conducting dielectric connections whenever joining dissimilar metals. Cast red-brass (not yellow brass) or bronze-bodied fittings such as valves and couplings may be used when joining steel to copper, steel to stainless steel, or copper to stainless steel. Steel and stainless steel may connect directly to iron, but copper may not connect directly to iron.
- Q. Where welded joints are required, steel piping shall be installed by the use of the oxyacetylene or electric welding process, except immediate connections to accessible equipment may be threaded. Piping shall have butt welds with welding fittings, standard factory fabricated tees, elbows, reducers, caps, and accessories. Branch outlets 2 inch (50.8 mm) and smaller shall be made by the use of approved welding type half-couplings, "Weldolet" or "Threadolet" fittings.
1. Piping smaller than 2 inch (50.8 mm) may be installed at the Contractor's option with welding type, or threaded type fittings, except that piping regardless of size concealed in trenches or inaccessible building construction (for example, concealed behind sheetrock walls or concealed above sheetrock ceilings) shall be welded.
 2. Offsets shall be installed with long radius welding elbows.
 3. Welding shall be executed only by certified welding mechanics in accordance with the best practice of the trade.
- R. Grooved Mechanical Couplings:
1. Use grooved mechanical couplings and fasteners in accessible locations only. Grooved mechanical couplings are not allowed in areas such as behind gypsum wallboard walls and above gypsum wallboard or wood ceilings.
 2. Install in strict accordance with manufacturer's instructions. Nothing in this Specification is intended to supersede manufacturer's instructions and recommendations.
 3. Prepare pipe ends properly, and check again before coupling installation.
 4. Lubricate gaskets as recommended. Check gasket before installation.
 5. Do not lubricate coupling mating surfaces (bolt pads) or bolt threads, because this might affect torque readings.
 6. Verify that pipe-end separation (all couplings) and deflection from centerline (flexible couplings only) do not exceed manufacturer's specifications. For piping which will operate at a colder temperature than installation temperature (for example, chilled water systems), butt pipes together to provide maximum contraction capability. For piping which will operate at a warmer temperature (for example, heating systems), separate pipe ends the maximum allowed amount to provide maximum expansion capability. Some systems operate at mixed temperatures (for example, cooling tower condenser water systems) and may require different spacing for different sections of the system, and/or a spacing somewhere between minimum and maximum in proportion to the need for expansion and contraction.
 7. NOTE: Tighten nuts evenly by alternating sides until tightened to recommended torque. Make sure the housings' keys completely engage the grooves. Make sure the offsets are equal at the bolt pads, during tightening and when fully tightened. NOTE: It is important to tighten nuts evenly to prevent gasket pinching.
 - a. Victaulic Couplings: On rigid couplings with angled bolt pads, pads will be offset

- when tightened. On flexible couplings, bolt pads will be in contact and aligned when tightened.
 - b. Anvil and Grinnell Couplings: On rigid couplings, bolt pads will have up to 1/16-inch (1.59 mm) gap when tightened. On flexible couplings, bolt pads will be in contact when tightened.
- 8. If an impact wrench or other power tool is used to tighten, use extra care. NOTE: Anvil International does not recommend use of impact wrenches with their Gruvlok products.
- 9. For couplings with manufacturer torque specifications, verify torque on each bolt. Do not exceed torque specification by more than 25 percent.
- S. Sleeve pipe passing through partitions, walls and floors:
 - 1. See Division 23 Section "Sleeves and Escutcheons for HVAC Piping."
 - 2. Set sleeves in position in advance of concrete work. Provide suitable reinforcing around sleeves.
 - 3. Extend sleeves through floors as follows: In locations not otherwise indicated, 2 in. (50 mm) above finished floor level. In normally-dry locations such as finished office spaces under fintube and baseboard radiation, 1 in. (25 mm) above finished floor level. Finished floor level includes the thickness of floor finish materials such as carpet and tile. Caulk sleeves full depth and provide floor plate.
 - 4. Where piping passes through floor, ceiling or wall, close off space between pipe sleeve and construction with non-combustible insulation or with approved firestopping material when penetrating fire rated floors, ceilings or walls. Provide tight fitting metal escutcheons on both ends of sleeves to prevent movement of sleeve during piping expansion. Escutcheons shall be sized slightly larger than outside diameter of piping and smaller than diameter of sleeve. Escutcheons shall be rigidly secured to walls.
 - 5. Where piping passes through fire rated floors, ceilings or walls, close off space between pipe insulation and sleeve with approved firestopping material
 - 6. Install chrome-plated escutcheons where piping passes through finished surfaces.
- T. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings. Refer to Division 23 Section "HVAC Piping Insulation."
- U. In the erection of mains, use special care in the support, working into place without springing or forcing, and proper allowance made for expansion.
- V. Pipes shall be anchored, guided, and otherwise supported, where necessary, to prevent vibration or to control expansion.
- W. Make such offsets as are shown and required to place the pipes and risers in proper position to avoid other work.
- X. Take branch lines off bottom of mains or at 45 degree bottom angle, as space permits.
- Y. Use unions, flanges, and couplings downstream of valves and at equipment or apparatus connections. Do not use direct welded or threaded connections to valves, equipment or other apparatus.
- Z. Install a sufficient number of unions or flanged fittings to facilitate making possible future alterations or repairs.

- AA. Install concealed pipes close to building structure to keep furring to a minimum.
- BB. Provide access where valves and fittings are not exposed.
- CC. Where pipe support members are welded to structural building framing, scrape, brush clean, and apply one coat of zinc rich primer to welds.
- DD. Prepare unfinished pipe, fittings, supports, and accessories, ready for finish painting. Refer to Division 09 Section "Painting."

3.3 CLEANING

- A. After satisfactory completion of pressure tests, before permanently connecting equipment, strainers, and the like, clean equipment thoroughly, blow and flush piping for a sufficient length of time as directed, so that interiors will be free of foreign matter. Perform cleaning in the presence of an authorized representative of the Architect. Provide a minimum of 10 days notification to the Architect prior to system cleaning.
- B. Fill, vent and circulate the system with approved solution in accordance with equipment (boiler, piping, coils, and others) manufacturer's recommendation, allowing it to reach design or operating temperatures. After circulating for 6 hours, drain the system completely and remove and clean strainer screens. Perform cleaning in the presence of an authorized representative of the Architect. Provide a minimum of 10 days notification to the Architect prior to system cleaning.
- C. Fill and vent system as required.
- D. Manually vent heat transfer units and high points of the system.
- E. Adjust the pressure reducing valve to provide minimum of 5 psig (35 kPa) pressure at the highest point of the system.
- F. After system has been completely filled, start zone pumps and circulate cold water for a short time to dislodge small air bubbles, and return them to air extraction device.
- G. Raise water temperature to 200 degrees F (93 degrees C) while operating pumps.
- H. Stop pump and vent radiation and high points of the system. Normal operation may now be started at any time.

3.4 TESTING

- A. No joint or section of piping shall be left untested.
- B. Before testing piping systems, remove, or otherwise protect from damage, control devices, air vents, and other parts which are not designed to stand test pressures.
- C. Test piping for leaks under 100 psig (689 kPa) air pressure with soap suds prior to hydrostatic testing.
- D. Test piping hydrostatically to 1-1/2 times the maximum systems operating pressure, but in no

case to less than 100 psig, for at least 4 consecutive hours, during which time pressure shall remain constant without pumping.

- E. Test and obtain Architect's approval before painting, covering, or concealing piping, including swing joints.

END OF SECTION 232113

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SECTION 232118 – HYDRONIC SPECIALTIES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Valves:
 - 1. Gate valves.
 - 2. Globe or angle valves.
 - 3. Ball valves.
 - 4. Plug valves.
 - 5. Butterfly valves.
 - 6. Check valves.
- B. Expansion tanks.
- C. Air vents.
- D. Air separators.
- E. Centrifugal separators.
- F. Strainers.
- G. Combination fittings.
- H. Flexible hose assemblies.
- I. Flow indicators, controls, meters.
- J. Pressure reducing valves for cold water makeup.
- K. Combination valve assemblies.
- L. Relief valves.

1.2 RELATED SECTIONS

- A. Division 23 Section “Meters and Gauges for HVAC Piping”: Test Ports.
- B. Division 23 Section “Hydronic Piping.”
- C. Division 23 Section “HVAC Water Treatment”: Pipe cleaning, and bypass (pot) feeder.

1.3 REFERENCES

- A. ASME - Boilers and Pressure Vessel Codes, SEC 8-D-Rules for Construction of Pressure Vessels.
- B. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials.

1.4 SUBMITTALS

- A. Product Data: Provide product data for manufactured products and assemblies required for this project. Include component sizes, rough-in requirements, service sizes, and finishes. Include product description, model and dimensions.
- B. Submit inspection certificates for pressure vessels from authority having jurisdiction.
- C. Manufacturer's Installation Instructions: Indicate hanging and support methods, joining procedures.

1.5 PROJECT RECORD DOCUMENTS

- A. Submit under provisions of documents.

1.6 OPERATION AND MAINTENANCE DATA

- A. Submit under provisions of Division 01 Section "Operation and Maintenance Data."
- B. Maintenance Data: Include installation instructions, assembly views, lubrication instructions, and replacement parts list.

1.7 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the Products specified in this Section with minimum 3 years experience.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect and handle products to site.
- B. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- C. Provide temporary protective coating on cast iron and steel valves.
- D. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- E. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.9 MAINTENANCE SERVICE

- A. Furnish service and maintenance of glycol system for 1 year from date of substantial completion.
- B. Monthly visit to make glycol fluid concentration analysis on site with refractive index measurement instrument. Detail findings with maintenance personnel in writing of corrective actions needed including analysis and amounts of glycol or water added.

PART 2 - PRODUCTS

2.1 VALVES

- A. Manufacturers:
 - 1. Nibco.
 - 2. Anvil International - Gruvlok product line.
 - 3. Apollo.
 - 4. Armstrong.
 - 5. Crane.
 - 6. Hammond.
 - 7. Milwaukee.
 - 8. Victaulic Company.
 - 9. Watts.
 - 10. Wheatley.
 - 11. Substitutions: Not permitted.
- B. Globe or Angle Valves:
 - 1. Up To and Including 2 inch (50 mm):
 - a. Bronze body, bronze trim, screwed or union bonnet, rising stem and handwheel, inside screw, renewable composition disc and bronze seat, solder or threaded ends.
 - b. 150 lb S.W.P., 300 lb W.O.G.
 - 2. Over 2 inch (50 mm):
 - a. Iron body, bronze trim, bolted bonnet, rising stem, handwheel, outside screw and yoke, rotating plug-type disc with renewable seat ring and disc, flanged ends.
 - b. 125 lb S.W.P., 200 lb W.O.G.
- C. Ball Valves:
 - 1. Up To and Including 2 inch (50 mm):
 - a. Bronze two piece body, chrome plated brass ball, teflon seats and stuffing box ring, lever handle, solder or threaded ends.
 - b. 150 lb S.W.P., 600 lb W.O.G.
 - 2. Over 2 Inch (50 mm):
 - a. Cast steel body, chrome plated steel ball, teflon seat and stuffing box seals, lever handle, flanged.
 - b. 150 lb S.W.P., 285 lb W.O.G.
 - 3. Polypropylene Valves for Polypropylene Piping: May be used instead of standard ball valves.
 - a. Manufacturer: Aquatherm, Greenpipe product line, no substitutions.
 - b. Material: Polypropylene body and handle.
 - c. Up to and including 2-1/2 inch (75 mm) size: Integral union ends, tee handle.
 - d. Over 2-1/2 inch: Flange ring ends, lever handle.
 - 4. PVC Piping:
 - a. PVC material for body, ball, and stem. Plastic handle. PTFE seats, EPDM seals.
 - b. Full port design through 4 inch (102 mm), tee or lever handle.
 - c. Working temperature 140 degrees F (60 degrees C).
 - d. Drain Valves Up To and Including 1 inch (25 mm):
 - 1) Hayward QIC2 Series.
 - 2) Compact ball valve.
 - 3) Working pressure 150 psig (1034 kPa) WOG.
 - e. Valves 1/2 to 6 inch (12 to 152 mm):

- 1) Hayward TB Series.
 - 2) True union ball valve. O-ring union seals.
 - 3) Blow-out proof stem, with double o-ring stem seals.
 - 4) Working pressure (socket or threaded) 230 psig (1585 kPa) WOG.
 - 5) Working pressure (flanged) 150 psig (1034 kPa) WOG.
5. Stem Extensions: Provide ball valves in insulated piping with stem extensions to allow for continuous thickness of field-installed insulation.
- D. Plug Valves:
1. Up To and Including 2 inch (50 mm):
 - a. Bronze body, bronze tapered plug, 70 percent port opening, non-lubricated, teflon packing, threaded ends.
 - b. Operator: One plug valve wrench for every ten plug valves minimum of one.
 2. Over 2 Inch (50 mm):
 - a. Cast iron body and plug, 70 percent port opening, pressure lubricated, teflon packing, flanged ends.
 - b. Operator: Each plug valve with a wrench with set screw.
- E. Butterfly Valves:
1. Body: Cast or ductile iron with resilient replaceable EPDM seat, wafer or lug ends, extended neck.
 2. Disc: Aluminum bronze or chrome plated ductile iron.
 3. Operator: 10 position lever handle for shut-off service, infinite position lever handle with memory stop for throttling service, handwheel and gear drive for sizes 8" (203 mm) and larger.
 4. Pressure rating shall be 150 psi at 225 degrees F (1034 kPa at 107 degrees C).
- F. Swing Check Valves:
1. Up To and Including 2 inch (50 mm): Bronze body, bronze trim, bronze rotating swing disc, with composition disc, solder or threaded ends.
 2. Over 2 inch (50 mm): Iron body, bronze trim, bronze or bronze faced rotating swing disc, renewable disc and seat, flanged ends.
- G. Spring Loaded Check Valves: Iron body, bronze trim, split plate, hinged with stainless steel spring, resilient seal bonded to body, wafer or threaded lug ends.

2.2 EXPANSION TANKS, BLADDER TYPE

- A. Manufacturers:
1. Taco.
 2. Grundfos.
 3. Bell & Gossett.
 4. Flo-Fab.
 5. John Wood.
 6. Watts.
 7. Wessels.
 8. Wheatley.
 9. Substitutions: Approved equal. See Section 016000 - Product Requirements
- B. Construction: Welded steel, tested and stamped in accordance with ASME SEC 8-D; supplied with National Board Form U-1, rated for working pressure of 125 psig (860 kPa), with

removable and replaceable flexible butyl or EPDM bladder, full or partial acceptance type as indicated on the Drawings, and integral steel support stand.

- C. Accessories: Schraeder-type air-charging fitting and protective heavy steel cap, drain fitting with plug, and field-furnished pressure gauge.

2.3 AIR VENTS

- A. Manual Type: Short vertical sections of 2 inch (50 mm) diameter pipe to form air chamber, with 1/8 inch (3 mm) brass needle valve at top of chamber.
- B. Float Type:
 - 1. Manufacturers:
 - a. Bell & Gossett.
 - b. Caleffi.
 - c. Taco.
 - d. Thrush.
 - e. Wheatley.
 - f. Substitutions: Approved equal. See Section 016000 - Product Requirements
 - 2. Brass or semi-steel body, copper, polypropylene, or solid non-metallic float, stainless steel valve and valve seat; suitable for system operating temperature and pressure; with isolating valve.
- C. Washer Type:
 - 1. Manufacturers:
 - a. Bell & Gossett.
 - b. Caleffi.
 - c. Taco.
 - d. Substitutions: Approved equal. See Section 016000 - Product Requirements
 - 2. Brass with hydroscopic fiber discs, vent ports, adjustable cap for manual shut-off, and integral spring loaded ball check valve.

2.4 AIR SEPARATORS

- A. In-line Combination Air/Dirt Separators, 2 inches (50 mm) and Larger Line Size:
 - 1. Manufacturers:
 - a. Taco, Inc. - 4900 and 4900H Series.
 - b. Armstrong Pumps Inc. - DAS and DASH Series.
 - c. Caleffi - Discal-Dirt ASME NA546 Series (up to 6 inch (50 mm) line size, up to 500 GPM (1892 liters/minute)).
 - d. Flamco - Flamcovent Clean Series.
 - e. Spirotherm - VDT and VHT Series.
 - f. Thrush Co. - SVR and HVR Series.
 - g. Substitutions: Approved equal. See Section 016000 - Product Requirements
 - 2. Steel body, with brass-or-cast-iron-body venting mechanism with components of stainless steel, EPDM, viton, brass, and engineered plastics. Tested and stamped in accordance with ASME SEC 8-D; for 125 psig (860 kPa) operating pressure, 270 degrees F (132 degrees C) maximum temperature, straight-through inlet and outlet connections, top fitting for air vent, bottom fitting for drain, side fitting with ball valve with hose-thread outlet for skimming and purge, with internal stainless steel or copper coalescing

- medium. Fittings 3-inch (76 mm) and under shall be NPT threaded or flanged, larger fittings shall be flanged. Primer paint finish.
3. Separator shall function on the coalescing principle. Manufacturer shall furnish documentation demonstrating that separator removes air microbubbles as small as 18 microns.
 4. Provide a top-mounted automatic air vent with hose-clamp or pipe-thread outlet. Vent shall be serviceable and replaceable. Provide integral or separate valve allowing the vent to be manually closed for its protection during startup and purging.
 5. Dirt and debris separation shall include a deep settling area below the level of the main piping connections. Dirt separation shall be effective down to 35 micron particle size, and at least 90 percent efficient down to 90 microns in 100 passes or fewer. Provide a factory-installed blowdown ball valve at base of unit.
 6. Provide welded steel base support ring for floor mounting on line sizes 8 inches (203 mm) and larger.

2.5 STRAINERS

- A. Manufacturers:
 1. Sarco.
 2. Armstrong.
 3. Barnes and Jones.
 4. Bell & Gossett.
 5. Flo-Fab.
 6. Keckley Co.
 7. Muesco.
 8. Wheatley.
 9. Substitutions: Approved equal. See Section 016000 - Product Requirements
- B. Size 2 inch (50 mm) and Under: Screwed brass or iron body for 175 psig (1200 kPa) working pressure, Y pattern with 1/32 inch (0.8 mm) stainless steel perforated screen.
- C. Size 2-1/2 inch (65 mm) to 4 inch (100 mm): Flanged iron body for 175 psig (1200 kPa) working pressure, Y pattern with 3/64 inch (1.2 mm) stainless steel perforated screen.
- D. Size 5 inch (125 mm) and Larger: Flanged iron body for 175 psig (1200 kPa) working pressure, basket pattern with 1/8 inch (3.2 mm) stainless steel perforated screen.

2.6 FLOW CONTROLS

- A. Manufacturers:
 1. Griswold Controls.
 2. Armstrong.
 3. Bell & Gossett.
 4. Taco.
 5. Watts.
 6. Substitutions: Approved equal. See Section 016000 - Product Requirements
- B. Construction: Brass or bronze body with union on inlet and outlet, temperature and pressure test plug on inlet and outlet, blowdown/backflush drain.
- C. Calibration: Control flow within 5 percent of selected rating, over operating pressure range of

10 times minimum pressure required for control, maximum minimum pressure 3.5 psig (24 kPa).

- D. Control Mechanism: Stainless steel or nickel plated brass piston or regulator cup, operating against stainless steel helical or wave formed spring.
- E. Accessories: In-line strainer on inlet and ball valve on outlet.

2.7 BALANCING VALVES AND COMBINATION BALANCING/SHUT-OFF VALVES.

- A. Manufacturers:
 - 1. Bell & Gossett.
 - 2. Armstrong.
 - 3. Flow Design, Inc.
 - 4. Gerand.
 - 5. Griswold Controls.
 - 6. Mepco.
 - 7. Nexus Valve.
 - 8. Taco.
 - 9. Tour and Andersson.
 - 10. Watts.
 - 11. Wheatley.
 - 12. Substitutions: Approved equal. See Section 016000 - Product Requirements
- B. Valves shall conform to one of the following:
 - 1. Fixed-Orifice Manual Balancing Valve: Calibrated, ball type balance valve with precision machined orifice, readout valves equipped with integral check valves and gasketed caps, calibrated nameplate and indicating pointer with memory stop. Readout valves measure the pressure differential across the fixed orifice plate or venturi. Valve shall be designed for positive shut-off.
 - 2. Variable-Orifice Manual Balancing Valve: Cast iron or bronze, globe style, balance valve with handwheel with vernier type ring setting and memory stop, readout valves equipped with integral check valves and gasketed caps. Readout valves measure the pressure differential across the variable opening between valve plug and valve seat. Valve shall be designed for positive shut-off. Drain valve may be furnished with this valve, and if positioned properly may be substituted for the separate drain valve indicated.
- C. Size balancing valves to allow a reading of 2 to 5 ft wg (6 to 15 kPa) pressure drop at design flow rates. Submittals shall include a chart of valve selections, indicating room number, terminal heating device tag, flow rate, pressure drop, and differential pressure reading.
- D. Insulation: Valves may be furnished with prefabricated thermal insulation. Flame spread reading shall be 25 or less per ASTM E84. R-value shall be 4 hr-sq.ft- F/Btu (0.704 K·m²/W) or greater. Install in accordance with Division 23 Section "HVAC Piping Insulation."

2.8 COMBINATION VALVE ASSEMBLIES

- A. Manufacturers:
 - 1. Flow Design, Inc.
 - 2. Griswold Controls.

3. Nexus Valve.
4. Substitutions: Approved equal. See Section 016000 - Product Requirements

- B. Assemblies combining valves and accessories may be furnished in lieu of the individual components, provided that the components are in the arrangement indicated on the Drawings and conform to the individual Specifications. Examples include combinations of manual balancing valves, unions, pressure/temperature test ports, strainers, manual air vents, flexible hose connections, and shutoff valves.

2.9 FLEXIBLE HOSE ASSEMBLIES

- A. Manufacturers:
1. Flow Design, Inc.
 2. Dadanco.
 3. Hays Fluid Controls.
 4. Paragon Performance.
 5. Twin City Hose, Inc.
 6. Unisource.
 7. Substitutions: Approved equal. See Section 016000 - Product Requirements
- B. General Description: This specification includes flexible hoses such as “heat pump hoses” which may be indicated at items of equipment including water-source heat pumps, fan-coil units, and chilled beams. For piping connections which are denoted on the Drawings as “flexible connections”, see Division 23 Section “Expansion Fittings and Loops for HVAC Piping.”
- C. 18 inch (457 mm) long flexible hoses consisting of a flexible hose with stainless steel wire braided jacket, with stainless steel or brass end fittings suitable for the specified system piping materials. Inner hose shall be nitrile or EPDM rubber, or PTFE, or fire-retardant thermoplastic conforming to UL 94 with a VO rating.
1. Sizing: Size for a maximum fluid velocity of 4 fps (1.22 m/sec) at scheduled equipment water flow rates. Minimum hose size of ½ inch (12.7 mm) diameter shall have a maximum flow rate of 3 GPM (11.4 l/sec).
- D. Rated for an operating pressure of 300 psig (2068 kPa) at 200 degrees F (93.3 degrees C), and a burst pressure of 1000 psig (6895 kPa). Hoses shall be factory tested for leakage at 100 psig (689 kPa).
- E. Metal ends shall include ferrules crimped to the hose. One end shall be a swivel fitting with NPT pipe threads, and may be tapered threads, or straight threads with fiber gasket or tapered cone seal, to match piping. The other end fitting shall be the same, or shall be fixed tapered NPT threads. Provide piping adapters as necessary.
- F. At the Contractor’s option, hoses may be furnished assembled with valves.

2.10 PRESSURE REDUCING VALVES FOR COLD WATER MAKEUP

- A. Manufacturers:
1. Watts.
 2. Bell & Gossett.
 3. Caleffi.

4. Spence.
5. Taco.
6. Wheatley.
7. Substitutions: Approved equal. See Section 016000 - Product Requirements

- B. Pressure Reducing Valve (PRV): Bronze body. Stainless steel, EPDM, and plastic internals. Maximum temperature rating 160 degrees F (71 degrees C). Maximum inlet pressure rating 200 psig (1378 kPa). Reduced pressure range suitable for the project. Provide inlet union, integral to the valve or furnished separately. Valve may include an integral inlet strainer. Valve may include a bypass lever or button. Valve internals shall be serviceable and replaceable without removing the body from the piping. Valve shall be line size unless otherwise indicated.
- C. Set pressure reducing valve to achieve 5 psi (34.5 kPa) gauge pressure at high point of system. Provide pressure gauge at high point of system, per Division 23 Section "Meters and Gauges for HVAC Piping." Set pressure reducing valve when the temperature of the water in the system is less than 80 degrees F (27 degrees C).
- D. Provide bypass line with full-port ball valve for fast system fill, sized as indicated. Reducing valve may include fast-fill lever, but this is not a substitute for the bypass line and valve.

2.11 RELIEF VALVES

- A. Manufacturers:
 1. Bell & Gossett.
 2. Cash Acme.
 3. Spence.
 4. Taco.
 5. Watts.
 6. Wheatley.
 7. Substitutions: Approved equal. See Section 016000 - Product Requirements
- B. Bronze body, teflon seat, stainless steel stem and springs, automatic, direct pressure actuated, capacities ASME certified and labeled.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Valve Type Selection:
 1. Use ball or butterfly valves for shut-off and to isolate equipment, part of systems, or vertical risers.
 2. Use globe, ball or butterfly valves for throttling, bypass, or manual flow control services.
 3. Use N.R.S. Gate Valves for general shut-off service in heating system piping 2-1/2 inch (63.5 mm) and larger.
 4. Use Plug Valves for general throttling applications where indicated.
 5. Use Bronze Globe Valves in throttling applications at control valve bypasses and in expansion tank connection.
 6. Use Bronze Ball Valves for general shut-off service in heating and cooling system piping 2 inch (50.8 mm) and smaller and at heating terminal units 2 inch (50.8 mm) and smaller, including fin-tube radiation, unit heaters, convectors and fan coil units.

7. Use Combination Balancing, Flow Measuring and Tight Shut-off Valves at terminal heating and cooling units, zone branches and as indicated.
 8. Use Bronze Ball Valves for drain valves with hose connections. Provide valve of size indicated; if size isn't indicated, provide at least 3/4 inch (19 mm) valve size. Provide outlet fitting for standard "garden hose" with 3/4 inch (19 mm) hose threads. Provide brass cap with retainer chain. Compression-type "boiler drain valves" are not allowed.
- B. With the exception of valves which must be properly sized to ensure design flow rates (such as balancing valves), valves shall be line sized.
 - C. For valves located more than 7 feet (2.1 m) above finished floor in equipment room areas, provide chain operated sheaves. Extend chains to 5 feet (1.5 m) above finished floor and hook to clips arranged to clear walking aisles.
 - D. For isolation valves, control valves and balancing valves located above suspended ceilings and in areas that are not visible to building occupants (for example, mechanical rooms), provide yellow colored surveyors tape. Permanently attach tape to valve handles and run tape down to 10 inches (254 mm) above ceiling or 12 inches (305 mm) below valve handle where ceilings do not exist (for example, mechanical rooms).
 - E. Standard details for heating and cooling coils are based on single coil arrangements. For heating and cooling coils that are supplied in a split coil arrangement, with 2 or more individual coils, provide additional piping and balancing valves at each coil to ensure that flow through each coil is proportional to the percentage of total coil face area that the coil occupies.
 - F. Install valves with stems upright or horizontal, not inverted.
 - G. Install specialties in accordance with manufacturer's instructions.
 - H. Where large air quantities can accumulate, provide enlarged air collection standpipes.
 - I. Provide manual air vents at system high points and as indicated.
 - J. For automatic air vents in ceiling spaces or other concealed locations, provide vent tubing to nearest drain, and shutoff ball valve upstream of vent to shut the vent off after initial system startup.
 - K. Provide air separator on suction side of system circulation pump and connect to expansion tank.
 - L. Provide valved drain and hose connection on strainer blow down connection.
 - M. Provide separate check, balancing, and shutoff valves on discharge side of base mounted centrifugal pumps.
 - N. Support pump fittings with floor mounted pipe and flange supports.
 - O. Provide balancing valves on water outlet from terminal heating and cooling units such as radiation, unit heaters.
 - P. Ensure that balancing valves are installed with minimum upstream length of straight pipe as recommended by the manufacturer.

- Q. Ensure that balancing valves are installed with the readout valves fully accessible, including space required for insertion of metering probes.
- R. Standard details for heating and cooling coils are based on single coil arrangements. For heating and cooling coils that are supplied in a split coil arrangement, with two or more individual coils, provide additional piping and balancing valves at each coil to ensure that flow through each coil is proportional to the percentage of total coil face area that the coil occupies.
- S. Expansion Tanks (Bladder and Diaphragm Type): Provide pressure gauge per Division 23 Section "Meters and Gauges for HVAC Piping" near point where expansion tank is connected to system, for determining required pre-charge pressure for air side of expansion tank. Isolate expansion tank from system and pre-charge air side of tank to same pressure as static head of system at point where expansion tank is connected to system. Measure static head of system after pressure reducing valve at cold water make-up has been properly set in accordance with this Section. Pre-charge air side of expansion tank only when the temperature of the water in the system is less than 80 degrees F (27 degrees C). Provide drain valve with hose end connection at point of connection to expansion tank to allow for periodic removal of system pressure in order to check expansion tank's pre-charge air pressure. Drain valve shall be located closest to expansion tank, isolation valve shall be immediately upstream of drain valve and pressure gauge shall be within sight upstream of isolation valve.
- T. Relief Valves:
1. Provide relief valves on pressure tanks, low pressure side of reducing valves, heat exchangers, and expansion tanks.
 2. Select system relief valve capacity so that it is greater than make-up pressure reducing valve capacity. Select equipment relief valve capacity to not exceed maximum pressure rating of connected equipment.
 3. Pipe relief valve outlet to nearest floor drain.
 4. Where one line vents several relief valves, make cross sectional area equal to sum of individual vent areas.

END OF SECTION 232118

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SECTION 232123 – HYDRONIC PUMPS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. In-line circulators.

1.2 RELATED SECTIONS

- A. Division 03 Section “Cast-in-Place Concrete.”
- B. Division 23 Section “Common Motor Requirements for HVAC Equipment.”
- C. Division 23 Section “Vibration and Seismic Controls for HVAC Piping and Equipment.”
- D. Division 23 Section “HVAC Piping Insulation.”
- E. Division 23 Section “HVAC Equipment Insulation”
- F. Division 23 Section “Hydronic Piping.”
- G. Division 23 Section “Hydronic Specialties”
- H. Division 26 “Electrical” Electrical characteristics and wiring connections.

1.3 REFERENCES

- A. UL 778 - Motor Operated Water Pumps.
- B. NFPA 70 - National Electrical Code.

1.4 PERFORMANCE REQUIREMENTS

- A. Ensure pumps operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading throughout the entire operating range in parallel or individual operation, and operate within 25percent of midpoint of published maximum efficiency curve.

1.5 SUBMITTALS

- A. Product Data: Provide certified pump curves showing performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable. Include electrical characteristics and connection requirements.
- B. Manufacturer's Installation Instructions: Indicate hanging and support requirements and recommendations.
- C. Millwright's Certificate: Certify that base mounted pumps have been aligned.

1.6 OPERATION AND MAINTENANCE DATA

- A. Operation and Maintenance Data: Include installation instructions, assembly views, lubrication instructions, and replacement parts list.

1.7 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing, assembly, and field performance of pumps with minimum 3 years' experience.
- B. Alignment: Base mounted pumps shall be aligned by a qualified millwright.

1.8 REGULATORY REQUIREMENTS

- A. Products Requiring Electrical Connection: Listed and classified by UL as suitable for the purpose specified and indicated.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Pumps, General:
 - 1. Taco.
 - 2. Armstrong.
 - 3. Bell & Gossett.
 - 4. Flo-Fab.
 - 5. Grundfos.
 - 6. Paco.
 - 7. Patterson.
 - 8. Peerless.
 - 9. Weinman.
 - 10. Wilo.
 - 11. Substitutions: Not permitted

GENERAL

- B. Statically and dynamically balance rotating parts.
- C. Construction shall permit complete servicing without breaking piping or motor connections.
- D. Pumps shall operate at 1750 rpm unless indicated or specified otherwise.
- E. Pump connections shall be flanged.
- F. Wetted parts shall be compatible with circulated fluid.

2.2 CARTRIDGE CIRCULATORS WITH INTEGRAL SPEED CONTROLLER

- A. Grundfos Magna series, with pump-mounted speed controller.
- B. Type: Cartridge type circulator, in-line mounting,

- C. Working Conditions:
 - 1. Working Pressure: 145 psig (10 bar) maximum.
 - 2. Minimum Inlet Pressure: 6.5 psig (0.45 bar) at 194 degrees F (90 degrees C).
 - 3. Fluid Temperature: 230 degrees F (110 degrees C) maximum for short periods, 203 degrees F (95 degrees C) maximum for continuous operation.
 - 4. Ambient Temperature: 32 to 104 degrees F (0 to 40 degrees C).
- D. Casing: Cast iron or stainless steel with flanged pump connections. Wet-varnished finish.
- E. Impeller: Stainless steel, or non-metallic composite.
- F. Shaft: Stainless steel, tungsten carbide, or aluminum oxide.
- G. Bearings: Carbon, with aluminum oxide outer bearing ring, aluminum oxide or silicon carbide inner bearing ring, and stainless steel bearing plate.
- H. Stator Housing: Aluminum, with EPDM O-rings.
- I. Rotor: Permanent-magnet rotor, with leak-proof stainless steel rotor can.
- J. Motor: Variable speed, electronically commutated, synchronous permanent magnet motor, with 3-lead Alpha snap-lock power plug at pump, and flexible power cord for field connection to junction box. Integral motor protection.
- K. Speed Controller: Integral pump-mounted frequency converter. Differential pressure control with "Auto-Adapt" function. Pump speed calculated via a built-in induction coil on the stator winding. Differential-pressure and temperature sensor located inside the pump housing. User interface with LED indicators of relative flow and head, operating mode, on-off status, and fault. Pushbuttons for speed settings and power on-off pushbutton. External start/stop input dry contact. 5 selectable operating modes. Infrared remote control receiver.
- L. Remote Control: Wireless remote control Model R100. Communicates to pump controller via infrared light.
- M. LON Module: Provide module using LonTalk protocol for LONWorks networks, for interface to the building automation system. Module shall provide access to controller information and alarms, allow remote adjustment of setpoints, and allow remote inputs such as start/stop signals. Coordinate requirements with Division 23 Section "Instrumentation and Control for Mechanical Systems."
- N. Insulation Shell: Provide Grundfos Magna insulation shell, factory-molded to the shape of the pump body. Insulation shall be suitable for chilled water service.
- O.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Verify that electric power is available and of the correct characteristics.

3.2 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Provide access space around pumps for service. Provide no less than minimum as recommended by manufacturer.
- C. Decrease piping from line size with long radius reducing elbows or reducers.
- D. Pump inlet conditions shall be as recommended by the pump manufacturer to eliminate system effects.
 - 1. Provide suction diffusers where indicated. Suction diffusers shall have adequate space provided for strainer removal. Remove fine-mesh start-up strainers after system startup, and hang adjacent to the pump for Architect/Engineer's approval.
 - 2. Where suction diffusers are not indicated, provide proper straight lengths of inlet piping and long-radius elbows at pump inlets.
- E. Support piping adjacent to pump such that no weight is carried on pump casings. Provide necessary brackets or hanger supports as required to relieve the stress on the pumps and piping. For close coupled or base mounted pumps, provide supports under elbows on pump suction and discharge line sizes 4 inches (102 mm) and over. Refer to Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment".
- F. Provide line sized shut-off valve and strainer on pump suction, and properly sized soft seat check valve and balancing/flow-measuring/shutoff valve on pump discharge.
- G. Install pumps with a pressure gauge piped to suction and discharge, with shutoff valves.
- H. Provide air cock and drain connections on horizontal pump casings.
- I. Provide drains for bases and seals, piped to and discharging into floor drains with air gaps.
- J. Lubricate pumps before start-up.
- K. Check, align, and certify alignment of base mounted pumps prior to start-up.
- L. Provide labor and materials required to ensure that pump impellers are adequately sized to provide flow rates as indicated. This shall include, but not be limited to, trimming impellers.

END OF SECTION 232123

SECTION 232300 – REFRIGERANT PIPING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Piping.
- B. Refrigerant.
- C. Moisture and Liquid Indicators.
- D. Valves.
- E. Strainers.
- F. Check Valves.
- G. Pressure Relief Valves.
- H. Filter-Driers.
- I. Solenoid Valves.
- J. Expansion Valves.
- K. Receivers.
- L. Flexible Connections.

1.2 RELATED SECTIONS

- A. Division 08 Section “Access Doors and Frames.”
- B. Division 09 Section “Painting.”
- C. Division 23 Section “Sleeves and Escutcheons for HVAC Piping.”
- D. Division 23 Section “Hangers and Supports for HVAC Piping and Equipment.”
- E. Division 23 Section “HVAC Piping Insulation.”
- F. Division 23 Section “HVAC Equipment Insulation.”
- G. Division 23 Section “Packaged Compressor and Condenser Units.”
- H. Division 23 Section “Split System Air Conditioners.”
- I. Division 23 Section “Instrumentation and Controls for Mechanical Systems.”
- J. Division 26 “Electrical.”

1.3 REFERENCES

- A. ARI 495 - Refrigerant Liquid Receivers.
- B. ARI 710 - Liquid Line Dryers.
- C. ARI 730 - Flow-Capacity Rating and Application of Suction-Line Filters and Filter-Driers
- D. ARI 750 - Thermostatic Refrigerant Expansion Valves.
- E. ARI 760 - Solenoid Valves for Use With Volatile Refrigerants.
- F. ASHRAE 15 - Safety Code for Mechanical Refrigeration.
- G. ASHRAE 34 - Number Designation of Refrigerants.
- H. ASME - Boiler and Pressure Vessel Codes, SEC 9 - Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators.
- I. ASME B16.22 - Wrought Copper and Copper Alloy Solder Joint Pressure Fittings.
- J. ASME B16.26 - Cast Copper Alloy Fittings For Flared Copper Tubes.
- K. ASME B31.5 - Refrigeration Piping.
- L. ASME B31.9 - Building Services Piping.
- M. ASME SEC 8D - Boilers and Pressure Vessels Code, Rules for Construction of Pressure Vessels.
- N. ASTM A53 - Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
- O. ASTM A234 - Pipe Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures.
- P. ASTM B88 - Seamless Copper Water Tube.
- Q. ASTM B280 - Seamless Copper Tube for Air Conditioning and Refrigeration Field Service.
- R. ASTM F405 - Standard Specification for Corrugated Polyethylene (PE) Pipe and Fittings.
- S. ASTM F667 - Standard Specification for 3 through 24 in. Corrugated Polyethylene Pipe and Fittings.
- T. ASTM F708 - Design and Installation of Rigid Pipe Hangers.
- U. AWS A5.8 - Brazing Filler Metal.
- V. AWS D1.1 - Structural Welding Code, Steel.
- W. MSS SP58 - Pipe Hangers and Supports - Materials, Design and Manufacturer.

- X. MSS SP69 - Pipe Hangers and Supports - Selection and Application.
- Y. MSS SP89 - Pipe Hangers and Supports - Fabrication and Installation Practices.
- Z. UL 429 - Electrically Operated Valves.

1.4 SYSTEM DESCRIPTION

- A. Where more than one piping system material is specified, ensure system components are compatible and joined to ensure the integrity of the system is not jeopardized. Provide necessary joining fittings. Ensure flanges, unions, and couplings for servicing are consistently provided.
- B. Liquid Indicators:
 - 1. Use line size liquid indicators in main liquid line leaving condenser.
 - 2. If receiver is provided, install in liquid line leaving receiver.
 - 3. Use line size on leaving side of liquid solenoid valves.
- C. Valves:
 - 1. Use service valves on suction and discharge of compressors.
 - 2. Use gauge taps at compressor inlet and outlet.
 - 3. Use gauge taps at hot gas bypass regulators and at filters and filter driers, inlet and outlet.
 - 4. Use check valves on compressor discharge.
 - 5. Use check valves on condenser liquid lines on multiple condenser systems.
- D. Refrigerant Charging (Packed Angle) Valve: Use in liquid line between receiver shut-off valve and expansion valve.
- E. Strainers:
 - 1. Use line size strainer upstream of each automatic valve.
 - 2. Where multiple expansion valves with integral strainers are used, use single main liquid line strainer.
 - 3. On steel piping systems, use strainer in suction line.
 - 4. Use shut-off valve on each side of strainer.
- F. Pressure Relief Valves: Use on ASME receivers and on compressors converted to higher pressure refrigerant. Pipe field-installed valves and valves furnished with equipment to outdoors as required by ASHRAE Standard 15 and where directed.
- G. Permanent Filter-Driers:
 - 1. Use in low temperature systems.
 - 2. Use in systems utilizing hermetic compressors.
 - 3. Use filter-driers for each solenoid valve.
- H. Replaceable Cartridge Filter-Driers:
 - 1. Use vertically in liquid line adjacent to receivers.
 - 2. Use with filter elements in suction line. Provide temporary wax removal filter-drier core in low temperature systems and systems where motor failure has occurred.
 - 3. Use filter-driers for each solenoid valve.

- I. Solenoid Valves:
 - 1. Use in liquid line of systems operating with single pump-out or pump-down compressor control.
 - 2. Use in liquid line of single or multiple evaporator systems.
 - 3. Use in oil bleeder lines from flooded evaporators to stop flow of oil and refrigerant into the suction line when system shuts down.
- J. Receivers:
 - 1. Use on systems 5 tons (18 kW) and larger, sized to accommodate pump down charge.
 - 2. Use on systems with long piping runs.
- K. Flexible Connectors: Utilize at or near compressors where piping configuration does not absorb vibration.

1.5 SUBMITTALS

- A. Shop Drawings: Indicate schematic layout of system, including equipment, critical dimensions, and sizes.
- B. Product Data: Provide general assembly of specialties, including manufacturer's catalog information. Provide manufacturer's catalog data including load capacity.
- C. Pipe Sizing Recommendations of Equipment Manufacturers:
 - 1. Verify indicated pipe sizes with the manufacturers of the associated equipment. If manufacturer's recommendations differ from the sizes indicated on the Drawings, submit recommendations to the Architect. The Architect will make the final determination of pipe sizes. Provide sizes per final determination at no additional cost to the Owner. In sizing piping, include modifications as required to affected items including but not limited to piping, valves, filters, other pipeline accessories, insulation, supports, sleeves, conduits, building openings, and building enclosures.
 - 2. Submission of manufacturer's recommendations, and equipment performance related to pipe sizing, is the Contractor's responsibility.
 - 3. Verify sizing prior to any preparation for piping installation.
- D. Design Data: Submit design data indicating pipe sizing. Indicate load carrying capacity of trapeze, multiple pipe, and riser support hangers.
- E. Test Reports: Indicate results of leak test, acid test.
- F. Manufacturer's Installation Instructions: Indicate support, connection requirements, and isolation for servicing.
- G. Submit welders' certifications of compliance with AWS D1.1., and their assigned identification letters, numbers or symbols.

1.6 PROJECT RECORD DOCUMENTS

- A. Record exact locations of equipment and refrigeration accessories on record drawings.

1.7 OPERATION AND MAINTENANCE DATA

- A. Maintenance Data: Include instructions for changing cartridges, assembly views, spare parts lists.

1.8 QUALIFICATIONS

- A. Installer: Company specializing in performing the work of this Section with minimum 3 years' experience.
- B. Design piping system under direct supervision of a Professional Engineer experienced in design of this work and licensed at the place where the Project is located.

1.9 REGULATORY REQUIREMENTS

- A. Conform to ASME B31.9 for installation of piping system.
- B. Welding Materials and Procedures: Conform to ASME SEC 9 and applicable state labor regulations.
- C. Welders Certification: In accordance with AWS D1.1. and state and local requirements.
- D. Products Requiring Electrical Connection: Listed and classified by UL, as suitable for the purpose indicated.
- E. Refrigerant Safety: Conform with ASHRAE 15, state and local codes and manufacturer's requirements for safe handling to avoid exposure to workers or to occupants.

1.10 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect and handle products to site.
- B. Deliver and store piping and specialties in shipping containers with labeling in place.
- C. Protect piping and specialties from entry of contaminating material by leaving end caps and plugs in place until installation.
- D. Dehydrate and charge components such as piping and receivers, seal prior to shipment, until connected into system.

1.11 MAINTENANCE MATERIALS

- A. Provide maintenance materials under provisions of documents.
- B. Provide 2 refrigeration oil test kits, each containing everything required to conduct 1 test.
- C. Provide 2 filter-dryer cartridges of each type.

PART 2 - PRODUCTS

2.1 PIPING

- A. Copper Tubing: ASTM B280, Type ACR hard drawn, degreased, nitrogen charged and sealed. Annealed (soft) tubing may be used only for underfloor or below grade runs or for short (6 feet (1.8 m) or less) above-grade connections to valves and equipment.
 - 1. Fittings: ASME B16.22 wrought copper.
 - a. Fittings shall be packaged and labeled for ACR use.
 - b. Elbows: Use long-radius elbows wherever possible. Do not use 45-degree elbows, because they are more likely to break at their inner surface in refrigeration service.
 - 2. Joints:
 - a. Braze, 15 percent silver for copper, brass, and bronze.
 - b. Braze, 35 percent silver, for brazing to ferrous metals (steel).
 - c. Solder (for use only at equipment and valve connections where required by the equipment manufacturer).
 - d. Other: If a valve or equipment manufacturer recommends a joint material other than those specified, submit it for approval.
 - e. Flux: Use as recommended by alloy manufacturer. Should not be needed for copper-to-copper brazed joints.
- B. Press fittings: Press fittings are not allowed for any condition whether recommended by manufacturer or any other entity.

2.2 PIPE SUPPORTS AND ANCHORS

- A. See Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."

2.3 PIPE SLEEVES

- A. See Division 23 Section "Sleeves and Escutcheons for HVAC Piping."

2.4 BRAZING MATERIALS - 15% Silver

- A. Manufacturers:
 - 1. Harris (Product: Stay-Silv 15).
 - 2. Lucas-Milhaupt (Product: Sil-Fos 15).
 - 3. Wolverine (Product: Silvaloy 15).
 - 4. Substitutions: Not permitted.
- B. Nominal Composition: 5.0 percent phosphorus, 15.0 percent silver, 0.15 percent other elements (total), remainder copper. Cadmium-free.
- C. Physical Properties:
 - 1. Color: Yellow/Gray
 - 2. Solidus: 1190 degrees F (643 degrees C)
 - 3. Liquidus: 1480 degrees F (802 degrees C)
 - 4. Brazing Range: 1300–1500 degrees F (704-816 degrees C)
 - 5. Electrical Conductivity: 9.9 percent IACS
 - 6. Electrical Resistivity: 17.40 microhm-cm

- D. Specification Compliance:
1. ANSI/AWS A5.8, class BCuP-5
 2. ASME SFA5.8, class BCuP-5
 3. Optional:
 - a. QQB 650C, class BCuP-5
 - b. QQB 654A, class BCuP-5
 - c. QQB 654, class BCuP-5
- E. Flux:
1. Harris (Stay-Silv For copper-to-brass joints. No flux required for copper-to-copper joints).

2.5 BRAZING MATERIALS – 35 percent Silver

- A. Manufacturers:
1. Harris (Product: Safety-Silv 35).
 2. Lucas-Milhaupt (Product: Braze 351).
 3. Wolverine (Product: Silvaloy A-35).
 4. Substitutions: Not permitted.
- B. Nominal Composition: 35.0 percent silver, 33 percent Zinc, 0.15 percent other elements (total), remainder copper. Cadmium-free.
- C. Physical Properties:
1. Color: Yellow/Gray
 2. Solidus: 1250 degrees F (677 degrees C)
 3. Liquidus: 1410 degrees F (732 degrees C)
 4. Electrical Conductivity: 19.8 percent IACS
 5. Electrical Resistivity: 8.2 microhm-cm
- D. Specification Compliance:
1. ANSI/AWS A5.8, class BAg-5
 2. ASME SFA5.8, class BCuP-5
- E. Flux:
1. Harris (Stay-Silv white flux, or where heating cycles are extended, Stay-Silv black flux).

2.6 SOLDER MATERIALS:

- A. Manufacturers:
1. Harris (Product: Stay-Brite).
 2. Lucas-Milhaupt (Product: Clean 'n Brite).
 3. Wolverine (Product: Silvabrite).
 4. Substitutions: Not permitted.
- B. Nominal Composition: Alloy of silver and tin (3-6 percent Ag, remainder Sn). Antimony-free.
- C. Physical Properties:
1. Color: Bright Silver
 2. Solidus: 430 degrees F (221 degrees C)
 3. Liquidus: 430 degrees F (221 degrees C)

4. Electrical Conductivity: 16.4 percent IACS
5. Shear Strength: 10,600 psi (73 MPa)
6. Tensile Strength: 14,000 psi (96 MPa)
7. Elongation: 48 percent

D. Specification Compliance:

1. NSF 51
2. ASTM B32-89, Alloy Grade Sn96
3. Federal Spec. QQ-S-571E, Class Sn 96 with exception to QPL paragraph 3.1
4. J-STD-006, Sn96Ag04A

E. Flux:

1. Harris (Product: Stay Clean Paste Flux, Stay Clean Liquid Flux (used with 4 inches or larger copper tubing also stainless steels), or Bridgit Water Soluble Paste Flux).
2. Canfield (Product: Aqua-Brite or AB Cream Flux). Glycerin-based, water soluble.

2.7 REFRIGERANTS AND LUBRICANTS

A. Refrigerant: ASHRAE 34;

1. As scheduled.

B. Oils and Other Lubricants: Provide as required by the refrigerant manufacturer and the equipment manufacturer(s).

2.8 MOISTURE AND LIQUID INDICATORS

A. Manufacturers:

1. Sporlan Valve Co, Model "See-All".
2. Emerson Climate Technologies.
3. Henry Technologies.
4. Mueller.
5. Substitutions: Approved equal. See Section 016000 - Product Requirements

B. Indicators: Double port type, UL listed, with steel body, flared or copper plated solder ends, leak proof fused sight glass, replaceable color coded paper moisture indicator and plastic cap; for maximum working pressure of 500 psig (3450 kPa) for connection sizes 1-1/8 inch (29 mm) O.D. and smaller, 430 psig (2960 kPa) for sizes 1-3/8 inch (35 mm) O.D. and larger, and maximum temperature of 200 degrees F (93 degrees C). Synthetic gaskets are not allowed.

2.9 VALVES

A. Diaphragm Packless Valves:

1. Manufacturers:
 - a. Henry Technologies.
 - b. Mueller.
 - c. Superior.
 - d. Substitutions: Approved equal. See Section 016000 - Product Requirements
2. UL listed, globe or angle pattern, forged brass body and bonnet, phosphor bronze and stainless steel diaphragms, rising stem and handwheel, stainless steel spring, nylon seat disc, solder or flared ends, with positive backseating; for maximum working pressure of 500 psig (3450 kPa) and maximum temperature of 275 degrees F (135 degrees C).

- B. Packed Angle Valves:
 - 1. Manufacturers:
 - a. Henry Technologies.
 - b. Mueller.
 - c. Superior.
 - d. Substitutions: Approved equal. See Section 016000 - Product Requirements
 - 2. Forged brass (or brass and copper), forged brass seal caps with copper gasket, rising stem and seat with backseating, molded stem packing, solder or flared ends; for maximum working pressure of 500 psig (3450 kPa) and maximum temperature of 275 degrees F (135 degrees C).
- C. Ball Valves:
 - 1. Manufacturers:
 - a. Henry Technologies.
 - b. Mueller.
 - c. Superior.
 - d. Substitutions: Approved equal. See Section 016000 - Product Requirements
 - 2. Two piece forged brass body with teflon ball seals and copper tube extensions, brass bonnet and seal cap, chrome plated ball, stem with neoprene ring stem seals; for maximum working pressure of 500 psig (3450 kPa) and maximum temperature of 325 degrees F (163 degrees C).
- D. Service Valves:
 - 1. Manufacturers:
 - a. Henry Technologies.
 - b. Mueller.
 - c. Superior.
 - d. Substitutions: Approved equal. See Section 016000 - Product Requirements
 - 2. Forged brass body with copper stubs, brass caps, removable valve core, integral ball check valve, flared or solder ends, for maximum pressure of 500 psig (3450 kPa).

2.10 CHECK VALVES

- A. Globe Type:
 - 1. Manufacturers:
 - a. Henry Technologies.
 - b. Mueller.
 - c. Superior.
 - d. Substitutions: Approved equal. See Section 016000 - Product Requirements
 - 2. Cast bronze or forged brass body, forged brass cap with neoprene seal, brass guide and disc holder, phosphor-bronze or stainless steel spring, teflon seat disc; for maximum working pressure of 500 psig (3450 kPa) and maximum temperature of 300 degrees F (149 degrees C).
- B. Straight Through Type:
 - 1. Manufacturers:
 - a. Henry Technologies.
 - b. Mueller.
 - c. Superior. Substitutions: Approved equal. See Section 016000 - Product Requirements

- C. Brass body and disc, phosphor-bronze or stainless steel spring, neoprene seat; for maximum working pressure of 500 psig (3450 kPa) and maximum temperature of 250 degrees F (121 degrees C).

2.11 EXPANSION VALVES

- A. Manufacturers:
 - 1. Sporlan.
 - 2. Henry Technologies.
 - 3. Parker Hannifin.
 - 4. Substitutions: Approved equal. See Section 016000 - Product Requirements
- B. Angle or Straight Through Type: ARI 750; balanced port or two-port design suitable for refrigerant, brass body, flare or solder connections, internal or external equalizer, resealable bleed hole, adjustable superheat setting, replaceable inlet strainer, with replaceable thermostatic power element with capillary tube and remote sensing bulb. Joints to the body at the removable power element and at the strainer shall be knife-edge type not requiring a synthetic seal.
- C. Selection: Evaluate refrigerant pressure drop through system to determine available pressure drop across valve. Select valve for maximum load at design operating pressure and minimum 10 degrees F (6 degrees C) superheat. Select to avoid being undersized at full load and excessively oversized at part load. Select thermostatic charge for the particular application.

2.12 ELECTRONIC EXPANSION VALVES

- A. Manufacturers:
 - 1. Sporlan.
 - 2. Henry Technologies.
 - 3. Parker Hannifin.
 - 4. Substitutions: Approved equal. See Section 016000 - Product Requirements
- B. Valve:
 - 1. Brass body with flared or solder connection, needle valve with floating needle and machined seat, stepper motor drive.
 - 2. Capacity: To meet the load of the equipment served.
 - 3. Electrical Characteristics: Compatible with the control system.
- C. Evaporation Control System:
 - 1. Electronic microprocessor based unit in enclosed case, proportional integral control with adaptive superheat, maximum operating pressure function, pre-selection allowance for electrical defrost and hot gas bypass.
 - 2. Electrical Characteristics: Compatible with the control system.
- D. Refrigeration System Control: Electronic microprocessor based unit in enclosed case, with proportional integral control of valve, on/off thermostat, air temperature alarm (high and low), solenoid valve control, liquid injection adaptive superheat control, maximum operating pressure function, night setback thermostat, timer for defrost control.

2.13 PRESSURE REGULATORS

- A. Manufacturers:
 - 1. Sporlan.
 - 2. Parker Hannifin.
 - 3. Substitutions: Approved equal. See Section 016000 - Product Requirements
- B. Brass body, stainless steel diaphragm, pilot operated with internal pressure pilot, adjustable over 0 to 100 psig (0 to 690 kPa) range, for maximum working pressure of 450 psig (3100 kPa).

2.14 PRESSURE RELIEF VALVES

- A. Manufacturers:
 - 1. Henry Technologies.
 - 2. Mueller.
 - 3. Superior.
 - 4. Substitutions: Approved equal. See Section 016000 - Product Requirements
- B. Straight Through or Angle Type: Brass body and disc, neoprene seat, factory sealed and stamped with ASME UV and National Board Certification NB; for standard setting; selected to ASHRAE 15.

2.15 SOLENOID VALVES

- A. Manufacturers:
 - 1. Sporlan.
 - 2. Henry Technologies.
 - 3. Parker Hannifin.
 - 4. Substitutions: Approved equal. See Section 016000 - Product Requirements
- B. Valve: ARI 760, pilot operated, brass or steel body and internal parts, teflon seat, stainless steel stem and plunger assembly, with flared, solder, or threaded ends; for maximum working pressure of 500 psig (3450 kPa). Stem shall have a knife-edge joint to the body and shall permit manual operation in case of coil failure.
- C. Coil Assembly: UL listed, replaceable with molded electromagnetic coil, moisture and fungus proof, with surge protector and color coded lead wires, integral junction box with pilot light.
- D. Electrical Characteristics: 10 to 15 watts, voltage compatible with control system, single phase, 60 Hz.

2.16 FILTER-DRIERS

- A. Replaceable Cartridge Angle Type:
 - 1. Manufacturers:
 - a. Sporlan, Model CW Catch-All.
 - b. Emerson Climate Technologies.
 - c. Substitutions: Approved equal. See Section 016000 - Product Requirements
 - 2. Shell: ARI 710, UL listed, steel with epoxy paint finish, copper sweat fittings, removable cap with zinc-plated fasteners, for maximum working pressure of 500 psig (3450 kPa), size as recommended by manufacturer.

3. Suction Filter Cartridge: Pleated media with integral end rings, stainless steel support, ARI 730 rating for capacity of the equipment served.
4. Filter/Dryer Cartridge: Pleated media with solid core molecular sieve with activated alumina, ARI 730 rating for capacity of the equipment served.
5. Wax Removal Cartridge: Molded bonded core of activated charcoal with integral gaskets, with filter surface area, desiccant volume and ARI 710 moisture rating as recommended by the manufacturer based on line size and refrigeration system horsepower (kW).

B. Permanent Straight Through Type:

1. Manufacturers:
 - a. Sporlan, Model CW Catch-All.
 - b. Emerson Climate Technologies.
 - c. Substitutions: Approved equal. See Section 016000 - Product Requirements
2. ARI 710, UL listed, steel shell with copper plated steel sweat or flare fittings, molded molecular sieve/activated alumina desiccant filter core, for maximum working pressure of 500 psig (3450 kPa).
3. Rating: ARI 730 flow capacity of the equipment served.

2.17 FLEXIBLE CONNECTORS

A. Manufacturers:

1. Metraflex.
2. Mason Industries.
3. Keflex.
4. Substitutions: Approved equal. See Section 016000 - Product Requirements

B. Corrugated bronze hose with single layer of exterior braiding, minimum 9 inches (230 mm) long with copper tube ends; for maximum working pressure 500 psig (3450 kPa).

2.18 RECEIVERS

A. Manufacturers:

1. Henry Technologies.
2. Refrigeration Research Inc.
3. Sporlan.
4. Standard Refrigeration Co.
5. Substitutions: Approved equal. See Section 016000 - Product Requirements

B. Internal Diameter 6 inch (150 mm) and Smaller: ARI 495, UL listed, steel, brazed; 400 psig (2760 kPa) maximum pressure rating, with tappings for inlet, outlet, liquid level gauge, sight glasses and pressure relief valve. Provide at least 2 bullseye liquid level sight glasses. Size receiver to hold at least 120 percent of fully charged system.

C. Internal Diameter Over 6 inch (150 mm): ARI 495, welded steel, tested and stamped in accordance with ASME SEC 8D; 400 psig (2760 kPa) with tappings for liquid inlet and outlet valves, pressure relief valve, sight glasses and magnetic liquid level indicator. Provide at least 2 bullseye liquid level sight glasses. Size receiver to hold at least 120 percent of fully charged system.

2.19 STRAINERS

- A. Straight Line or Angle Line Type:
 - 1. Manufacturers:
 - a. Henry Technologies.
 - b. Sporlan.
 - c. Superior.
 - d. Substitutions: Approved equal. See Section 016000 - Product Requirements
 - 2. Brass or steel shell, steel cap and flange, and replaceable cartridge, with screen of stainless steel wire or monel reinforced with brass; for maximum working pressure of 430 psig (2960 kPa).
- B. Straight Line, Non-Cleanable Type:
 - 1. Manufacturers:
 - a. Henry Technologies.
 - b. Mueller.
 - c. Substitutions: Approved equal. See Section 016000 - Product Requirements
 - 2. Steel shell, copper plated fittings, stainless steel wire screen, for maximum working pressure of 430 psig (2960 kPa).
- C. Screens: 80 mesh (0.007 in. (0.18 mm) square openings) in most uses, 60 mesh (0.010 in. (0.25 mm) square openings) in line sizes above 1-1/8 inch (29 mm), and 40 mesh (0.015 in. (0.38 mm) square openings) for use in suction lines.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Remove scale and dirt on inside and outside before assembly.
- C. Prepare piping connections to equipment with flanges or unions.

3.2 INSTALLATION

- A. Follow ASHRAE 15 procedures for charging and purging of systems and for disposal of refrigerant.
- B. Comply with Federal, State, and local Codes and regulations regarding the handling and disposal of refrigerants and oil. Provide documentation of quantities installed in the system. Document handling and disposal; see "Project Closeout" in this Section.
- C. Install refrigeration specialties in accordance with manufacturer's instructions.
- D. Flood piping system with nitrogen when brazing.
- E. Route piping in orderly manner, parallel or perpendicular to building structure, and maintain gradient.

- F. Install annealed piping free of kinks, and with bends only as necessary.
- G. Install piping to conserve building space and not interfere with use of space.
- H. Group piping whenever practical at common elevations and locations. Slope piping one percent in direction of oil return.
- I. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- J. Arrange piping to return oil to compressor. Provide traps and loops in piping, and provide double risers as required.
- K. Provide liquid line replaceable cartridge (unless sealed type is indicated) filter-driers, with isolation valves and valved bypass. On low temperature systems, or after a hermetic motor burnout, provide wax removal cores. Provide upstream and downstream pressure-testing access valves.
- L. Provide suction line replaceable cartridge filters, with isolation valves and valved bypass. Provide upstream and downstream pressure testing access valves. On low temperature systems, or after a hermetic motor burnout, provide temporary wax removal cores. After cleanup of the system, replace cores with filter elements for lower pressure drop.
- M. Locate expansion valve sensing bulb immediately downstream of evaporator on suction line.
- N. Provide external equalizer piping on expansion valves with refrigerant distributor connected to evaporator.
- O. Install flexible connectors at right angles to axial movement of compressor, parallel to crankshaft.
- P. Pipe Sleeves and Escutcheons:
 - 1. See Division 23 Section "Sleeves and Escutcheons for HVAC Piping."
 - 2. Provide sleeves, sized to fit outside the pipe insulation with at least 1/4 inch (6 mm) clearance, at penetrations of building assemblies. Interrupt insulation where required by fire ratings.
 - 3. Extend floor sleeves to 2 inches (50 mm) above finished floor and seal watertight.
 - 4. For below-grade penetrations and where indicated, provide watertight link-type pipe seals.
 - 5. Secure sleeves in place, and caulk, grout or firestop into the building assembly.
 - 6. Provide split chrome or painted escutcheons where exposed to occupancy.
- Q. Provide clearance for installation of insulation and access to valves and fittings.
- R. Provide access to concealed valves and fittings. Coordinate size and location of access doors with Division 08 Section "Access Doors and Frames."
- S. Where pipe support members are welded to structural building frame, brush clean, and apply one coat of zinc rich primer to welding.
- T. Prepare unfinished pipe, fittings, supports, and accessories ready for finish painting. Refer to

Division 09 Section "Painting."

- U. Insulate piping and equipment; refer to Division 23 Sections "HVAC Piping Insulation" and "HVAC Equipment Insulation"
- V. Fully charge completed system with refrigerant after testing.
- W. Provide electrical connection to solenoid valves. Refer to Division 26 - Electrical.

3.3 FIELD QUALITY CONTROL

- A. Perform field inspection and testing under provisions of documents.
- B. Test refrigeration system in accordance with ASME B31.5.
- C. Pressure test system with dry nitrogen to 200 psig (1470 kPa). Perform final tests at 27 inches of mercury (92 kPa) vacuum and 200 psig (1470 kPa) pressure using electronic leak detector. Test to no leakage.
- D. Evacuate the system as required by Codes and by equipment manufacturer, including a vacuum test at 0.02 inches of mercury (500 microns). The system shall be valved off and tested for 2 hours with a pressure rise of no more than 0.002 inches of mercury (50 microns).

3.4 SYSTEM STARTUP

- A. Lubricate motors and other moving parts as necessary before operating them.
- B. Charge the system with liquid refrigerant into the low pressure side of the system, where the liquid will evaporate. Expel air from the system. Operate the compressor, condenser, water cooling pumps and evaporator fans during charging. Monitor compressor discharge pressure. Monitor oil levels for a period of 24 hours.
- C. Coordinate control setpoints and wiring prior to startup.
- D. Change suction filter elements if the pressure drop exceeds 1 Psi (6.9 kPa) after the initial 24 hours of operation. Change suction wax removal cores to filter elements after system cleanup.
- E. Adjust expansion valve superheat using a thermistor or thermocouple temperature sensor at the bulb location and a pressure gauge at the external equalizer line (or the compressor). Adjust under full system load, and again when the system stabilizes.
- F. Check the system again after seven full days of operation.
- G. Periodically clean strainers until no more accumulation occurs.

3.5 PROJECT CLOSEOUT

- A. Indicate exact locations of buried piping conduits on As-Built Drawings.
- B. Submit records of handling and disposal of refrigerant and oil to verify compliance with Federal, State, and local Codes and regulations.

- C. Submit records of installed quantities of refrigerants and oils in each system. Submit manufacturer's product sheets, MSDS, and instructions in the Operation and Maintenance Manuals.

3.6 SCHEDULES

- A. State and Local Codes: If code requirements are more stringent than those indicated herein, provide as required by Code.

END OF SECTION 232300

SECTION 232500 – HVAC WATER TREATMENT

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Cleaning of piping systems.
- B. Chemical feeder equipment.
- C. Chemical treatment.

1.2 PRODUCTS FURNISHED BUT NOT INSTALLED UNDER THIS SECTION

- A. Division 23 Section “Hydronic Piping”: Placement of water coupon rack, by-pass (pot) feeder.

1.3 PRODUCTS INSTALLED BUT NOT FURNISHED UNDER THIS SECTION

- A. Owner-furnished treatment equipment and chemicals.

1.4 RELATED SECTIONS

- A. Division 23 Section “Instrumentation and Controls For Mechanical Systems.”
- B. Division 26 “Electrical”: Electrical characteristics and wiring connections.

1.5 REFERENCES

- A. NFPA 70 - National Electrical Code.

1.6 SUBMITTALS

- A. Product Data: Provide chemical treatment materials, chemicals, and equipment including electrical characteristics and connection requirements.
- B. Manufacturer's Field Reports: Indicate start-up of treatment systems when completed and operating properly. Indicate analysis of system water after cleaning and after treatment.
- C. Submit certificate of compliance from authority having jurisdiction indicating approval of chemicals and their proposed disposal.

1.7 OPERATION AND MAINTENANCE DATA

- A. Operation and Maintenance Data: Include data on chemical feed pumps, agitators, and other equipment including spare parts lists, procedures, and treatment programs. Include step by step instructions on test procedures including target concentrations.

1.8 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the products specified in this Section with minimum 3 years’ experience. Company shall have local representatives with water

analysis laboratories and full time service personnel.

- B. Installer: Company specializing in performing the work of this Section with minimum 3 years' experience and approved by manufacturer.

1.9 REGULATORY REQUIREMENTS

- A. Conform to applicable code for addition of non-potable chemicals to building mechanical systems, and for discharge to public sewage systems.
- B. Products Requiring Electrical Connection: Listed and classified by UL as suitable for the purpose specified and indicated.

1.10 MAINTENANCE SERVICE

- A. Furnish service and maintenance of treatment systems for 1-year from Date of Substantial Completion.
- B. Provide monthly technical service visits to perform field inspections and make water analysis on site. Detail findings in writing on proper practices, chemical treating requirements, and corrective actions needed. Submit 2 copies of field service report after each visit.
- C. Provide laboratory and technical assistance services during this maintenance period.
- D. Include 2-hour training course for Owner's operating personnel, instructing them on installation, care, maintenance, testing, and operation of water treatment systems. Schedule the course at Owner's convenience after start-up of systems.
- E. Provide on-site inspections of equipment during scheduled or emergency shutdown to properly evaluate success of water treatment program, and make recommendations in writing based upon these inspections.

1.11 MAINTENANCE MATERIALS

- A. Provide sufficient chemicals for treatment and testing during warranty period.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Chemical Treatment Systems Products, and Services:
 - 1. Barclay Water Management, Inc., Watertown, MA office.
 - 2. Nalco Company, Windham, ME office.
 - 3. Substitutions: Approved equal. See Section 016000 - Product Requirements
- B. Chemical Treatment Products:
 - 1. Nu-Calgon.
 - 2. Culligan.
 - 3. H-O-H Water Technology, Inc.
 - 4. Wesco Chemicals, Inc.

5. Substitutions: Approved equal. See Section 016000 - Product Requirements

2.2 MATERIALS

- A. System Cleaner:
 1. Liquid alkaline compound with emulsifying agents and detergents to remove grease and petroleum products
 2. Biocide; chlorine release agents such as sodium hypochlorite or calcium hypochlorite, or microbiocides such as quarternary ammonia compounds, tributyl tin oxide, methylene bis (thiocyanate), or isothiazolones.
- B. Closed System Treatment (Water):
 1. Sequestering agent to reduce deposits and adjust pH; polyphosphate.
 2. Corrosion inhibitors; liquid boron-nitrite, sodium nitrite and borax, sodium totyltriazole, low molecular weight polymers, phosphonates, sodium molybdate, or sulphites.
 3. Conductivity enhancers; phosphates or phosphonates.

2.3 BY-PASS (POT) FEEDER

- A. Manufacturers:
 1. Neptune Chemical Pump Co.: Model DBF-5HP.
 2. General Treatment Products, Inc.: Model DB5-QC-AR.
 3. Griswold Water Sytems: Model DB-5-GE-CS-Z-230.
 4. Wheatley - a division of Global Flow Products: Model VFT-005-0.
 5. Substitutions: Not permitted.
- B. 5.0 gal (18.9 l), with quick opening cap (coarse threaded or Victaulic grooved coupling type), domed (convex) top and bottom, for working pressure of 200 psig (1370 kPa) at 200 degrees F (93 degrees C), fittings as required for piping configuration indicated on the Drawings, minimum of 3/4 inch (19 mm) FPT inlet, outlet, and bottom drain.
- C. Provide fitting for air vent ball valve, either on the feeder or on piping, to allow release of pressure before opening the cap.
- D. Plug any unused openings.
- E. Open fill funnel is not desired. If a fill funnel is provided, provide a lockable ball valve, and padlock with 3 keys, to prevent tampering. If more than one lock is provided, they shall be keyed alike. Furnish keys to the Owner.
- F. Install above the floor with legs or pedestal. For feeders which don't have integral legs or pedestal, provide additional support or concrete housekeeping pad.

2.4 DRIP FEEDER

- A. Plastic reservoir with coil of capillary tubing with probe, weight, charging syringe, and clip.

2.5 SOLUTION METERING PUMP

- A. Manufacturers:
 1. Milton Roy – LMI Pumps.

2. Neptune.
3. Pulsafeeder, Inc.
4. Stenner Pump Co.
5. Walchem.
6. Substitutions: Approved equal. See Section 016000 - Product Requirements

- B. Positive displacement, diaphragm pump with adjustable flow rate, thermoplastic construction, continuous-duty fully enclosed electric motor and drive, and built-in relief valve.
- C. Electrical Characteristics: Suitable for 15 or 20 amp circuit, 120V/1ph/60Hz, with cord and 3-prong plug for standard receptacle.

2.6 SOLUTION TANKS

- A. 30-gallon (114-l) capacity, polyethylene, self-supporting, one-gallon (3.8-l) graduated markings; molded fiberglass cover with recess for mounting pump, agitator (if required), and liquid level switch.

2.7 AGITATOR

- A. Totally enclosed electric motor, stainless steel clamp and motor mount, Type 316 stainless steel propeller.
- B. Electrical Characteristics: Suitable for 15 or 20 amp circuit, 120V/1ph/60Hz, with cord and 3-prong plug for standard receptacle.

2.8 LIQUID LEVEL SWITCH

- A. Polypropylene housing with integrally mounted PVC air trap, receptacles for connection to metering pump, and low level alarm.
- B. Electrical Characteristics: 120V/1ph/60Hz.

2.9 CONDUCTIVITY CONTROLLER

- A. Packaged monitor controller with solid state circuiting, five percent accuracy, linear dial adjustment, built-in calibration switch, on-off switch and light, control function light, output to control circuit and recorder.
- B. Electrical Characteristics: 120V/1ph/60Hz.

2.10 WATER METER

- A. Displacement type cold water meter with sealed, tamper-proof magnetic drive, impulse contact register, single pole, double throw dry contact switch.
- B. Electrical Characteristics: 120V/1ph/60Hz.

2.11 SOLENOID VALVES

- A. Forged brass body globe pattern, normally open or closed as required, general purpose solenoid

enclosure, and continuous duty coil.

- B. Electrical Characteristics: 120V/1ph/60Hz.

2.12 TIMERS

- A. Electronic timers, infinitely adjustable over full range, 150 second and five minute range, mounted together in cabinet with hands-off-automatic switches and status lights.
- B. Electrical Characteristics: Suitable for 15 or 20 amp circuit, 120V/1ph/60Hz, with cord and 3-prong plug for standard receptacle.

2.13 TEST EQUIPMENT

- A. Provide white enamel test cabinet with local and fluorescent light, capable of accommodating 4 – 10 ml zeroing titrating burettes and associated reagents.
- B. Provide the Following Test Kits (verify suitability for the installed hot water piping systems):
 - 1. Alkalinity titration test kit.
 - 2. Chloride titration test kit.
 - 3. Sulphite titration test kit.
 - 4. Total hardness titration test kit.
 - 5. Low phosphate test kit.
 - 6. Conductivity bridge, range 0 - 10,000 microhms.
 - 7. Creosol red pH slide complete with reagent.
 - 8. Portable electronic conductivity meter.
 - 9. High nitrite test kit.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Systems shall be operational, filled, started, and vented prior to cleaning. Use water meter to record capacity in each system.
- B. Place terminal control valves in open position during cleaning.
- C. Verify that electric power is available and of the correct characteristics.

3.2 CLEANING SEQUENCE

- A. Concentration:
 - 1. As recommended by manufacturer.
 - 2. 1 pound per 100 gallons (1 kg per 1000 L) of water contained in the system.
 - 3. 1 pound per 100 gallons (1 kg per 1000 L) of water for hot systems and 1 pound per 50 gallons (1 kg per 500 L) of water for cold systems.
 - 4. Fill steam boilers only with cleaner and water.
- B. Hot Water Heating Systems:
 - 1. Apply heat while circulating, slowly raising temperature to 160 degrees F (71 degrees C)

- and maintain for 12 hours minimum.
 - 2. Remove heat and circulate to 100 degrees F (37.8 degrees C) or less; drain systems as quickly as possible and refill with clean water.
 - 3. Circulate for 6 hours at design temperatures, then drain.
 - 4. Refill with clean water and repeat until system cleaner is removed.
- C. Use neutralizer agents on recommendation of system cleaner supplier and approval of Architect/Engineer.
 - D. Flush open systems and glycol filled closed systems with clean water for one hour minimum. Drain completely and refill.
 - E. Remove, clean, and replace strainer screens.
 - F. Inspect, remove sludge, and flush low points with clean water after cleaning process is completed. Include disassembly of components as required.
- 3.3 INSTALLATION
- A. Install in accordance with manufacturer's instructions.
- 3.4 CLOSED SYSTEM TREATMENT
- A. Provide one bypass feeder on each system. Install isolating and drain valves and necessary piping. Install around balancing valve downstream of circulating pumps unless indicated otherwise.
 - B. Introduce closed system treatment through bypass feeder when required or indicated by test.

END OF SECTION 232500

SECTION 233113 – HVAC DUCTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Metal Ductwork.
- B. Nonmetal Ductwork.
- C. Casing and Plenums.
- D. Kitchen Hood Ductwork.
- E. Air Duct Leakage Tests.

1.2 PRODUCTS INSTALLED BUT NOT FURNISHED UNDER THIS SECTION

- A. Division 11 Section “Foodservice Equipment”: Supply of kitchen range hoods for placement by this Section.
- B. Division 23 Section “Air Duct Accessories”: Kitchen hoods.
- C. Division 23: Sensors and airflow measuring stations furnished under Division 23 Section “Instrumentation and Control for Mechanical Systems”; gauges and meters.
- D. Division 26 – Electrical: Smoke detectors.

1.3 RELATED SECTIONS

- A. Division 03 Section “Cast-in-Place Concrete.”
- B. Division 09 Section “Painting”: Weld priming, weather resistant, paint or coating.
- C. Division 23 Section “Testing, Adjusting and Balancing for HVAC.”
- D. Division 23 Section “Hangers and Supports for HVAC Piping and Equipment”: Sleeves.
- E. Division 23 Section “Duct Insulation”: External insulation and duct liner.
- F. Division 23 Section “HVAC Air Duct Cleaning.”
- G. Division 23 Section “Air Duct Accessories”
- H. Division 23 Section “Air Outlets and Inlets.”

1.4 REFERENCES

- A. ASTM
- B. AWS D9.1 - Welding of Sheet Metal.

- C. NBS PS 15 - Voluntary Product Standard for Custom Contact-Molded Reinforced-Polyester Chemical Resistant Process Equipment.
- D. NFPA
- E. SMACNA
- F. UL.

1.5 PERFORMANCE REQUIREMENTS

- A. No variation of duct configuration or sizes is permitted except by written permission from the Architect. Size proposed substitutions of round ducts in place of rectangular ducts in accordance with ASHRAE table of equivalent rectangular and round ducts.

1.6 SUBMITTALS

- A. Shop Drawings: Indicate duct fittings, particulars such as gauges, sizes, welds, and configuration. Submit prior to start of work.
- B. Product Data: Provide data for duct materials, duct liner and duct connectors.
- C. Test Reports: Submit testing apparatus, procedures, and preliminary forms prior to performing tests. On final reports, indicate pressure tests performed. Include date, section tested, test pressure, and leakage rate, following SMACNA HVAC Air Duct Leakage Test Manual.

1.7 PROJECT RECORD DOCUMENTS

- A. Record actual locations of ducts and duct fittings. Record changes in fitting location and type. Indicate additional fittings used.

1.8 QUALITY ASSURANCE

- A. Perform Work in accordance with SMACNA HVACDCS.

1.9 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the Products specified in this Section with minimum 3 years' experience.
- B. Installer: Company specializing in performing the work of this Section with minimum 3 years' experience.

1.10 REGULATORY REQUIREMENTS

- A. Construct ductwork to NFPA 90A, NFPA 90B and NFPA 96 standards.

1.11 ENVIRONMENTAL REQUIREMENTS

- A. Do not install duct sealants when temperatures are less than those recommended by sealant manufacturers.

- B. Maintain temperatures during and after installation of duct sealants.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

- A. Flexible Ducts:
 - 1. Flexible Technologies Group - Thermaflex product line.
 - 2. Buckley Associates - Flexmaster Triple-Lock Buck Duct product line.
 - 3. Substitutions: Not permitted.
- B. Plastic Drawbands:
 - 1. Panduit.
 - 2. Thomas and Betts.
 - 3. Tyton.
 - 4. Substitutions: Approved equal. See Section 016000 - Product Requirements
- C. Tape for Flexible Ducts:
 - 1. Ideal Tape Co., division of American Biltrite Inc.
 - 2. 3M Company.
 - 3. Nashua Tape Products, division of Berry Plastics Corp.
 - 4. Venture Tape Corporation.
 - 5. Substitutions: Not permitted.
- D. Manufactured Ductwork - Round and Flat Oval:
 - 1. McGill AirFlow LLC, a subsidiary of United McGill Corporation.
 - 2. Aero Heating & Ventilating, Inc.; Portland, ME.
 - 3. Air Purchases, Inc.; Manchester, NH – spiral duct lengths.
 - 4. Atlantic Air Products LLC; Bow, NH.
 - 5. Hahnel Brothers; Bangor and Lewiston, ME.
 - 6. Lindab, Inc. – duct fittings only.
 - 7. Macy Industries, Inc.; Hookset, NH.
 - 8. Northeastern Sheet Metal Inc.; Goffstown, NH.
 - 9. Semco Inc., division of the Flakt Woods Group.
 - 10. Total Air Supply; Nashua, NH – spiral duct lengths.
 - 11. Substitutions: Not permitted.
- E. Manufactured Ductwork - Transverse Duct Connection System:
 - 1. Ductmate.
 - 2. HFC Enterprises; Baldwin Park, CA – Dura Flange product line, for round and flat oval ducts only
 - 3. Substitutions: Approved equal. See Section 016000 - Product Requirements.
- F. Manufactured Ductwork - Kitchen Hood Single-Wall Grease Duct:
 - 1. Ampco, a division of Hart & Cooley Inc.
 - 2. CaptiveAire.
 - 3. Grease Master.
 - 4. Metal-Fab Inc.
 - 5. Schebler Chimney Systems, a division of The Schebler Co.
 - 6. Selkirk.

7. Substitutions: Approved equal. See Section 016000 - Product Requirements

G. Manufactured Ductwork - Kitchen Hood Double-Wall Grease Duct:

1. Ampco, a division of Hart & Cooley Inc.
2. CaptiveAire.
3. Metal-Fab Inc.
4. Schebler Chimney Systems, a division of The Schebler Co.
5. Selkirk.
6. Substitutions: Approved equal. See Section 016000 - Product Requirements

H. Sealants:

1. Hardcast, a division of Carlisle Corporation.
2. 3M Company.
3. Ductmate.
4. Foster.
5. McGill AirSeal LLC, a subsidiary of United McGill Corporation.
6. Mon-Eco Industries, Inc - Eco product line.
7. Polymer Adhesive Sealant Systems.
8. Substitutions: Approved equal. See Section 016000 - Product Requirements

2.2 MATERIALS

A. Galvanized Steel Ducts:

1. Steel sheet metal components of galvanized ductwork in this Specification Section shall be galvanized steel sheet, lock-forming quality, having G60 or heavier zinc coating (G90 minimum for outdoor or moist applications) conforming to ASTM A653 rating system and tested in accordance with ASTM A90.
2. Provide paint-grip exterior surfaces for exposed ducts, where available.
3. Sheet metal gauge shall be not less than 24 gauge.

B. Carbon Steel Ducts: ASTM A1008, A1011. Also known as black iron.

C. Aluminum Ducts: ASTM B209; aluminum sheet, alloy 3003-H14. Aluminum Connectors and Bar Stock: Alloy 6061-T6 or of equivalent strength.

2.3 FLEXIBLE DUCTS

A. Insulated Flexible Ducts:

1. Semi-Rigid Flexible Aluminum Ductwork:
 - a. Flexmaster Triple-Lock Buck Duct - Insulated.
 - b. Triple lock mechanical joint aluminum flex duct, constructed entirely without the use of adhesive.
 - c. Fiberglass insulation and fire-retardant polyethylene vapor retarder film.
 - d. Pressure Rating: Positive pressure 12 in. WG for all sizes. Negative pressure 12 in. WG for sizes thru 16 in. diameter, 8 in. WG for sizes 18 and 20 in. diameter.
 - e. Maximum Velocity: 5500 fpm.
 - f. Inside bend radius: Minimum one diameter.
 - g. Temperature Range: -40 to 250 degrees F
 - h. UL 181, Class 1 air duct.
 - i. Insulation: ASTM C518 or ASTM C177
 - 1) R-value: R-6 at 75 degrees F

- 2) Vapor Transmission Rating: 0.10 perms, ASTM E96.
 - 3) Minimum density: 2" at 0.71 lb/cu. ft.
 - j. Meets NFPA 90A and 90B standards.
- B. Non-Insulated Flexible Ducts:
- 1. Semi-Rigid Flexible Aluminum Ductwork:
 - a. Flexmaster Triple-Lock Buck Duct - Bare.
 - b. Triple lock mechanical joint aluminum flex duct, constructed entirely without the use of adhesive.
 - c. Pressure Rating: 12 inches WG positive for all sizes, 12 inches WG negative for sizes thru 16 in. diameter, 8 inches WG negative for sizes 18 in. and 20 in. diameter.
 - d. Maximum Velocity: 5500 fpm.
 - e. Inside bend radius: Minimum one diameter.
 - f. Temperature Range: -40 to 250 degrees F.
 - g. UL 181, Class 0 air duct.
 - h. Meets NFPA 90A and 90B standards.
- C. Return and Exhaust: Use either semi-rigid flexible aluminum type (insulated or bare), or fabric-core type (insulated). Non-insulated fabric-core type does not have adequate negative pressure rating.

2.4 ACCESSORIES

- A. Drawbands for Flexible Ducts:
- 1. Stainless Steel: ½ inch wide with screw-driven worm gear.
 - 2. Plastic: Panduit PLT5H or PLT8H; Thomas and Betts Dukt-Rap, VAL-26-50, or VAL-275X-25; or Tyton T150L or LX. Install with manufacturer's lever-action tightening tool.
- B. Tape for Flexible Ducts: Ideal-Seal 587A/B, UL 181B-FX listed, aluminum foil with pressure-sensitive acrylic adhesive, -20 to 250 degrees F temperature range, 25.0 lb/in. width tensile strength.
- C. Fasteners: Rivets, bolts, or sheet metal screws.
- D. Sealants: See Duct Sealant portion of this Specification.
- E. Hanger Rod: ASTM A36; galvanized steel; threaded both ends, threaded one end, or continuously threaded.

2.5 DUCTWORK FABRICATION

- A. Fabricate and support in accordance with SMACNA HVACDCS, as specified or as indicated on the drawings. Provide duct material, gauges, reinforcing, and sealing for operating pressures indicated.
- B. SMACNA Duct Construction Manuals:
- 1. The SMACNA recommendations shall be considered as mandatory requirements.
 - 2. Substitute the word "shall" for the word "should" in these manuals.
 - 3. Where the Contract Specifications differ from SMACNA recommendations, the more

- stringent requirements (as determined by the Architect) shall take precedence.
4. Details on the Contract Drawings take precedence over SMACNA standards.
- C. Sheet metal shall be galvanized steel as specified in Part 2 paragraph "Materials" in this Section, unless otherwise indicated or specified.
- D. Construct Tees, bends, and elbows with radius of not less than 1-1/2 times width of duct on centerline.
1. Where space is too restricted for full-radius elbows, provide mitered (square-throat) elbows with single wall turning vanes. Do not use air foil turning vanes.
 2. Mitered elbows in round or flat-oval ductwork shall be factory-manufactured.
 3. Radiused elbows with throat radius 1/2 times width of duct (centerline radius 1 width of duct) may be used instead of mitered elbows, but only where space is too restricted for full radius.
 4. Fittings not conforming to these requirements will be ordered removed and replaced with proper fittings.
- E. Increase duct sizes gradually, not exceeding 15 degrees divergence or convergence (per side) wherever possible; maximum 30 degrees divergence (per side) upstream of equipment and 45 degrees convergence (per side) downstream.
- F. Fabricate continuously welded round and oval duct fittings two gauges heavier than duct gauges indicated in SMACNA Standard. Joints shall be minimum 4 inch cemented slip joint, brazed or electric welded. Prime coat welded joints.
- G. Provide standard 45 degree lateral wye takeoffs unless otherwise indicated where 90 degree conical tee connections may be used.
- H. Longitudinal locks or seams known as "button-punch-snap-lock" and other "snap-lock" types will not be permitted in rectangular duct. Snap-lock longitudinal seams may be used on round ducts up to 8 inches diameter, with screws provided to secure the seams at 24 inches on center maximum spacing.
- I. Exposed Ducts: Select and handle materials with care for a neat appearance. Joint connections on round and flat oval ducts shall be sleeve or flanged type; drawbands are not acceptable.

2.6 MANUFACTURED DUCTWORK AND FITTINGS

- A. Manufacturers:
1. McGill Airflow: Standard Uni-Seal product line (smooth surface between spiral lockseams)
 2. Uni-Rib product line (one standing seam reinforcement between each pair of spiral lockseams).
 3. Substitutions: Approved equal. See Section 016000 - Product Requirements
 - a. Standard spiral product line (smooth surface between spiral lockseams).
- B. Manufactured ductwork and fittings listed above are acceptable alternatives to standard ductwork systems. For exposed round and flat oval ductwork, factory-manufactured ductwork and fittings are required.
- C. Manufacture in accordance with SMACNA HVACDCS, and as specified or as indicated on the

drawings. Provide duct material, gauges, reinforcing, and sealing for operating pressures indicated.

- D. Ductwork and fittings shall be products of a single manufacturer.
- E. Exposed Ducts:
 - 1. Select and handle materials with care for a neat appearance.
 - 2. Joint connections on round ducts shall be sleeve or flanged type; drawbands are not acceptable. Joint connections on flat oval ducts 42 inches and wider shall be flanged type to ensure tight fit and good appearance.
 - 3. Provide exterior reinforcing only where required, with prior approval from the Architect.
- F. Galvanized sheet metal used in fabrication shall be not less than 26 gauge thickness. Aluminum shall be not less than 0.025 in. nominal thickness. This requirement supersedes SMACNA requirements.
- G. Round Duct and Fittings:
 - 1. Shall be suitable for at least 4 in. WG positive pressure and 2 in. WG negative pressure in accordance with SMACNA HVACDCS standards. This is a minimum; provide higher ratings where required.
 - 2. Fittings shall be fabricated of sheet metal at least one gauge heavier than straight duct of the same size.
 - 3. Fittings shall be factory-sealed so that no field sealing of joints between gores or segments is required. Acceptable methods of construction are fully welded, spot-welded with inner sealant, or standing-seam crimped joints.
- H. Radiused Elbows in Round :
 - 1. In exposed ductwork shall be non-adjustable type, factory-sealed.
 - 2. In concealed ductwork may be adjustable type, with full long radius as detailed on the Drawings. Short-radius elbows are not allowed.
 - 3. Shall be constructed of the following minimum number of segments or gores: 90-degree: 4 gores; 60-degree: 3 gores; 45-degree: 3 gores; 30-degree: 2 gores; 22-1/2-degree: 2 gores.
 - 4. 1-piece stamped elbows are acceptable up to 12 inches diameter. Pleated elbows are acceptable up to 10 inches diameter.
- I. Mitered Elbows in Round:
 - 1. Available in both 90-degree and 45-degree elbows.
 - 2. Shall have minimum number of welded single-wall vanes as follows (size is duct width in plane of bend):
 - a. 3 to 9 inch: 2.
 - b. 10 to 14 inch: 3.
 - c. 15 to 19 inch: 4.
 - d. 20 to 60 inch: 5.
 - e. Larger Sizes: 12-inch maximum spacing.
- J. Inner tie-rod reinforcement is not allowed. Increase duct sheet metal gauge or external reinforcement as required.
- K. Transverse Duct Connection System: SMACNA "F" rated or SMACNA "J" rated rigidity class connection, interlocking angle and duct edge connection system with sealant, gasket, cleats, and

corner clips. Product shall be Ductmate factory-manufactured connectors, or field-formed flanges using a specialized machine.

2.7 KITCHEN GREASE HOOD EXHAUST DUCTWORK

- A. Fabricate in accordance with SMACNA HVACDCS and NFPA 96.
- B. Construct of 16 gauge carbon steel or 18 gauge type 304 or 316 stainless steel, using continuous external welded joints. Ductwork exposed to view or exposed to weather shall be stainless steel unless otherwise indicated.
- C. Gaskets and sealants shall be rated for 1500 degrees F continuous operation.
- D. Connection to Fan: Provide transition plate to fan base, of same material as duct. Outer perimeter shall be full size of fan base or curb. Inner opening shall be same size as duct and similar to fan inlet size. Inner opening shall be centered in plate to align with fan inlet and to maintain clearances. Duct shall be welded smoothly and continuously to the transition plate, preferably butt-welded to the underside of the plate or with plate corners turned down into duct, rather than duct turned out onto plate. Provide a smooth flat surface for installation of high-temperature gasket between transition plate and fan base. Fasten transition plate to the roof curb (or non-combustible wall opening).
- E. Elbows:
 - 1. Mitered: Internal turning vanes are not allowed. Mitered elbows should be avoided in grease ducts except where indicated.
 - 2. Radiused: Provide full radius (centerline radius 1-1/2 times the duct width), continuously curved for rectangular duct, gored for round duct. In manufactured round duct, elbows may be manufacturer's standard, with throat radius as little as 6 inches.
- F. Factory-manufactured single-wall grease duct may be used where single-wall round duct is indicated.
 - 1. The system shall be UL Classified in accordance with UL 1978.
 - 2. The factory-built grease duct system shall be designed and installed to be liquid tight to prevent leakage of the exhaust into the building.
 - 3. The system shall be designed to compensate for thermal expansion.
 - 4. The single wall exhaust shall be of type 430, 304 or 316 stainless steel. Minimum steel thickness shall be 0.035 inch (20 gauge)
 - 5. Pipe joints shall be sealed by use of factory-supplied V-Bands and sealant.
 - 6. The entire system from outlet to the termination, including accessories and support brackets, except as noted, shall be from the manufacturer. Access doors may be the product of other manufacturers.
 - 7. The diameter for the exhaust shall be verified by the manufacturers' computations. The computation shall be technically sound, shall follow ASHRAE calculation methods, and incorporate the specific flow characteristics of the pipe.
 - 8. Provide offset collars for transitions from vertical to horizontal, to provide proper slope.
 - 9. Provide adjustable lengths to field-fit ductwork, with adjustable clamping collar.
- G. Factory-Manufactured Double-Wall Grease Duct with Zero Clearance to Combustibles:
 - 1. Products:
 - a. Ampco - Model IVSI-4ZC.
 - b. Captive-Aire – Model DW-3Z (available diameters 8 to 24 in..)

- c. Metal-Fab - Models 3G and 4G.
- d. Schebler - FyreGuard.
- e. Selkirk - ZeroClear.
- f. Substitutions: Approved equal. See Section 016000 - Product Requirements
- 2. The system shall be UL Classified in accordance with UL 1978 and UL 2221.
- 3. The system shall be rated for zero clearance to combustibles.
- 4. The outer shell shall have a 2 hour fire rating, as an integral enclosure eliminating field-built enclosures.
- 5. The system shall be designed and installed to be liquid tight to prevent leakage of the exhaust into the building.
- 6. The system shall be designed to compensate for thermal expansion.
- 7. The inner wall shall be Type 430, 304, or 316 stainless steel. Minimum steel thickness shall be 0.035 inch (20 gauge).
- 8. The outer wall shall be Type 430, 304, or 316 stainless steel. Minimum steel thickness shall be 0.024 inch (24 gauge) on diameters up to 24 inches, 0.035 inch (20 gauge) on diameters up to 36 inches, and 0.048 inch (18 gauge) on larger sizes.
- 9. The integral interstitial insulation shall be heavy-duty high-temperature blanket type. Thickness 3 or 4 inches as required for UL classification. The insulation shall be attached to the inner duct wall using metal bands and fasteners.
- 10. Pipe joints shall be sealed by use of factory-supplied V-Bands and sealant.
- 11. Provide hood transitions, roof support section, and fan adapter.
- 12. The entire system from outlet to the termination, including access doors, accessories and support brackets, except as noted, shall be from the manufacturer.
- 13. The diameter for the exhaust shall be verified by the manufacturers' computations. The computation shall be technically sound, shall follow ASHRAE calculation methods, and incorporate the specific flow characteristics of the pipe.
- 14. Provide offset collars for transitions from vertical to horizontal, to provide proper slope.
- 15. Provide adjustable lengths to field-fit ductwork, with adjustable clamping collar.

H. Factory-Manufactured Double-Wall Grease Duct with $\frac{3}{4}$ inch Clearance to Combustibles:

- 1. Products:
 - a. Captive-Aire – Model DW-2R (available diameters 8 to 24 in..)
 - b. Products of other manufacturers which are listed for zero clearance may be substituted. These products have thicker insulation and require additional space for installation, which is the Contractor's responsibility to provide.
 - 1) Ampco - Model IVSI-4ZC.
 - 2) Metal-Fab - Models 3G and 4G.
 - 3) Schebler - FyreGuard.
 - 4) Selkirk - ZeroClear.
 - 5) Substitutions: Approved equal. See Section 016000 - Product Requirements
- 2. The system shall be UL Classified in accordance with UL 1978 and UL 2221.
- 3. The system shall be rated for $\frac{3}{4}$ inch clearance to combustibles, measured from the duct outer shell.
- 4. The outer shell shall have a 2 hour fire rating, as an integral enclosure eliminating field-built enclosures.
- 5. The system shall be designed and installed to be liquid tight to prevent leakage of the exhaust into the building.
- 6. The system shall be designed to compensate for thermal expansion.
- 7. The inner wall shall be Type 430, 304, or 316 stainless steel. Minimum steel thickness shall be 0.035 inch (20 gauge)
- 8. The outer wall shall be Type 430, 304, or 316 stainless steel. Minimum steel thickness

- shall be 0.024 inch (24 gauge) on diameters up to 24 inches, 0.035 inch (20 gauge) on diameters up to 36 inches, and 0.048 inch (18 gauge) on larger sizes.
9. The integral interstitial insulation shall be heavy-duty high-temperature blanket type. Thickness 2 or 3 inches as required for UL classification. The insulation shall be attached to the inner duct wall using metal bands and fasteners.
 10. Pipe joints shall be sealed by use of factory-supplied V-Bands and sealant.
 11. Provide hood transitions, roof support section, and fan adapter.
 12. The entire system from outlet to the termination, including access doors, accessories and support brackets, except as noted, shall be from the manufacturer.
 13. The diameter for the exhaust shall be verified by the manufacturers' computations. The computation shall be technically sound, shall follow ASHRAE calculation methods, and incorporate the specific flow characteristics of the pipe.
 14. Provide offset collars for transitions from vertical to horizontal, to provide proper slope.
 15. Provide adjustable lengths to field-fit ductwork, with adjustable clamping collar.

2.8 PRESSURE CLASSIFICATION

- A. Ratings as indicated on the Drawings or as specified. See Ductwork Pressure Class Schedule in Part 3 of this Section.
- B. If no ratings are indicated, ductwork shall be rated for the external static pressure of the system plus 25 percent.
 1. If 4 dampers (of any type) or fewer can isolate a duct system, that portion of the system shall be rated for the shut-off pressure of the system fans.

2.9 DUCT SEALING

- A. Seal ductwork as outlined in the SMACNA HVACDCS. Seal ductwork to a minimum of class A (transverse joints, longitudinal seams, and duct wall penetrations), regardless of pressure class.
- B. Seal ductwork systems as required to ensure that maximum duct leakage does not exceed that allowed by the latest edition of the SMACNA HVAC Air Duct Leakage Test Manual. Allow sealant to dry in accordance with manufacturer's requirements of time and environmental conditions before ductwork systems are pressurized.
- C. Duct sealing materials used shall be non-flammable and non-combustible in both liquid and solid states.
- D. Seal Pittsburgh hammered lockseams by flooding the joint with sealant prior to assembly.
- E. Seal exposed ducts by applying mastic-type or gasket-type sealer just before the joint or seam is made; remove excess sealant for a neat appearance.
- F. Fill (with matching duct material such as sheet metal) any gaps in duct which exceed the recommendations of the sealant manufacturer, and in no case shall liquid or mastic sealant be used to fill gaps or openings which exceed 1/8 inch in any direction. Verify that system air pressure acting on a wide gap will not exert enough force to damage or loosen the sealant.
- G. Materials for Sealing:
 1. Hardcast: Flex-Grip 550 or Iron-Grip 601 mastic.

2. Hardcast: gypsum-based tape and mastic, waterproof type when used on moist-air exhaust or in humid or outdoor locations.
3. Ductmate: Flanged lateral joints with gaskets.
4. Ductmate: PROseal.
5. Foster: Duct-Fas or Safetee mastic sealant. Duct-Fas is UV resistant and recommended for applications exposed to sunlight.
6. Mon-Eco: Eco-Duct Seal 4450 (red color) or 4452 (grey color). Use grey color where ducts will be unpainted and exposed to public view.
7. Polymer Adhesives Sealant Systems: Airseal No. 11 premium sealant.
- 8.

2.10 UNIFORMITY OF MATERIALS

- A. Ductwork accessories, including but not limited to volume dampers, smoke dampers, fire dampers, combination fire/smoke dampers, backdraft dampers and motorized dampers, shall be fabricated of materials that are similar to the ductwork in which they are installed.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install components furnished under other Section and Divisions of the Specifications. Such items may include but are not limited to: Sensors and airflow measuring stations furnished under Division 23 Section "Instrumentation and Control for Mechanical Systems"; gauges and meters; and smoke detectors furnished under Division 26 – Electrical.
- C. Install ducts in accordance with SMACNA HVACDCS.
- D. Duct Hangers and Supports:
 1. Provide in accordance with SMACNA HVAC Duct Construction Standards, Section 4.
 2. Regardless of SMACNA standards, duct hangers shall be provided as follows:
 - a. Hang ducts up to and including 36 inches (914 in width by a minimum of 1 in x 16 ga flat straps on each side of the duct on 4 ft centers, bent under bottom of duct a minimum of 2 inches and securely fastened to duct. Hang ducts larger than 36 inches in width by 3/8 inch steel rods and 2 x 2 x 1/4-inch steel angle trapeze hangers, spaced 4 ft on center. Anchor risers in the center of the vertical run to allow ends of riser free vertical movements.
 - b. Ducts with Extra Weight Such As Lead Lining or Lagging: Include the extra weight in determination of suitable hangers and supports.
- E. Hanging of Ductwork:
 1. Attach supports only to structural framing members and non-metal deck concrete slabs.
 2. Support ductwork from the top chord of bar joists at the "Panel Points" or from the top flange of beams. Provide intermediate support consisting of steel angle or equal as required where supports are installed between joist spaces.
 3. Do not anchor supports to metal decking with or without a concreted slab.
- F. Duct Sizes are inside clear dimensions. For lined ducts, maintain sizes inside lining.

- G. “Fishmouth” duct connections are not allowed.
- H. Inner tie-rod reinforcement is not allowed. Increase duct sheet metal gauge or external reinforcement as required.
- I. Exposed Ducts:
 - 1. Handle with care for a neat appearance. Repair or replace dented or damaged ductwork as required by the Architect. Select hangers for appearance, and to prevent sagging or distortion of duct.
 - 2. Seal ductwork from inside, do not permit exterior sealant to remain.
 - 3. Remove labels attached to ducts before receiving paint.
- J. Provide openings in ductwork where required to accommodate thermometers and controllers. Provide pitot tube openings where required for testing of systems, complete with metal can with spring device or screw to ensure against air leakage. Where openings are provided in insulated ductwork, install insulation material inside a metal ring.
- K. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.
- L. Use crimp joints with or without bead for joining round duct sizes 8 inch and smaller with crimp in direction of air flow.
- M. Use double nuts and lock washers on threaded rod supports. Strap hangers shall be minimum 16 gauge x 1 inch galvanized straps. Hanger and support components including but not limited to “unistrut” shall be galvanized steel except that where other duct materials are used, the hanger materials shall be compatible and non-corrosive to the duct. Wire hangers are not acceptable.
- N. Flexible Ducts:
 - 1. Connect diffusers to low pressure supply ducts directly or with 5 feet maximum length of flexible duct held in place with strap or clamp.
 - 2. Minimum bend radius shall be one and one half times the duct diameter. Support the bend to maintain this radius.
 - 3. Bends shall not exceed 45 degrees.
 - 4. Connect flexible ducts to metal ducts with 2 turns of duct tape and metal draw bands. Plastic drawbands may be used if they are installed using the band manufacturer’s lever-action tightening tool. On insulated flexible ducts, provide an additional seal of tape and drawband on the insulation’s vapor barrier.
- O. During construction, provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system. Do not start ducted air moving equipment until construction is completed to a stage where airborne construction dust is no longer present. At the time of substantial completion, the entire air distribution system shall be turned over to the Owner clear of construction dust and debris. If the interior surfaces of any ducted air moving equipment or the interior surfaces of any portion of the ductwork distribution system are found, as determined by the Architect, to contain significant construction dust and debris, the entire air distribution system shall be cleaned in accordance with Division 23. If proper precautions are taken to prevent construction dust and debris from entering the ductwork during construction and if the Architect finds all ductwork to be free from such dust and debris, air duct cleaning shall not be required.

- P. For fresh air intake and exhaust plenums connected to louvers or brick or block vents, pitch bottom of plenums down to bottom of louver at minimum 1/4 inch per foot (2 percent). Seal connections and joints on bottom of plenums watertight with mastic. Connect bottom of plenum to top-inside edge of bottom louver blade or waterstop as detailed on the Drawings, to ensure positive drainage. Provide 3/4" drain connection at the lowest point upstream of pitched duct connection to louver. Pipe to nearest floor drain.
- Q. Install duct-mounted components furnished under other Sections of this Specification, such as smoke dampers, control dampers, control sensors, and smoke detectors. Install with straight lengths of duct as required for proper operation. Provide access at such components as required. Install in accessible locations for maintenance; notify the Architect if a location indicated or selected requires addition of access by other trades.
- R. Kitchen Grease Hood Exhaust Ductwork:
1. Install grease ducts without forming dips or traps.
 2. Use polished stainless steel for ductwork exposed to view, and stainless steel or carbon steel for ducts where concealed.
 3. Seams, joints, and penetrations shall have a liquidtight continuous external weld.
 4. Connect to hood as required by the Mechanical Code, NFPA 96, and manufacturer's instructions. If a factory raised angle collar is provided with the hood, provide a compatible angle on the duct end, and weld continuously or provide a bolted and gasketed connection to allow disassembly. If no factory collar is provided, insert the duct 1 inch into the hood and weld continuously. Do not field-modify or cut the hood with written permission from the Architect.
 5. At fan, provide a fan adapter of same construction as duct, with flat plate the full size of fan base or curb. Weld duct continuously to the plate, centered to maintain clearances to curb and straight inlet to fan. Provide a smooth flat surface for installation of fan gasket.
 6. Manufactured Ductwork: Install in accordance with manufacturer's instructions.
 7. Ducts shall not pass through fire walls or fire partitions.
 8. Clearances: Maintain minimum 18 inches from ductwork to combustible materials and minimum 3 inches from ductwork to limited combustible materials. Clearances may be reduced in accordance with manufacturer's UL listing for fire-resistive duct wrap
 9. Provide mechanical sealing adapter by Ansul Fire Protection (or equal by Kidde) to allow access by balancing contractor for balancing hood system. Coordinate size of mechanical sealing adapter with balancing contractor. Provide cap for adapter when not in use. Install mechanical sealing adapter in exhaust ductwork as close to exhaust fan as possible.

3.2 AIR DUCT LEAKAGE TESTS

- A. Perform air duct leakage tests in accordance with the testing procedures outlined in the latest edition of the SMACNA HVAC Air Duct Leakage Test Manual.
- B. Leakage testing shall be performed on complete ductwork including fittings and accessories such as dampers, access doors, branch connections, and inlets and outlets. Flexible ducts, VAV boxes, air handling units, and duct coils may be excluded. Ducts may be temporarily sectioned and capped for testing, for reasons of limited test apparatus capacity, or requirements of construction phasing.
- C. Leakage tests, including retests as required, shall be performed prior to concealment and

insulation.

- D. The Following Duct Systems Shall Be Tested for Leakage, regardless of whether or not SMACNA recommends testing:
 - 1. Ductwork.
- E. Submit testing apparatus, procedures, and preliminary forms prior to performing tests.
- F. Once leakage tests are complete, submit leakage test report. Leakage test report forms shall include the following:
 - 1. Project and system identification data
 - 2. Description of ductwork under test
 - 3. Leakage class specified
 - 4. Test pressure specified
 - 5. Duct construction pressure class
 - 6. Duct design air flow
 - 7. Surface area of ductwork under test
 - 8. Maximum allowable leakage factor
 - 9. Calculated allowable leakage
 - 10. Test apparatus
 - a. Blower
 - b. Orifice, tube size
 - c. Orifice size
 - d. Orifice coefficient
 - e. Calibration date
 - 11. Test orifice differential pressure
 - 12. Leakage for tested section
 - 13. Total leakage for system
 - 14. Date of test
 - 15. Witnesses
- G. Air duct leakage testing shall be performed by an experienced agency that is independent of the Testing, Adjusting and Balancing (TAB) Agency specified in Division 23 - Testing, Adjusting and Balancing.
- H. The TAB Agent shall witness the duct leakage tests performed under Division 23. At a minimum, the first duct leakage test shall be witnessed and approved by the TAB Agent and the Engineer. At a minimum, subsequent duct leakage tests shall be witnessed and approved by the TAB Agent. The TAB Agent shall confirm proper testing procedures and shall give written approval of the leakage tests. If deficiencies are discovered, the TAB agent shall document these deficiencies to the Contractor and the Engineer. Once deficiencies are corrected, the TAB Agent shall witness follow-up leakage tests.
- I. Coordinate with TAB Agency and receive written sign-off of the leakage tests by the TAB Agent prior to submitting leakage test report.

Leakage Class Schedule:

DUCT PRESSURE CLASS	DUCT TYPE	LEAKAGE CLASS
Below 3 inch W.G.	Rectangular Metal	12

Below 3 inch W.G.	Round Metal	6
3 inch W.G. and above	Rectangular Metal	6
3 inch W.G. and above	Round Metal	3

3.3 SCHEDULES

A. Ductwork Material Schedule

AIR SYSTEM	MATERIAL
Low Pressure Supply (Heating Systems)	Galvanized Steel, Aluminum
Low Pressure Supply (System with Cooling Coils)	Galvanized Steel, Aluminum
Return and Relief	Galvanized Steel, Aluminum
General Exhaust	Galvanized Steel, Aluminum
Kitchen Grease Hood Exhaust	Steel, Stainless Steel
Outside Air Intake	Galvanized Steel, Aluminum

END OF SECTION 233113

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SECTION 233300 – AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Dampers:
 - 1. Backdraft Dampers.
 - 2. Counterbalanced Dampers.
 - 3. Volume Control Dampers.
- B. Airflow Control Valves.
- C. Drip Pans.
- D. Duct Access Doors.
- E. Duct Sleeves, Prepared Openings and Closure Collars.
- F. Duct Test Holes.
- G. Flexible Duct Connections.
- H. Roof Curbs.
- I. Round Duct Branch Taps.
- J. Turning Vanes.
- K. Wire Mesh for Screens.
- L. General Exhaust Hoods.
- M. Kitchen Exhaust Hoods.
- N. Kitchen Hood Fire Extinguishing Systems.

1.2 RELATED SECTIONS

- A. Division 07 Section “Through-Penetration Firestop Systems.”
- B. Division 23 Section “Common Work Results for HVAC”
- C. Division 23 Section “Identification for HVAC Piping and Equipment.”
- D. Division 23 Section “Vibration and Seismic Controls for HVAC Piping and Equipment.”
- E. Division 23 Section “Instrumentation and Control for Mechanical Systems.”
- F. Division 23 Section “Metal Ducts.”

- G. Division 23 Section "Sound Attenuators."
- H. Division 26 "Electrical": Electrical characteristics and wiring connections.

1.3 REFERENCES

- A. ASTM C423-02a - Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method.
- B. ASTM E477-99 - Standard Test Method for Measuring Acoustical and Airflow Performance of Duct Liner Materials and Prefabricated Silencers.
- C. NFPA 90A - Installation of Air Conditioning and Ventilating Systems.
- D. NFPA 92A - Smoke Control Systems.
- E. NFPA 70 - National Electrical Code.
- F. NFPA 96 - Installation of Equipment for the Removal of Smoke and Grease-Laden Vapors from Commercial Cooking Equipment.
- G. SMACNA - HVAC Duct Construction Standards - Metal and Flexible, Third Edition - 2005 (HVACDCS).
- H. SMACNA - Seismic Restraint Manual - Guidelines for Mechanical Systems (SRMGMS).
- I. UL 33 - Heat Responsive Links for Fire-Protection Service.
- J. UL 94 - Safety of Flammability of Plastic Materials for Parts in Devices and Appliances Testing.
- K. UL 555 - Fire Dampers and Ceiling Dampers.
- L. UL 555S - Leakage Rated Dampers for Use in Smoke Control Systems.
- M. UL 1995 - Heating and Cooling Systems.

1.4 SUBMITTALS

- A. Shop Drawings: Indicate for shop fabricated assemblies including volume control dampers, duct access doors and duct test holes.
- B. Product Data: Provide for shop fabricated assemblies including volume control dampers, duct access doors, duct test holes and hardware used. Include electrical characteristics and connection requirements.
- C. Manufacturer's Installation Instructions: Indicate for fire dampers and combination fire and smoke dampers.

1.5 PROJECT RECORD DOCUMENTS

- A. Record actual locations of access doors and test holes.

1.6 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the products specified in this Section with minimum 3 years' experience.

1.7 REGULATORY REQUIREMENTS

- A. Products Requiring Electrical Connection: Listed and classified by Underwriters' Laboratories Inc., as suitable for the purpose specified and indicated.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect and handle products to site under provisions of documents.
- B. Protect dampers from damage to operating linkages and blades.

PART 2 - PRODUCTS

2.1 GALVANIZED STEEL

- A. Steel sheet metal components of accessories in this Specification Section shall be galvanized steel sheet, lock-forming quality, having G60 or heavier zinc coating conforming to ASTM A653 rating system and tested in accordance with ASTM A90. Provide paint-grip exterior surfaces for exposed ducts, where available.

2.2 DAMPERS

- A. Manufacturers:
 - 1. Ruskin.
 - 2. Air Balance, Inc.
 - 3. Arrow.
 - 4. Cesco.
 - 5. Greenheck.
 - 6. NCA.
 - 7. Tamco.
 - 8. Ventex.
 - 9. Vent Products, Inc.
 - 10. Substitutions: Not permitted.
- B. Backdraft Dampers:
 - 1. Gravity Backdraft Dampers, Size 18 x 18 inches (450 x 450 mm) or Smaller, Furnished with Air Moving Equipment: Air moving equipment manufacturer's standard construction.
 - 2. Multi-Blade, Parallel Action Gravity Backdraft Dampers: Frames of 16 ga (1.5 mm) thick galvanized steel, or extruded aluminum, with blades of maximum 6 inch (150 mm) width,

with felt or flexible vinyl sealed edges, linked together in rattle-free manner with 90 degree stop, steel ball or sintered bronze bearings, and plated steel pivot pin; Pressure and velocity ratings shall be suitable for the application.

C. Counterbalanced Dampers:

1. Multi-Blade, Parallel Action Gravity Balanced Counterbalanced Dampers: Frames of 16 ga (1.5 mm) thick galvanized steel, or extruded aluminum, with blades of maximum 6 inch (150 mm) width, with felt or flexible vinyl sealed edges, linked together in rattle-free manner with 90 degree stop, steel ball or sintered bronze bearings, and plated steel pivot pin; adjustment device to permit setting for varying differential static pressure. Pressure and velocity ratings shall be suitable for the application.

D. Volume Control Dampers:

1. Factory-fabricate in accordance with SMACNA HVACDCS, and as specified or as indicated on the Drawings.
2. Shop fabrication is permitted for single blade dampers only.
3. Height is the dimension perpendicular to the blade rod or shaft. Width is the dimension parallel to the blade rod.
4. Single Blade Dampers: For duct sizes (height x width) up to 7 x 30 inch (175 x 760 mm). When height or width exceeds its respective maximum, provide multi-blade damper.
5. Multi-Blade Damper: Opposed blade pattern with maximum blade sizes (height x width) 8 x 72 inch (200 x 1825 mm). Assemble center and edge crimped blades in prime coated or galvanized channel frame with suitable hardware.
6. End Bearings: Except in round ductwork 6 inches (150 mm) and smaller, provide end bearings. On multiple blade dampers, provide oil-impregnated nylon or sintered bronze bearings. Provide retainer clips or other devices to prevent bearings from pulling out. For single-blade dampers, plastic bearings are allowed.
 - a) Manufacturers:
 - 1) Duro Dyne.
 - 2) Elgen Manufacturing.
 - 3) Rossi.
 - 4) Ventfabrics.
 - 5) Substitutions: Approved equal. See Section 016000 - Product Requirements
 - b) Snap-in Plastic Bearings for Single-Blade Dampers: Designed to push into hole in sheet metal, with retaining tabs. Flame Retardant, Glass Reinforced, "Zytel" polymer by Dupont, conforming to UL 1995 and UL 94 with the required flammability rating of 5VA or lower. Acceptable materials include Polyamide 66 (PA66) (glass-reinforced Dupont Zytel), nylon and acetyl. Submit manufacturer's verification of the suitability of these bearings for the application, including operating pressures and temperatures.
7. Quadrants:
 - a) Manufacturers:
 - 1) Duro-Dyne.
 - 2) Elgen Manufacturing.
 - 3) Rossi.
 - 4) Ventfabrics.
 - 5) Substitutions: Approved equal. See Section 016000 - Product Requirements
 - b) Duro-Dyne Specline SR and SRH series; Quadline series; or Stampline dial regulators and wedge-loc regulators. Or equal by Elgen, Rossi, or Ventfabrics. Factory-manufactured dampers shall have damper manufacturer's choice of

- quadrant equal to the Duro-Dyne products specified.
 - c) Provide locking, indicating quadrant regulators on single and multi-blade dampers. Regulators shall include lever handle, locking wing nut and graduated indicator dial. Provide shaft seals, bushings, or gaskets for duct penetrations. Quadrants without these features are not allowed.
 - 1) Rossi Everlock Regulators: Locking lever handle of Polyamide 66 (PA66) (glass-reinforced Dupont Zytel) plastic, thumb trigger with stainless steel spring, with at least 9 latching positions in a 90 degree rotation.
 - d) On insulated ducts mount quadrant regulators on stand-off mounting brackets, bases, or adapters, with open space to run insulation through.
 - e) Where rod lengths exceed 30 inches (750 mm) provide regulator at both ends, with a single rod so that either regulator will control the entire damper.
- 8. Provide required operating wrenches for balancing, and furnish to the Owner at project completion.

2.3 DRIP PANS

- A. Provide each cooling coil section in both field-and-factory assembled casings with a stainless or galvanized steel drip pan not less than 18 ga (1.31 mm) with drain connections. Drip pans shall collect, confine, and dispose of condensate from cooling coils and attachments, including headers, return bends, distributors, and uninsulated pipe and fittings. Slope pans toward the drain pipe connection(s) to ensure complete drainage. Where individual coil fins are in section (not in one piece from top to bottom of coil bank), provide auxiliary drip troughs at bottom of each section with drains to drip pans. Insulate drip pans with water impervious insulation of sufficient thickness to prevent condensate formation on the exterior at ambient conditions to be encountered.

2.4 DUCT ACCESS DOORS

- A. Manufacturers:
 - 1. Standard Doors:
 - a) Ruskin.
 - b) Air Balance, Inc.
 - c) Arrow.
 - d) Buckley Associates.
 - e) Cesco.
 - f) DuctMate.
 - g) Greenheck.
 - h) Nailor.
 - i) Vent Products, Inc.
 - j) Shop fabricated.
 - k) Substitutions: Approved equal. See Section 016000 - Product Requirements
 - 2. Medium and High-Pressure Doors:
 - a) Ruskin.
 - b) DuctMate.
 - c) Greenheck.
 - d) Nailor.
 - e) Substitutions: Not permitted.
 - 3. Grease Duct Doors:
 - a) Ductmate.

- b) Shop fabricated.
 - c) Substitutions: Approved equal. See Section 016000 - Product Requirements
- B. Fabricated in accordance with SMACNA HVACDCS, and as specified or as indicated on the Drawings. Standard access doors and access doors for grease ducts may be shop-fabricated. Pressure rating shall be equal to the rating of the associated ductwork; see Part 3 Division 23 Section "Metal Ducts" for schedule of pressure classes.
- C. Standard Doors: Removable, with retainer chain. Rigid and close-fitting with sealing gaskets and quick fastening locking devices. For insulated ductwork, install minimum 1 inch (25 mm) thick insulation with galvanized steel sheet metal airstream-side cover.
 - 1. 16 inches (406 mm) Square and Smaller: Secure with two sash locks.
 - 2. Over 16 inches (406 mm), up to 24 inches (610 mm) Square: Provide four sash locks.
 - 3. Larger Sizes: Hinges and two compression latches with outside and inside handles.
 - 4. Clamping-type doors with knob handles, as manufactured by Ductmate, may be substituted for standard sizes.
 - 5. Material: Galvanized steel in galvanized steel ductwork. Stainless steel in stainless steel ductwork. Aluminum as manufactured by Arrow in aluminum ductwork.
 - 6. Provide in negative-pressure systems, and in positive-pressure systems with specified pressure class at or below 2 in. WG (498 Pa).
- D. Medium- and High-Pressure Positive-Pressure Ducts:
 - 1. Ruskin ADHP-3 high pressure access door rated up to 12 in. WG (2985 Pa), with spring latches to allow the door to open temporarily to relieve negative pressures.
 - 2. Provide in positive-pressure systems with specified pressure class above 2 in. WG (498 Pa).
- E. Access Doors For Grease Duct Applications:
 - 1. Shop-fabricated:
 - a) Material to match duct.
 - b) High-temperature ceramic gasket, suitable for at least 1500 degrees F (815.6 degrees C).
 - 2. Ductmate Industries, Inc. HI-TEMP access door, or approved equal.
 - a) 16 gage (1.61 mm) black iron backing plate.
 - b) High temperature ceramic gasket, 2300 degrees F (1260 degrees C) maximum.
 - c) Zinc plated conical springs, zinc coated wing nuts and zinc plated carriage bolts.
 - 3. Ductmate Industries, Inc. ULtimate or ULtimate II access door.
 - a) UL 1978 Listed.
 - b) UL label and "Do Not Obstruct" label.
 - c) 2 layers of 11 gage metal (provide black iron (carbon steel) or Type 304 stainless to match ductwork).
 - d) High temperature ceramic gasket, 2300 degrees F (1260 degrees C) maximum.
 - e) The ULtimate door is sandwich style, and requires no welding and special tools, but requires extra duct size.
 - f) The ULtimate II door has a welded frame, and is available with or without a piano hinge.
 - g) Collapsible loop handle welded to outer door.
 - h) Corner thumb bolts. ULtimate door has studs with wingnuts welded to inner door.
 - i) Can be used with high temperature insulation.
 - 4. For factory-manufactured round grease ducts, access doors may be furnished by the duct

manufacturer. For double-wall ducts, access doors shall include inner and outer stainless steel and inner layer of insulation.

5. Duct openings in horizontal ducts shall be above the bottom of duct to form a grease dam.
6. Meet NFPA 96 requirements for use in grease duct systems.

F. Access doors with sheet metal screw fasteners are not acceptable.

G. Sizing: Select sizes to allow testing, service, and maintenance within the ductwork. Such access may require the insertion of one or both hands, arms, and shoulders as appropriate. Doors sized for viewing-only are not acceptable. Doors found to be of inadequate size shall be replaced with proper size.

2.5 DUCT SLEEVES, PREPARED OPENINGS AND CLOSURE COLLARS

A. Duct Sleeves and Closure Collars: Fabricate from minimum 20 ga (1.0 mm) galvanized steel or equivalent thickness of aluminum, select material to match duct material. Where sleeves are installed in bearing walls, provide structural steel sleeves.

B. Prepared Openings: Provide 1 inch (25.4 mm) clearance between the duct and the sleeve.

2.6 DUCT TEST HOLES

A. Manufacturers:

1. Ductmate.
2. Carlyle Corporation.
3. Duro-Dyne.
4. Ventfabrics.
5. Substitutions: Approved equal. See Section 016000 - Product Requirements

B. Temporary Test Holes: Cut or drill in ducts as required. Cap with neat patches, neoprene plugs, threaded plugs, or threaded or twist-on metal caps.

C. Permanent Test Holes: Factory fabricated, air tight flanged fittings with screw cap. Provide extended neck fittings to clear insulation.

2.7 FLEXIBLE DUCT CONNECTIONS

A. Manufacturers:

1. Ductmate.
2. Ventfabrics.
3. Duro-Dyne.
4. Substitutions: Not permitted.

B. Fabricate in accordance with SMACNA HVACDCS, and as specified or as indicated on the Drawings.

C. Connector: Fabric crimped into metal edging strip.

1. Connectors shall be Ductmate PROFLEX Commercial series.
2. Fabric: UL listed coated woven glass fiber fabric meeting the requirements of NFPA

90A and NFPA 701. Resistant to weather and most chemicals, fat, grease, and oil.

- a) Supply Ducts: Neoprene coated, minimum density 30 oz per sq yd (1.0 kg/sq m). Fire-retardant coating. Black color. Temperature range -40 to 200 degrees F (-40 to 93 degrees C).
- b) Exhaust Ducts Serving Fume Hoods: Hypalon coated, minimum density 24 oz per sq yd (0.8 kg/sq m). Flame proof coating. White color. UV and ozone resistant. Temperature range -40 to 250 degrees F (-40 to 121 degrees C).
3. Net Fabric Width: Approximately 3 inches (75 mm) wide.
4. Metal: 3 inch (75 mm) wide, 24 ga (0.6 mm thick).
 - a) Supply Ducts: G-60 galvanized steel.
 - b) Exhaust Ducts Serving Fume Hoods: Type 316 stainless steel.
5. Connectors shall have double fold seams. Single fold seams (metal folded once only) shall not be accepted.

2.8 ROOF CURBS

- A. Manufacturers:
 1. Greenheck.
 2. Acme Engineering and Manufacturing Corp.
 3. Loren Cook.
 4. Thybar Corporation.
 5. Substitutions: Approved equal. See Section 016000 - Product Requirements
- B. For miscellaneous duct applications requiring roof curbs which are not specified with equipment in other Sections, provide curbs as specified in this Section.
- C. Construction: Galvanized steel or aluminum, with continuously welded seams, 1-1/2 in. (38 mm) thick rigid fiberglass insulation with 3.0 lb/cu.ft (48 kg/m³) density and coated for airstream exposure, base flashing flange at least 1-1/8 in. (38 mm) wide, and factory installed wood nailer strip installed with notched and lapped joints for strength. For curbs where duct is not continuous thru the curb (such as curbs with sound baffles), provide metal liner to keep the wood nailer out of the airstream. For curbs with hot ducts where clearance to combustibles is a concern, wood nailer may be omitted.
- D. Height: For installations where base of curb is under the roof insulation, curb shall be 16 inch (400 mm) high (unless otherwise indicated or specified) with built-in cant strips. For installations where base of curb is not under any roof insulation (but may be under thin roof finish material such as membrane, shingles, or metal roofing), curb shall be at least 12 inch (300 mm) high (unless otherwise indicated) with no cant strips.
- E. Pitched Roof Curbs: Curbs for pitched and double-pitched roofs shall have base with built-in slopes to match roof pitches. Height of these curbs shall be at least the height specified above, measured at the highest point on the sloped base.
- F. Curb Seal: Provide rubber curb seal for installation between curb and equipment.

2.9 ROUND DUCT BRANCH TAPS AND SPIN-IN FITTINGS

- A. Saddle Taps: For round ducts branching off main ducts at 90 degrees, provide factory fabricated, saddle-tap fittings with conical or bellmouth taps, or 45 degree rectangular-to-round

branch fittings. For round ducts branching off at 45 degrees, fittings do not require conical or bellmouth expansion. Fittings shall be furnished with flange for fastening and sealing designed to overlap onto adjacent duct, and shall be shaped to fit tight to the exterior of the duct, flat for rectangular duct, curved for round duct.

- B. Spin-in fittings, factory-fabricated with conical or bellmouth taps are an acceptable substitute for saddle taps.
- C. Factory-fabricated taps and spin-ins may be furnished with integral volume dampers and quadrants as specified in paragraph "Manual Dampers" in this Section.

2.10 TURNING VANES

- A. Manufacturers for Turning Vanes and Vane Rails:
 - 1. Ductmate Industries - PROrail 2 inch Turning Vane Rail.
 - 2. Duro Dyne - Junior Vane Rail.
 - 3. Hardcast, a division of Carlisle Corporation - Dyn-O-Rail Jr.
 - 4. Substitutions: Approved equal. See Section 016000 - Product Requirements
- B. Factory-fabricated and factory-or-field-assembled units consisting of curved turning vanes for uniform air distribution and change of direction with minimum turbulence and pressure loss. Provide curved single thickness vanes for mitered elbows with change in direction of 45 degrees or greater, conforming to SMACNA HVACDCS single vane schedule for small vanes. Each vane shall form a 90 degree arc. Fill the entire duct cross-section with vanes. Orient leading edge of vanes parallel to the side of the duct (directed straight into the entering airstream).
- C. Turning vanes shall be minimum 16 gauge (1.61 mm), regardless of gauges that are recommended by SMACNA. Double thickness turning vanes are not allowed.
- D. Turning vanes in rectangular ductwork and shop-fabricated round ductwork shall conform with details on the Drawings. If not detailed, the SMACNA detail for small-radius small-spacing single-thickness vanes shall be used.
- E. Turning vanes in manufactured round and flat oval duct elbows shall be the duct manufacturer's standard size, spacing, and gauge, but must be single-wall and not less than 16 gauge (1.61 mm).
- F. Material for vanes shall be the same as the duct sheet metal.
- G. Factory-fabricated turning vane rails shall be a minimum of 24 ga (0.7 mm) and shall be the same material as the duct sheet metal.

2.11 WIRE MESH FOR SCREENS

- A. Manufacturers:
 - 1. McNichols Co.
 - 2. Banker Wire and Iron Works, Inc.
 - 3. Belleville Wire Cloth Co.
 - 4. Edward J. Darby & Son, Inc.
 - 5. Substitutions: Not permitted.

- B. Galvanized Welded Wire Mesh: Hardware and industrial class welded wire square mesh, hot dipped galvanized, welded trimmed construction, 2 mesh (2 openings per inch, wires ½ inch on center), 0.0630 inch wire nominal diameter parallel to width and length, 0.437 inch openings, 76 percent open area, 0.51 lb/sq. ft weight. Specification is the minimum acceptable for strength and weight of materials.
- C. Material to Match Ductwork: Where screens are installed in ductwork or louvers of other materials such as stainless steel or aluminum, provide screens of material to match the ductwork or louver, with strength equal to the requirements specified for galvanized mesh. Aluminum screens may be fabricated of expanded metal instead of welded wire.
- D. Provide mesh installed in a removable frame to support the mesh completely flat and rigid, with fasteners in an accessible location.

2.12 UNIFORMITY OF MATERIALS

- A. Ductwork accessories, including but not limited to volume dampers, smoke dampers, fire dampers, combination fire/smoke dampers, backdraft dampers and motorized dampers, shall be fabricated of materials that are similar to the ductwork in which they are installed.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Verify that electric power is available and of the correct characteristics.

3.2 INSTALLATION

- A. Install accessories in accordance with manufacturer's instructions, NFPA 90A, and follow SMACNA HVACDCS. Refer to Division 23 Section "Metal Ducts" for duct construction and pressure class.
- B. Install components furnished under other Section and Divisions of the Specifications. Such items may include but are not limited to: Sensors and airflow measuring stations furnished under Division 23 Section "Instrumentation and Control for Mechanical Systems"; gauges and meters; and smoke detectors furnished under Division 26 – Electrical.
- C. Duct Hangers and Supports: SMACNA HVACDCS, Section 4.
 - 1. Flexible Ducts: Support ducts by hangers every 3 feet (0.9 m), unless supported by ceiling construction. Stretch flexible air ducts to smooth out corrugations, and long radius elbows, where possible, using a minimum length to make connections.
 - 2. Flexible Connectors: Provide flexible connectors between fans and ducts or casings and where ducts are of dissimilar metals. For round ducts, securely fasten flexible connectors by zinc-coated steel clinch-type draw-bands. For rectangular ducts, lock flexible connectors to metal collars.
- D. Attach supports only to structural framing members and non-metal deck concrete slabs. Do not anchor supports to metal decking unless a means is provided and approved for preventing the anchors from puncturing the metal decking. Where supports are required between structural

framing member, provide suitable intermediate metal framing. Where C clamps are used, use retainer clips.

E. Access Doors:

1. Provide duct access doors in horizontal return air, exhaust air and fresh air intake ductwork to facilitate the removal of accumulations of dust and combustible materials in accordance with NFPA 90A. Install access doors at maximum 20 foot (6 m) intervals and at the base of each vertical riser.
2. Provide duct access doors for inspection, servicing, and cleaning before filters, before and after coils, before and after fans, before automatic dampers, at fire dampers, at smoke dampers, at combination fire and smoke dampers, at smoke detector sampling tubes (upstream of the sampling tube), at multiple blade volume dampers, at backdraft and counterbalanced dampers, and elsewhere as specified or as indicated on the Drawings. Provide at changes in direction of kitchen exhaust ductwork and as otherwise required for cleaning kitchen exhaust ductwork in accordance with NFPA 96. Provide minimum 8 x 8 inch (200 x 200 mm) size for hand access, 18 x 18 inch (450 x 450 mm) size for shoulder access, and as specified or as indicated on the Drawings. Review locations prior to fabrication.
3. Access doors installed for access to fire dampers and fire/smoke dampers shall have one side at least 12 inches long to allow two hand access. Provide identification with letters of minimum 1/2 inch (13 mm) height to indicate the presence of fire protection devices within. Conform with NFPA 90A and applicable Codes. Refer to Division 23 Section "Identification for HVAC Piping and Equipment" for labeling materials specifications.

F. Grease Duct Access Doors:

1. Provide approved access doors at the following locations:
 - a) Changes in direction of kitchen exhaust ductwork.
 - b) Every 12 feet for non-vertical ductwork.
 - c) Where duct pass through multiple floors, provide access door at each floor.
2. Provide nameplate of suitable material on access doors stating "ACCESS PANEL - DO NOT OBSTRUCT". Install access doors on top or sides of duct; in horizontal ducts, locate opening above the bottom of the duct to prevent formation of a grease dam.

G. Provide backdraft dampers on exhaust fans or exhaust ducts nearest to outside and where indicated.

H. Provide balancing dampers at points on supply, return, and exhaust systems where branches are taken from larger ducts as required for air balancing. Install minimum 2 duct widths from duct take-off.

I. Provide balancing dampers on high velocity systems where indicated. Refer to Division 23 Section "Air Terminal Units"

J. Provide balancing dampers on duct take-offs to diffusers, grilles, and registers, regardless of whether dampers are specified as part of the diffuser, grille, or register assembly. Where branch duct is completely above non-accessible wallboard ceiling and the Architect has not approved the use of access doors, duct mounted balancing dampers shall not be required.

K. For volume dampers located above suspended ceilings and in areas that are not visible to building occupants (e.g. mechanical rooms), provide fluorescent orange colored surveyor's tape.

Permanently attach tape to damper handles and run tape down to 10 in. (254 mm) above ceiling or 12 in. (304 mm) below damper handle where ceilings do not exist (e.g. mechanical rooms).

- L. Provide flexible connections immediately adjacent to equipment in ducts associated with fans and motorized equipment, and support by vibration isolators. Staple and seal connections airtight.
- M. Duct Sleeves and Prepared Openings: Install for ducts passing through roofs, ceilings, walls and floors. Field determine the proper size and location of sleeves and prepared openings.
 - 1. Duct Sleeves: Allow one-inch (25 mm) clearance between duct and sleeve or one-inch (25 mm) clearance between insulation and sleeve for insulated ducts, except at grilles, registers, and diffusers.
 - 2. Prepared Openings: Allow one-inch (25 mm) clearance between duct and opening or one-inch (25 mm) clearance between insulation and opening for insulated ducts, except at grilles, registers, and diffusers.
- N. Closure Collars:
 - 1. Provide not less than 4 inches (100 mm) wide on each side of walls or floors where sleeves or prepared openings are installed. Fit collars snugly around ducts. Grind smooth edges of collar to prevent tearing or puncturing insulation covering or vapor barrier.
 - 2. Where insulated ducts penetrate non-fire-rated walls, insulation shall be continuous through the closure collars and the closure collars shall be installed tight to the insulation.
 - 3. Where insulated ducts penetrate fire rated walls, insulate ducts on both sides of closure collars and seal points of contact between closure collar and insulation with vapor proof adhesive.
 - 4. Where ducts penetrate fire rated walls, provide fire proof sealant at closure collar. Refer to Division 07 Section "Through Penetration Firestop Systems," for fire proof sealant requirements.
 - 5. Secure closure collars to ducts with sheet metal screws at maximum 6 inch (152 mm) centers and secure closure collars to walls or floors with sheetrock screws, nails or other appropriate fastener at maximum 6 inch (152 mm) centers.
 - 6. Packing: Pack with non-combustible glass fiber insulation in spaces between sleeve/opening and duct/duct insulation. Cover or seal edges of packing to contain loose fibers.
- O. Provide duct test holes where indicated and required for testing and balancing purposes.
- P. Duct Silencers:
 - 1. Install with straight runs of ductwork upstream and downstream as recommended by the manufacturer and as indicated on the Drawings, to minimize noise and pressure drop. If there is conflict between manufacturer's recommendations and the Drawings, notify the Architect in writing prior to installing silencers.
 - 2. Provide access doors upstream and downstream sized to allow cleaning.
 - 3. Provide flanged connections to allow removal of silencers. Provide removable sections in the external insulation at flanges.
- Q. Airflow Measuring Stations:
 - 1. Installation: Install in accordance with manufacturer's instructions at the locations indicated on the Drawings, and as required by Division 23 Section "Instrumentation and

Control for Mechanical Systems.”

2. Submit a written report to the Architect if any discrepancies are found.
3. Adjusting: Duct and plenum devices shall not be adjusted without approval from the Architect.

R. Provide interconnecting power and control wiring as required, in accordance with Division 26.

END OF SECTION 233300

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SECTION 233400 – HVAC FANS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Centrifugal Fans:
 - 1. Backward Inclined Centrifugal Fans.
 - 2. Forward Curved Centrifugal Fans.
 - 3. Airfoil Centrifugal Fans.
 - 4. Radial Centrifugal Fans.
 - 5. Tubular Centrifugal Fans.
 - 6. Inline Centrifugal Fans.
 - 7. Vent Sets.
 - 8. Upblast Centrifugal Roof Exhaust Fans for Kitchen Hood Exhaust.
- B. Round Inline Centrifugal Fans.
- C. Power Ventilators:
 - 1. Roof Exhausters.
 - 2. Wall Exhausters.
 - 3. Cabinet Exhaust Fans.
 - 4. Ceiling Exhaust Fans.
- D. Motors and Drives.
- E. Fan Accessories.

1.2 RELATED SECTIONS

- A. Division 23 Section “Common Motor Requirements for HVAC Equipment.”
- B. Division 23 Section “Vibration and Seismic Controls for HVAC Piping and Equipment.”
- C. Division 23 Section “Duct Insulation.”
- D. Division 23 Section “Indoor Central-Station Air-Handling Units.”
- E. Division 23 Section “Metal Ducts.”
- F. Division 23 Section “Air Duct Accessories”: Backdraft dampers.
- G. Division 23 Section “Instrumentation and Controls for Mechanical Systems”: Sequence of Operation.
- H. Division 26 “Electrical.”

1.3 REFERENCES

- A. ANSI/ABMA 9 - Load Ratings and Fatigue Life for Ball Bearings.

- B. ANSI/ABMA 11 - Load Ratings and Fatigue Life for Roller Bearings.
- C. AMCA 99 - Standards Handbook.
- D. AMCA 210 - Laboratory Methods of Testing Fans for Rating.
- E. AMCA 261 - Directory of Products Licensed to Use the AMCA Certified Ratings Seal.
- F. AMCA 300 - Reverberant Room Method for Sound Testing of Fans.
- G. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data.
- H. NEMA MG1 - Motors and Generators.
- I. NFPA 70 - National Electrical Code.
- J. SMACNA - HVAC Duct Construction Standards - Metal and Flexible.
- K. NFPA 96 - Installation of Equipment for the Removal of Smoke and Grease Vapors from Commercial cooking Equipment.
- L. UL 705 - Power Ventilators.
- M. UL 762 - Power Roof Ventilators For Restaurant Exhaust Appliances.

1.4 SUBMITTALS

- A. Product Data: Provide data on fans and accessories including fan curves with specified operating point clearly plotted, power, RPM, sound power levels for both fan inlet and outlet at rated capacity, and electrical characteristics and connection requirements.
- B. Shop Drawings: Indicate assembly of fans and accessories including fan curves with specified operating point clearly plotted, sound power levels for both fan inlet and outlet at rated capacity, and electrical characteristics and connection requirements.

1.5 SUBMITTALS AT PROJECT CLOSEOUT

- A. Maintenance Data: Include instructions for lubrication, motor and drive replacement, spare parts list, and wiring diagrams.

1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this Section with minimum 3 years experience.

1.7 REGULATORY REQUIREMENTS

- A. Kitchen Grease Hood Exhaust Fans: Comply with requirements of NFPA 96.
- B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

1.8 DELIVERY, STORAGE, AND PROTECTION

- A. Transport, handle, store, and protect products.
- B. Protect motors, shafts, and bearings from weather and construction dust.

1.9 ENVIRONMENTAL REQUIREMENTS

- A. Environmental conditions affecting products on site.
- B. Do not operate fans for any purpose until ductwork is clean, filters in place, bearings lubricated, and fan has been test-run under observation.

PART 2 - PRODUCTS

2.1 ELECTRONICALLY-COMMUTATED (EC) MOTORS - ALSO KNOWN AS BRUSH-FREE DC (BFDC) MOTORS

- A. Manufacturers:
 - 1. Greenheck Fan Corporation - "Vari-Green" motor.
 - 2. General Electric.
 - 3. Twin City Fan Co.
 - 4. Substitutions: Approved equal. See Section 016000 - Product Requirements
- B. Applications: Ceiling and cabinet fans, centrifugal inline fans, centrifugal roof exhaust fans, and centrifugal upblast exhaust fans, in sizes up to 3/4 hp (0.56 kW). Voltage 115V/1ph/60Hz.
- C. See Division 23 Section "Common Motor Requirements for HVAC Equipment" for general requirements.
- D. Speed Control:
 - 1. Typical motor speed range is 350 RPM to 1725 RPM.
 - 2. Motor operates on a voltage signal of 2-10 VDC, with 15-20 percent speed at 2V and 100 percent speed at 10V. Motor is switched off when the signal is 0-1.9 VDC.
 - 3. Control method furnished with the motor shall be one of the following, as indicated on the Drawings or in the Specifications:
 - a. Motor-mounted potentiometer with screwdriver setting. Provide this unless otherwise indicated or specified.
 - b. Remote-mounted Belimo potentiometer with calibrated 0-100 percent dial. Potentiometer includes a toggle switch to select an output range of 0-10V or 2-10V, so that with the 0-10 V setting the control can turn the fan off. Factory-mounted 24 VDC transformer in a junction box.
 - c. Factory-furnished circuitry to accept a 0-10V signal from the building control system. Requires an additional 24 VDC power supply to the motor's controls, 0.70 VA capacity.
 - 4. Provide field-furnished metal 2 x 4 in. (50 x 100 mm) junction box for mounting remote potentiometer dials.
 - 5. Provide field-furnished interconnecting power and control wiring as required, including separate flexible conduits for line-voltage and low-voltage wiring.

2.2 POWER VENTILATORS

- A. Manufacturers:
 - 1. Greenheck.
 - 2. Loren Cook.
 - 3. Acme.
 - 4. Hartzell.
 - 5. Penn Barry.
 - 6. Twin City Fan Co.
 - 7. Substitutions: Approved equal. See Section 016000 - Product Requirements
- B. Product Requirements:
 - 1. Performance Ratings: Conform to AMCA 210 and bear the AMCA Certified Rating Seal.
 - 2. Sound Ratings: AMCA 301, tested to AMCA 300, and bear AMCA Certified Sound Rating Seal.
 - 3. Fabrication: Conform to AMCA 99.
 - 4. UL Compliance: UL listed and labeled, designed, manufactured, and tested in accordance with UL 705.
- C. Cabinet and Ceiling Exhaust Fans:
 - 1. Centrifugal Fan Unit: Centrifugal impeller, V-belt or direct driven as scheduled on the Drawings, with galvanized steel housing lined with 1/2 inch (13 mm) acoustic insulation, resilient mounted motor, gravity backdraft damper in discharge.
 - 2. Speed Control Switch: unit mounted solid state speed controller.
 - 3. Sheaves: For V-belt drives, provide cast iron or steel, dynamically balanced, bored to fit shafts and keyed; variable and adjustable pitch motor sheaves selected so required rpm is obtained with sheaves set at mid-position; fan shaft with self-aligning pre-lubricated ball bearings.
 - 4. Vibration Isolation: Provide mounting brackets to accept rubber hangers as specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment". Vibration isolators furnished by the fan manufacturer are not allowed.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Division 01 Section "Quality Requirements": Manufacturer's instructions.
- B. Install fans with resilient mountings and flexible electrical leads. Refer to Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."
- C. Install flexible connections between fan inlet and outlet and ductwork, including roof and wall-mounted fans unless otherwise indicated; refer to Division 23 Section "Air Duct Accessories." Ensure metal bands of connectors are parallel with minimum 1 inch (25 mm) flex between ductwork and fan while running.
- D. Hung Cabinet Fans:
 - 1. Install fans with resilient mountings and flexible electrical leads. Refer to Division 23

Section "Common Motor Requirements for HVAC Equipment."

2. Install flexible connections specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment" between fan and ductwork. Ensure metal bands of connectors are parallel with minimum 1 inch (25 mm) flex between ductwork and fan while running.
- E. Provide sheaves required for final air balance.
 - F. Provide safety screen where inlet or outlet is exposed.
 - G. Do not operate fans in normal operation until ductwork is clean, filters are in place, bearings are lubricated, and fan has been test run under observation.

END OF SECTION 233400

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SECTION 233700 - AIR OUTLETS AND INLETS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Diffusers.
- B. Registers/Grilles.
- C. Louvers.
- D. Roof Hoods.

1.2 RELATED SECTIONS

- A. Division 09 Section "Painting": Painting of ductwork visible behind outlets and inlets.
- B. Division 23 Section "Particulate Air Filtration."

1.3 REFERENCES

- A. AAMA 611 - Voluntary Specification for Anodized Architectural Aluminum.
- B. ADC 1062 - Certification, Rating and Test Manual.
- C. AMCA 500 - Test Method for Louvers, Dampers and Shutters.
- D. AMCA 511 - Certified Ratings Program for Air Control Devices
- E. ARI 650 - Air Outlets and Inlets.
- F. ASHRAE 70 - Method of Testing for Rating the Air Flow Performance of Outlets and Inlets.
- G. ASTM E90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Elements.
- H. ASTM E413 - Classification for Rating Sound Insulation.
- I. SMACNA - HVAC Duct Construction Standard - Metal and Flexible.
- J. NFPA 70 - National Electrical Code.
- K. NFPA 90A - Installation of Air Conditioning and Ventilating Systems.

1.4 SUBMITTALS

- A. Product Data: Provide data for equipment required for this project. Review outlets and inlets as to size, finish, and type of mounting prior to submission. Submit schedule of outlets and inlets

indicating type, size, application, rated airflow, noise level, pressure drop, and throw distance as applicable. Submit both manufacturer's standard performance tables and graphs, AND tabulated selection data specific to this project. NOTE: Submittals without complete and sufficient information, to verify the performance specified and scheduled on the Drawings, shall be rejected.

1.5 PROJECT RECORD DOCUMENTS

- A. Record actual locations of air outlets and inlets.

1.6 QUALITY ASSURANCE

- A. Test and rate air outlet and inlet performance in accordance with ADC Equipment Test Code 1062 and ASHRAE 70.
- B. Test and rate louver performance in accordance with AMCA 500.

1.7 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the Products specified in this Section with minimum 3 years' experience.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Diffusers, Registers, Grilles, and Drum Louvers:
 - 1. Titus.
 - 2. Anemostat.
 - 3. Krueger.
 - 4. Metalaire.
 - 5. Price.
 - 6. Nailor
 - 7. Substitutions: Not permitted
- B. Louvers (Non-acoustical Type):
 - 1. Greenheck.
 - 2. Airolite.
 - 3. American Warming and Ventilating.
 - 4. Arrow.
 - 5. Ruskin.
 - 6. United Enertech.
 - 7. Nailor
 - 8. Substitutions: Not permitted
- C. Roof Hoods and Roof Caps:
 - 1. Greenheck.
 - 2. Acme.
 - 3. Loren Cook.
 - 4. Penn.

- 5. United Enertech.
- 6. Substitutions: Not permitted

2.2 RECTANGULAR CEILING DIFFUSERS

- A. Type: Square and rectangular, multi-louvered directional diffuser to discharge air in pattern as indicated. Removable and interchangeable core for cleaning and changing patterns without tools.
- B. Frame: Surface mount, inverted T-bar, snap-in, or spline type, as indicated and as required to be compatible with ceiling. In plaster ceilings, provide plaster frame and ceiling frame.
- C. Fabrication: Steel or aluminum with baked enamel finish with color as schedule.
- D. Accessories: Opposed blade damper and multi-louvered equalizing grid, with damper adjustable from diffuser face when schedule.

2.3 CEILING GRID CORE EXHAUST AND RETURN REGISTERS/GRILLES

- A. Type: Fixed grilles of 1/2 x 1/2 x 1/2 inch (13 x 13 x 13 mm) vanes in square grid pattern.
- B. Frame: 1-1/4 inch (32 mm) margin with countersunk screw mounting. For suspended grid ceilings, provide channel lay-in frame for suspended grid ceilings.
- C. Fabrication: Aluminum with factory enamel finish color as scheduled.
- D. Damper: Integral, gang-operated, opposed blade type with removable key operator, operable from face.
- E.

2.4 LOUVERS (4-INCH)

- A. Louvers shall be equal to, and shall have free areas no less than, Greenheck Model ESD-403. Acceptable substitutes by other listed manufacturers (subject to performance specified and scheduled on Drawings) shall be:
 - 1. Ruskin: Model ELF445DX.
 - 2. American Warming & Ventilating: Model LE-23.
 - 3. Airolite: Model
 - 4. Arrow: Model EA-415-D.
 - 5. United Enertech: Model D-HFA-4.
 - 6. Substitutions: Approved equal. See Section 016000 - Product Requirements
- B. For reference, free area of a model ESD-403 in 48 inch x 48 inch (1.2 m x 1.2 m) size is 8.0 sq. ft (0.74 m²).
- C. Free area velocity at beginning of water penetration shall be at least 1000 fpm (5.0 m/sec). Beginning of water penetration is defined by AMCA as 0.01 oz. per sq. ft (3 g/m²).
- D. Air pressure drop for intake air at an air velocity of 1000 fpm (5.0m/sec) in intake mode shall not exceed 0.20 in.wg (49.8Pa).

- E. Testing for water penetration and air performance shall be in accordance with AMCA Standard 511, using a 48 inch x 48 inch (1.2 m x 1.2 m) louver.
- F. Type: 4 inch (100 mm) deep with drainable blades on approximately 37 to 45 degree slope, heavy channel frame, removable expanded aluminum bird screen with 1/2 inch (13mm) mesh mounted on interior face.
- G. Fabrication: 0.081 inch (2.05 mm) thick 6063-T5 extruded aluminum alloy, welded assembly.
- H. Mounting: Furnish with standard box frame and angles for installation.
- I. Finish: Factory 2-coat, 1.2-mil (0.03 mm) thickness 70 percent Kynar 500/Hylar 5000 fluoropolymer finish, with 10-year warranty. Submit manufacturer's standard color chart. The Architect will select color for each louver individually, with up to 4 different colors for the project. Accessories visible from outdoors or exposed to the airstream, such as interior and exterior screens, shall have finish identical to the louver.
- J. Louvers shall bear the AMCA rating seal for water penetration and air performance.

2.5 ROOF HOODS

- A. Roof hoods shall be equal to Greenheck FABRA HOOD. Pressure drop through hood shall not exceed that of the Greenheck FABRA HOOD.
- B. Fabricate air inlet or exhaust hoods in accordance with SMACNA HVAC Duct Construction Standards - Metal and Flexible.
- C. Fabricate of galvanized steel, minimum 16 gauge (1.50 mm) base and 20 gauge (0.90 mm) hood, or aluminum, minimum 16 gauge (1.50 mm) base and 18 gauge (1.20 mm) hood; suitably reinforced; with removable hood; birdscreen with 1/2 inch (13 mm) square mesh for exhaust and 3/4 inch (19 mm) for intake.
- D. Fabricate with mitered corners and reinforce with structural angles.
- E. Make hood outlet area minimum of twice throat area.
- F. Finish: Factory mill finish.
- G. Mount unit on minimum 24 inch (600 mm) high curb base for exhaust hoods and minimum 30 inch (750 mm) high curb base for intake hoods, with insulation between duct and curb.

2.6 ROOF CURBS

- A. Construction: Galvanized steel or aluminum, with continuously welded seams, 1-1/2 in. (38 mm) thick rigid fiberglass insulation with 3.0 lb/cu.ft (48 kg/m³) density and coated for airstream exposure, base flashing flange at least 1-1/8 in. (38 mm) wide, and factory installed wood nailer strip installed with notched and lapped joints for strength. For curbs where duct is not continuous thru the curb (such as curbs with sound baffles), provide metal liner to keep the wood nailer out of the airstream.
- B. Height: For installations where base of curb is under the roof insulation, curb shall be 24inch (600 mm) high (unless otherwise indicated or specified) with built-in cant strips. For

installations where base of curb is not under any roof insulation (but may be under thin roof finish material such as membrane, shingles, or metal roofing), curb shall be at least 18 inch (450 mm) high (unless otherwise indicated) with no cant strips.

- C. Pitched Roof Curbs: Curbs for pitched and double-pitched roofs shall have base with built-in slopes to match roof pitches. Height of these curbs shall be at least the height specified above, measured at the highest point on the sloped base.
- D. Curb Seal: Provide rubber curb seal for installation between curb and equipment.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Check location of outlets and inlets and make necessary adjustments in position to conform to architectural features, symmetry, and lighting arrangement.
- C. Install outlets and inlets to ductwork with air tight connection.
- D. Slope ducts or plenums at louvers, and at brick or block vents, to drain outward, and seal bottoms watertight.
- E. Provide balancing dampers on duct take-off to diffusers, and grilles and registers, despite whether dampers are specified as part of the diffuser, or grille and register assembly.
- F. Paint ductwork visible behind air outlets and inlets matte black. Refer to Division 09 Section "Painting."
- G. Surfaces exposed to view shall be clean, and free of stains, smudges, and scratches.
- H. Provide hex-head fasteners to curb in each hole in curb caps or bases of roof-mounted units. Provide protection between dissimilar metals.

END OF SECTION 233700

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SECTION 233813 - COMMERCIAL-KITCHEN HOODS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes Type I and commercial kitchen hoods.

1.3 DEFINITIONS

- A. Listed Hood: A hood, factory fabricated and tested for compliance with UL 710 by a testing agency acceptable to authorities having jurisdiction.
- B. Standard Hood: A hood, usually field fabricated, that complies with design, construction, and performance criteria of applicable national and local codes.
- C. Type I Hood: A hood designed for grease exhaust applications.

1.4 SUBMITTALS

- A. Product Data: For the following:
 - 1. Standard hoods.
 - 2. Filters/baffles.
 - 3. Fire-suppression systems.
 - 4. Lighting fixtures.
- B. Shop Drawings: Signed and sealed by a qualified professional engineer.
 - 1. Show plan view, elevation view, sections, roughing-in dimensions, service requirements, duct connection sizes, and attachments to other work.
 - 2. Show cooking equipment plan and elevation to confirm minimum code-required overhang.
 - 3. Indicate performance, exhaust and makeup air airflow, and pressure loss at actual Project-site elevation.
 - 4. Show drain piping connections.
 - 5. Show control cabinets.
 - 6. Show fire-protection cylinders, piping, actuation devices, and manual control devices.
 - 7. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 8. Design Calculations: Calculate requirements for selecting seismic restraints.
 - 9. Wiring Diagrams: Power, signal, and control wiring.
 - 10. Piping Diagrams: Detail fire-suppression piping and components and differentiate between manufacturer-installed and field-installed piping. Include roughing-in

requirements for drain connections. Show cooking equipment plan and elevation to illustrate fire-suppression nozzle locations.

- C. Welding certificates.
- D. Manufacturer Seismic Qualification Certification: Submit certification that commercial kitchen hoods, accessories, and components will withstand seismic forces defined in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment." Include the following:
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
 - 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- E. Field quality-control test reports.

1.5 QUALITY ASSURANCE

- A. Engineering Responsibility: Preparation of Shop Drawings and comprehensive engineering analysis by a qualified professional engineer.
- B. Welding: Qualify procedures and personnel according to AWS D1.1/D 1.1M, "Structural Welding Code - Steel," for hangers and supports; and AWS D9.1/D9.1M, "Sheet Metal Welding Code," for joint and seam welding.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- D. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."

1.6 COORDINATION

- A. Coordinate equipment layout and installation with adjacent Work, including lighting fixtures, HVAC equipment, plumbing, and fire-suppression system components.

1.7 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Furnish one complete set(s) of grease filters/baffles.

PART 2 - PRODUCTS

2.1 STAINLESS STEEL KITCHEN HOODS

A. Approved Manufacturers:

1. Captive Aire
2. Greenheck.
3. GreaseMaster
4. Halton.
5. Substitutions: Not permitted

B. Hood:

1. Furnish and install a complete kitchen exhaust canopy. The canopy shall bear the Underwriters' Laboratories U.L. label. U.L. listed range hood without exhaust fire damper per Standard 710 and be fabricated in compliance with NFPA96, and shall bear the National Sanitation Foundation Seal of Approval (NSF).
2. The installation shall be in accordance with the manufacturer's recommendations and conform to NFPA96 Guidelines and all applicable local codes.
3. Size shall be as indicated on Drawing and or Specifications.
4. All necessary angle and channel supports shall be included.
5. Hood systems shall be balanced by TAB contractor prior to substantial completion.
6. Each hood shall be furnished and installed with a controls and ANSUL Fire Extinguishing System cabinet. The cabinet shall be located in one (1) end of hood. The cabinet shall be capable of housing the ANSUL Automan, magnetic starters, and relays, etc.
7. The canopy inner liner shall be 18-gauge stainless steel, where exposed, Type 304 with #4 finish. The canopy shall have integral exhaust duct collars. All seams of the inner liner shall have grease tight joints. Each canopy shall have a filter housing of the same material as the canopy liner. The filter housing shall be equipped with a pitched drip tray the full length of the canopy and with grease cup for easy removal and daily cleaning.
8. The outer shell shall be 18-gauge stainless steel, where exposed, Type 304 with #4 finish. Canopy ends shall be double side wall construction. All exterior joints shall be continuously welded liquid-tight and ground smooth and be polished to #4 finish.
9. Canopy shall have U. L. listed vaporproof lights suitable for grease use on 3 - 4 foot center prewired to a junction box on top of the canopy.
10. The exhaust air flow rates will be based on the convective heat generated by appliances underneath each canopy. Submitted hood designs shall include convective heat calculations based on the input power of the appliance serviced.
11. The hood manufacturer will supply a master electric panel (MEP) consisting of one starter per motor, main disconnect switch, terminal block wiring and control circuits prewired. The MEP shall be contained within the controls and fire extinguishing cabinet.
12. Enclosure Panels: Where required, the hood manufacturer shall provide panels constructed of the same steel as the exposed hood surfaces. A mounting clip is factory welded to the top of the hood to accommodate field installation of enclosure panels exceeding 6" high. Panels shall be sized to extend from the top of the hood to the drop ceiling.
13. Hoods shall extend a minimum of 6 inches beyond the sides of the equipment and 12 inches over front of the equipment. Refer to detail for mounting height AFF.
14. Provide UL listed, factory-installed motorized damper at the hood collar.

C. Exhaust Fan:

1. Furnish and install where indicated on drawings, separate roof exhaust fans with capacities and sizes as scheduled. Fans shall be complete, including the following:
 - a. The exhaust fans shall be supplied by the hood manufacturer. The fans shall be the belt drive, upblast type. Base shall be epoxy-coated steel construction. Fan

housings shall be heavy-duty spun aluminum. The motor compartments shall be isolated and forced cooled by air drawn from outside the fans through breather tubes. The fans shall be U. L. rated under #762 for grease laden vapors. The motors shall be continuous duty type with shielded ball bearings. The drives shall be the variable speed V belt type.

- b. Fan ratings shall be AMCA certified.
- c. Provide integral grease through at base of housing.
- d. The fans shall have hinged subbases with flexible weatherproof electrical cables and service hold-open retainers to permit proper inspection and cleaning.
- e. Provide factory-fabricated roof curbs with proper height (but in no case less than 18" high) to insure that the fans discharge a minimum of 40" above the roof surface.
 - 1) Curbs shall be constructed of galvanized steel and shall incorporate a non-combustible gasket around perimeter top and be designed for installation on flat roof.
 - 2) Curbs shall be installed, shimmed for roof pitch, leveled and flashed by Roofing Contractor.
- f. Provide disconnect switch equal to Bryant Electric model 30102.
 - 1) Silver-alloy contacts.
 - 2) Brass binding screw terminals with combination Robertson / Phillips / slothead.
 - 3) Back wiring: clamp-type terminals accept up to #10 wire.
 - 4) Non-tracking urea base.
 - 5) Nylon toggle.
 - 6) Fully enclosed.
 - 7) Quick make, slow break contact design.

2.2 KITCHEN EXHAUST HOOD FIRE EXTINGUISHING SYSTEMS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Ansul
 - 2. Kidde
 - 3. Substitutions: Not permitted
- B. Hood Fire Extinguishing System:
 - 1. The hood shall contain an Ansul R-102 or a wet chemical fire suppression system. The system shall be properly sized for the duct, plenum and appliances. The system shall be completely installed by factory trained personnel. Field hook-up shall be subcontracted to an authorized factory representative and shall be performed after hood installation. System activation shall be by fusible link connected to automatic release or manual pull station.
 - 2. The installation shall be in accordance with UL listing and conform to local and state codes and standards, including NFPA 17A and U. L. Standard 300, November 1994.
 - 3. Materials:
 - a. Cylinders shall be manufactured, tested and marked in accordance with DOT Specifications. Charge with "Karbaloxy II" or approved equal extinguishing and pressurize with nitrogen. Provide suitable brackets for mounting.
 - b. Piping shall be Schedule 40, black steel with malleable iron fittings. Discharge nozzles shall be of the proper design for the intended use (duct nozzle, plenum nozzle, appliance nozzle) and orifices shall be protected with appropriate seals.

4. Controls for automatic operation and manual release shall be mechanical in design, using fusible metallic links, stainless steel cabling, corner pulleys and manual pull-station. Provide a pressure release device for automatic opening of the cylinder valves.
5. Provide relays to shut down hood fan and actuate the building fire alarm system. Relays for interface with fire alarm system shall be suitable for use in supervised systems. Coordinate with Electrical Contractor for shutting down of electrical power sources under hoods and closure of main gas valve through Emergency Shut Down Panel. Wiring to this equipment through these devices is included in the Electric Section of these Specifications. The Owner shall be instructed in the operation and maintenance of the system.
6. Perform tests and submit certificates of approval as required by local officials. Also submit manufacturer's report certifying final inspection and system test.
7. Pull device shall be located next to exit from space. Pull device shall be fully recessed in wall and conduit shall be concealed.
8. A start-up test shall be required. Copies of the test shall be submitted for approval.

2.3 MAKE-UP AIR UNIT

- A. Approved Manufacturers (manufacturer shall match hood manufacturer):
 1. Captive Aire
 2. Greenheck.
 3. GreaseMaster
 4. Halton.
 5. Substitutions: Not permitted
- B. Description: A modular packaged heating, cooling and ventilating unit(s), as indicated on the drawings shall be furnished. Unit(s) shall be tested in accordance with ANSI Standard Z83 and shall bear the ETL label. Orientation shall be horizontal, down or side discharge. Unit(s) shall be factory assembled, tested and shipped as a complete packaged assembly, for outdoor mounting, consisting of the following:
 1. Gas burner
 2. Centrifugal blower (forward-curved double width/double inlet or backward inclined)
 3. Motor starter with thermal overload protection
 4. Motor and drive assembly
 5. Fuel burning and safety equipment
 6. Temperature control system
 7. Gas piping
 8. Pre-piped and charged condenser(s)
- C. Construction
 1. Housing: Unit housing shall be constructed of 20 gauge G-90 galvanized steel. The wall panels and roof panels shall be fabricated by forming double-standing, self-locking seams that require no additional support. The floor and wall panels shall be caulked air tight with a silicone caulk. All casing panels shall be attached with sheet metal screws or rivets, which can be removed to field service large components. The unit base shall be suitable for curb or flat mount. Housing construction should be suitable for outdoor installation.
 2. An observation port shall be located on the exterior of the unit for observation of the main flame and pilot flame. All controls, gas valves, modulating controls and electrical components shall be mounted within the burner vestibule. The burner vestibule shall be

- an integral part of the unit and not extend outside the exterior casing of the unit and not exposed to the main air stream. The vestibule full-size door shall provide easy access to controls and gas-train components. Blower door shall provide easy access to blower, motor and drives. Access doors shall be provided on both front and backside of unit providing full access to every part of the unit.
3. Internal ridged board 1" x 1.5" foil face installation shall be installed on roof, walls and base of casing.
- D. Base: The base shall be constructed of galvanized steel for improved rigidity. Base shall be structurally reinforced to accommodate the blower assembly and burner.
- E. Blower:
1. Wheels shall be balanced in two planes and done in accordance with AMCA standard 204-96, Balance Quality and Vibration Levels for Fans. The wheel blades shall be aerodynamically designed to minimize turbulence, increase efficiency and reduce noise. The wheel blades shall be securely attached to the wheel inlet ring. The wheel shall be firmly attached to the fan shaft with setscrews and keys. The blower assembly shall be isolated from the fan structure with vibration isolators.
 2. External Static is the sum of duct loss plus duct component static pressure. All blowers shall be tested and set at rated speed after being installed in the factory-assembled unit.
 3. Direct Drive
 - a. Direct drive blower assembly shall consist of a centrifugal backward inclined, non-overloading wheel secured directly to a heavy duty, ball bearing type motor via two set screws.
 - b. The motor and wheel assembly shall be mounted to a heavy gauge galvanized steel frame.
 - c. The motor shall be controlled by a variable frequency drive, allowing for variable airflow without the need of belts and pulleys.
- F. Motor & Motor Compartment: Motors shall be heavy-duty ball bearing type and furnished at the specified voltage, phase and enclosure. Motor mounting plate shall be constructed of heavy gauge galvanized steel and shall be designed to provide easy adjustment of the belt tension.
- G. Shaft & Bearings: Shafts shall be precision ground and polished. Heavy duty, pre-lubricated bearings shall be selected for a minimum (L50) life in excess of 200,000 hours of operation at maximum cataloged operating speed. They shall be designed for, and individually tested, specifically for use in air handling applications.
- H. Burner
1. The gas burner shall be direct-fired, draw-through type.
 2. The burner shall burn over its entire length at all times when the system is in operation.
 3. The burner shall have non-clogging, 4302B stainless-steel combustion baffles attached to a ductile aluminum gas-supply section with no moving parts to wear out or fail. The burner shall be capable of 92% combustion efficiency with a maximum turndown ratio of up to 30 to 1.
 4. The gas burner shall be furnished with a pilot package arranged so that the pilot flame lights the burner with instantaneous ignition. Pilot assembly includes a flame rod, spark rod and pilot, which is automatically ignited by ignition transformer. A flame-rod rectification system shall be used to prove pilot and main flame.
 5. Rear access doors will provide complete access to burner and pilot assembly.

6. Burner profile plates shall be self-adjusting to operate across the complete CFM range of each model heater. Every unit shall be designed for variable air volume capabilities.
- I. Cooling Coil Section
 1. Cooling coil section shall be field bolted directly to discharge of blower section. Coil section to be designed to fit onto common curb with main unit. Base of coil section to be constructed with double pitch stainless steel drain pan for coil, same as main unit. Casing and roof to be 20-gauge G-90 galvanized construction. Inside of section to be fully insulated with foil back insulation. DX coil to meet scheduled requirements.
 2. Cooling interlock relay. Locks out burner circuit when cooling is energized.
 3. Single circuit modular packaged DX cooling option for packaged unit. Includes condenser, DX coil, filter/dryer kit, thermal expansion valve, R-410A refrigerant, and refrigerant piping.
 4. DX cooling intake air thermostat and relays mounted in unit - set point for thermostat should be 85°F.
 5. Moisture eliminator - allows cooling coil face velocity to increase to 650 FPM.
 - J. Accessories
 1. Dampers: Manufacturer shall provide and install on unit, a two-position, motor-operated damper with internal end switch to energize the blower-starter circuit, when damper is 80% open. Blades shall be a maximum of 6" wide 16-gauge G-90 galvanized steel and shall be made to guarantee the absence of noticeable vibration at design air velocities. Damper blades are to be mounted on friction-free synthetic bearings. Damper edges shall have PVC coated polyester fabric mechanically locked into blade edge. Jamb seals used are flexible metal, compression type.
 2. Filters: The filters shall be (2") thick, pleated throw away. Filter media is supported on the air leaving side by a metal grid.
 3. Filter Section: Shall be insulated constructed of G-90 galvanized steel with filters supported by internal slides and with removable access panels.
 4. Fresh-Air Inlet Hood/Filter Combination: Shall be constructed of G-90 galvanized steel with bird screen and (2") cleanable filters supported by internal slides mounted in the inlet face of the hood.
 5. Curb: 20" curb shall be constructed of 18-gauge aluminized steel as a completed welded assembly.
 - K. Temperature control systems
 1. Discharge Temperature Control: Use for building exhaust-air replacement to maintain a constant discharge temperature of supply air. The burner flame modulates and the cooling compressors cycle to compensate for outdoor temperatures. Discharge air temperature setpoint shall be reset between 65 deg F (heating setpoint) and 80 deg F (cooling setpoint).
 - L. Wiring and electrical
 1. Each condenser shall have a separate circuit enabling the supply fan motor to accept signals from a VFD without interfering with condenser operation.
 2. Unit(s) shall be complete with all items such as relays, starters, switches, safety controls, conduit and wire, and as required for proper operation. All factory-mounted controls shall be factory pre-wired to the unit control panel. A safety disconnect switch shall be standard on all units and shall be sized according to the unit.
 - M. Factory tested

1. Unit(s) shall be operated, tested and set at the factory using job-site conditions for electrical and gas input. All operating and safety controls shall be tested and set at the factory. Adjustable or fixed sheaves shall be set for proper RPM at specified conditions. Gas-pressure regulator shall be set for specified burning rate at specified inlet pressure.
- N. Service and parts
1. The supplier shall furnish as built wiring connection and control-circuit diagrams, dimension sheets and a full description of the unit(s). Service manuals, showing service and maintenance requirements, shall be provided with each unit.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Examine roughing-in for piping systems to verify actual locations of piping connections before equipment installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Complete field assembly of hoods where required.
 1. Make closed butt and contact joints that do not require filler.
 2. Grind field welds on stainless-steel equipment smooth, and polish to match adjacent finish. Comply with welding requirements in Part 2 "General Hood Fabrication Requirements" Article.
- B. Install hoods and associated services with clearances and access for maintaining, cleaning, and servicing hoods, filters/baffles, grease extractor, and fire-suppression systems according to manufacturer's written instructions and requirements of authorities having jurisdiction.
- C. Make cutouts in hoods where required to run service lines and to make final connections, and seal openings according to UL 1978.
- D. Securely anchor and attach items and accessories to walls, floors, or bases with stainless-steel fasteners, unless otherwise indicated.
- E. Install hoods to operate free from vibration.
- F. Install trim strips and similar items requiring fasteners in a bed of sealant. Fasten with stainless-steel fasteners at 48 inches (1200 mm) o.c. maximum.
- G. Install sealant in joints between equipment and abutting surfaces with continuous joint backing, unless otherwise indicated. Provide airtight, watertight, vermin-proof, sanitary joints.
- H. Install lamps, with maximum recommended wattage, in equipment with integral lighting.
- I. Set initial temperatures, and calibrate sensors.

- J. Set field-adjustable switches.

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping with clearance to allow service and maintenance.
- C. Connect ducts according to requirements in Division 23 Section "Air Duct Accessories." Install flexible connectors on makeup air supply duct. Weld exhaust-duct connections with continuous liquidtight joint.
- D. Install fire-suppression piping for remote-mounted suppression systems according to NFPA 17A, "Wet Chemical Extinguishing Systems."

3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.
- B. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- C. Tests and Inspections:
 - 1. Test each equipment item for proper operation. Repair or replace equipment that is defective, including units that operate below required capacity or that operate with excessive noise or vibration.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - 3. Test water, drain, gas, and liquid-carrying components for leaks. Repair or replace leaking components.
 - 4. Perform hood performance tests required by authorities having jurisdiction.
 - 5. Perform fire-suppression system performance tests required by authorities having jurisdiction.
- D. Prepare test and inspection reports.

3.5 DEMONSTRATION

Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain commercial kitchen hoods.

END OF SECTION 233813

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SECTION 235100 – BREECHINGS, CHIMNEYS, AND STACKS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Manufactured breechings.
- B. Manufactured stacks.
- C. Manufactured vent systems for high-efficiency gas fired equipment.

1.2 RELATED SECTIONS

- A. Division 23 Section “Common Motor Requirements for HVAC Equipment.”
- B. Division 23 Section “HVAC Equipment Insulation.”
- C. Division 26 Section “Electrical.”

1.3 REFERENCES

- A. ANSI Z21.66 - Electrically Operated Automatic Vent Damper Devices for Use with Gas-Fired Appliances.
- B. ANSI Z21.67 - Mechanically Actuated Automatic Vent Damper Devices for Use with Gas-Fired Appliances.
- C. ANSI Z21.68 - Thermally Operated Automatic Vent Damper Devices for Use with Gas-Fired Appliances.
- D. ASTM A167 - Stainless and Heat-Resisting Chromium-Nickel Steel Plate, Sheet, and Strip.
- E. ASTM A525 - Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, General Requirements.
- F. ASTM A527 - Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process, Lock-Forming Quality.
- G. ASTM A569 - Steel, Sheet and Strip, Carbon (0.15 Maximum Percent) Hot-Rolled Commercial Quality.
- H. ASTM C64 - Refractories for Incinerators and Boilers.
- I. ASTM C105 - Ground Fire Clay as a Refractory Mortar for Laying-up Fireclay Brick.
- J. ASTM C401 - Classification of Castable Refractories.
- K. NEMA MG1 - Motors and Generators.
- L. NFPA 31 (ANSI Z95.1) - Standard for the Installation of Oil Burning Equipment.

- M. NFPA 54 (ANSI Z223.1) - The National Fuel Gas Code.
- N. NFPA 70 - National Electrical Code.
- O. NFPA 82 - Standard on Incinerators, Waste, and Linen Handling Systems and Equipment.
- P. NFPA 211 - Standard for Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances.
- Q. SMACNA - HVAC Duct Construction Standards - Metal and Flexible.
- R. UL 103 - Standard for Factory Built Low Heat Chimneys.
- S. UL 127 - Standard for Factory Built Fireplaces.
- T. UL 378 - Standard for Draft Equipment.
- U. UL 441 - Standard for Gas Vents.
- V. UL 641 - Standard for Low Temperature Venting Systems.
- W. UL 959 (ANSI Z181.1) - Medium Heat Appliance Factory Built Chimneys.
- X. UL 1738 - Venting Systems for Gas-Burning Appliances, Categories II, III, and IV.

1.4 DEFINITIONS

- A. Breeching: Vent Connector.
- B. Chimney: Primarily vertical shaft enclosing at least one vent for conducting flue gases outdoors.
- C. Smoke Pipe: Round, single wall vent connector.
- D. Vent: That portion of a venting system designed to convey flue gases directly outdoors from a vent connector or from an appliance when a vent connector is not used.
- E. Vent Connector: That part of a venting system that conducts the flue gases from the flue collar of an appliance to a chimney or vent, and may include a draft control device.

1.5 DESIGN REQUIREMENTS

- A. Factory built vents and chimneys used for venting natural draft appliances shall comply with NFPA 211 and be UL listed and labeled.

1.6 SUBMITTALS FOR REVIEW

- A. Shop Drawings: Indicate general construction, dimensions, weights, support and layout of breechings. Submit layout drawings indicating plan view and elevations where factory built units are used.

- B. Product Data: Provide data indicating factory built chimneys, including dimensional details of components and flue caps, dimensions and weights, electrical characteristics and connection requirements.
- C. Clearances to Combustibles: Submit requirements for clearances. The required clearances to combustible materials for submitted products shall be equal to or less than the clearances required for the basis-of-design products.
- D. Manufacturer's Calculations: Provide to verify sizing of systems.
- E. Manufacturer's Installation Drawings: Provide computer-drawn diagrams customized to the project, indicating parts and lengths required for a complete installation.

1.7 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this Section with minimum 3 years experience.
- B. Installer Qualifications: Company specializing in performing the work of this Section with minimum 3 years experience.
- C. Design stacks under direct supervision of a Professional Structural Engineer experienced in design of this Work and licensed at the place where the Project is located.

1.8 REGULATORY REQUIREMENTS

- A. Conform to NFPA 54 (ANSI Z223.1) code for of natural gas and liquefied petroleum (LP) gas burning appliances and equipment.
- B. Conform to NFPA 31 (ANSI Z95.1) for installation of oil burning appliances and equipment.
- C. Products Requiring Electrical Connection: Listed and classified by Underwriters' Laboratories, Inc., as suitable for the purpose specified and indicated.

PART 2 - PRODUCTS

2.1 SINGLE-WALL SPECIAL GAS VENT SYSTEM FOR MID-AND-HIGH-EFFICIENCY APPLIANCES

- A. Verify approval of appliance (refer to Section 15430), and the appliance manufacturer's requirements, prior to submitting vent system.
- B. Manufacturers (subject to approval by the appliance manufacturer):
 - 1. Selkirk, Model Saf-T Vent, EZ Seal and GC series.
 - 2. Metal Fab, Corr/Guard Model CGSW.
 - 3. ICC
 - 4. Substitutions: Not permitted
- C. The system shall be a factory-built special gas vent and connector system, tested and listed by Underwriters Laboratories for use with Listed natural gas or propane burning equipment that produce flue-gas temperatures not above 550 degrees F. The system shall be listed as vents

(horizontal or vertical) for gas burning appliances, suitable for ANSI Category I, II, III, and IV Gas-Burning Appliances. The system shall be fabricated from AL 29-4C7 stainless steel, suited for use with high efficiency condensing gas burning equipment.

- D. Clearances: When connected to gas-burning appliances with the following maximum continuous flue-gas temperature ratings, the system shall be rated to be installed with the following clearances to combustible materials:
 - 1. At 550 degrees F, there may be combustible materials on a maximum of 3 sides at only 2 in. clearance.
 - 2. At 300 degrees F, there may be combustible materials on a maximum of 3 sides at only 1 inch clearance.
 - 3. At 480 degrees F, the system may be enclosed by combustibles on all sides with an air space clearance of 8 in. horizontally or 6 in. vertically.
- E. Joints in the system shall be fastened with Selkirk's Ring and Tab tapered closure system (sizes 3 in. thru 16 in.) or Sure-Seal system (sizes 18 in. thru 32 in.) and sealed with factory applied seal. This closure system shall be rated to be gas tight at two and one-half times the Listed pressure rating of 8 in. water column. Closure systems of other manufacturers shall provide equivalent structural and sealing performance, subject to approval.
- F. Size the system in accordance with the appliance manufacturer's specifications, NFPA 54, NFPA 211, and local codes. Submit manufacturer's verification of sizing. Notify the Architect if the manufacturer's calculated inner diameter differs from that indicated.
- G. Accessories:
 - 1. Sealant: Heat-Fab recommends RTV sealant, either General Electric RTV 106 or Dow Corning 732.
 - 2. Thimble for wall penetration to provide the required clearances from combustible materials.
 - 3. Termination: Heat-Fab screened outlet comes with integral wall penetration assembly. If fan furnished under Division 22 is used as termination, screened outlet may not be required.
 - 4. Drain Tee. Provide tee section of vent, and clear silicone tubing of required length to extend to floor drain. Provide tee in orientation and location recommended by the appliance manufacturer.
 - 5. Tee for Barometric Damper: Refer to Division 22 for damper.
 - 6. Appliance adapter with coupler.
 - 7. Supports.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install breechings with a minimum of joints. Align accurately at connections, with internal surfaces smooth.
- C. Support breechings from building structure, rigidly with suitable ties, braces, hangers and anchors to hold to shape and prevent buckling. Support vertical breechings, chimneys, and

stacks at 12 foot (4 m) spacing, to adjacent structural surfaces, or at floor penetrations. Refer to SMACNA HVAC Duct Construction Standards - Metal and Flexible for equivalent duct support configuration and size.

- D. Install concrete inserts for support of breechings, chimneys, and stacks in coordination with formwork.
- E. Pitch breechings with positive slope up from fuel-fired equipment to chimney or stack.
- F. Install vent dampers, locating close to draft hood collar, and secured to breeching.
- G. Assemble and install stack sections in accordance with NFPA 82, industry practices, and in compliance with UL listing. Join sections with acid-resistant joint cement to ASTM C105. Connect base section to foundation using anchor lugs.
- H. Level and plumb chimney and stacks.
- I. Clean breechings, chimneys, and stacks during installation, removing dust and debris.
- J. At appliances, provide slip joints permitting removal of appliances without removal or dismantling of breechings, breeching insulation, chimneys, or stacks.
- K. Provide minimum length of breeching to connect appliance to chimney.

END OF SECTION 235100

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SECTION 235216 - CONDENSING BOILERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes packaged, factory-fabricated and assembled, gas-fired, condensing boilers, trim, and accessories for generating hydronic heating-system hot water.

1.3 SUBMITTALS

- A. Product Data: Include performance data, operating characteristics, furnished specialties, and accessories.
- B. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
- C. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- D. Source quality-control test reports.
- E. Field quality-control test reports.
- F. Operation and Maintenance Data: For boilers to include in emergency, operation, and maintenance manuals.
- G. Warranty: Special warranty specified in this Section.
- H. Other Informational Submittals:
 - 1. ASME Stamp Certification and Report: Submit "A," "S," or "PP" stamp certificate of authorization, as required by authorities having jurisdiction, and document hydrostatic testing of piping external to boiler.

1.4 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this Section with minimum of 3 years of experience.
- B. Installer Qualifications: Company specializing in performing the work of this Section with minimum 3 years' experience.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

- D. ASME Compliance: Fabricate and label boilers to comply with ASME Boiler and Pressure Vessel Code.
- E. ASHRAE/IESNA 90.1 Compliance: Boilers shall have minimum efficiency according to "Gas and Oil Fired Boilers - Minimum Efficiency Requirements."
- F. DOE Compliance: Minimum efficiency shall comply with 10 CFR 430, Subpart B, Appendix N, "Uniform Test Method for Measuring the Energy Consumption of Furnaces and Boilers."
- G. UL Compliance: Test boilers for compliance with UL 795, "Commercial-Industrial Gas Heating Equipment." Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.
- H. Source Quality Control: Test and inspect boilers according to the ASME Boiler and Pressure Vessel Code, Section IV. Boilers shall be test fired in the factory, and a report attached permanently to the exterior cabinet of the boiler for field reference.

1.5 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.6 WARRANTY

- A. Limited Warranty: Manufacturer's standard form in which manufacturer agrees to provide replacement components of boilers which fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period for Condensing Boilers:
 - a. Heat Exchanger: 10 years from date of Substantial Completion.
 - b. All Other Parts: 1 year from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 BOILER TYPES

- A. Basis of Design Boiler Type:
 - 1. Stainless steel 1 pass down-fired firetube type.
- B. Boiler types shall conform to their specifications in this Section. Boilers which do not conform, or are of types other than those specified, are not allowed.

2.2 CONDENSING BOILERS – STAINLESS STEEL 1-PASS DOWN-FIRED FIRETUBE TYPE

- A. Manufacturers:
 - 1. Weil-McLain "Evergreen" product line.
 - 2. Or approved equal.
- B. General Description: Each unit shall be a single-pass down-fired firetube type complete with boiler fittings and automatic controls. The boiler, with its piping and wiring, shall be factory packaged. Each boiler shall be neatly finished, thoroughly tested and packaged for shipping.

Boiler design and construction shall be in accordance with Section IV of the ASME Code for hot water heating boilers with a maximum working pressure of 80 psig. The boiler shall be CSA (formerly AGA/ CGA) certified as an indirect or direct vent boiler and comply with ASME CSD-1 Code requirements.

- C. Performance: The capacity of each unit shall be indicated on the Drawing schedule.
 - 1. Burner Turndown Ratio: 10:1.
 - 2. NOX Emission (maximum): 20 PPM (corrected to 3 percent O₂).
 - 3. Electrical: 115-120 V, 60Hz, 1 phase.
- D. Boiler Design:
 - 1. Boiler shall be a compact, single-pass, vertical down-fired firetube type, with stainless steel fire-tube heat exchanger.
 - 2. A condensate neutralizing box complete with limestone granules shall be shipped loose for field installation by the Contractor.
 - 3. The condensing capability shall allow the boiler to be operated without the use of a 3-way valve for the boiler supply water temperature reset. No minimum boiler return water temperature {A secondary pump is required and is supplied by the manufacturer.} shall be required.
 - 4. Each boiler shall be constructed in accordance with the A.S.M.E. Section IV Code and bear the "H" stamp.
 - 5. The maximum pressure drop through the boiler shall not exceed 0.6 Ft. W.C. with a 27 degrees F differential and less than 0.05 Ft. W.C. with a 45 degrees F differential.
- E. Burner Design:
 - 1. General: Forced draft burner mounted in and integral with the boiler.
 - 2. Emissions: The boiler(s) burner shall be guaranteed to limit NO_x emissions to 20 PPM or less, as certified by an independent testing lab. NO_x emissions shall be at full operating conditions. Proof of such certification shall be made available to the Architect/Engineer and Owner. External flue gas recirculation shall not be accepted for emission control.
 - 3. Gas Train - As a minimum, the gas train shall meet the requirements of CSA and ASME CSD-1 and shall include:
 - a. Low Gas Pressure Interlock, manual reset.
 - b. High Gas Pressure Interlock, manual reset.
 - c. Upstream and downstream manual test cocks.
 - d. Ball Type manual shutoff valve upstream of the main gas valve.
 - e. Unibody double safety gas valve assembly.
 - f. Gas Pressure Regulator
 - g. Union connection to permit burner servicing.
 - 4. Combustion Air Proving Switch shall be furnished to ensure sufficient combustion airflow is present for burner firing.
 - 5. To ensure that proper draft is not blocked in the stack, the burner shall include a High Air Pressure Switch sensing the outlet pressure connection relative to stack back draft.
- F. Boiler Trim:
 - 1. Safety valve(s) shall be ASME Section IV approved side outlet type mounted on the boiler water outlet. Size shall be in accordance with code requirements and set to open at 30 psig.
 - 2. Temperature and pressure gauge shall be mounted on the water outlet.
 - 3. Solid State Low water cut-off probe with manual reset and test switch.

4. Outlet water supply sensing probe for operating water limit setpoint.
5. Return water-sensing probe for operating water limit setpoint.

G. Boiler Controls:

1. The Boiler shall include a Falcon Computerized Boiler Burner control which shall be an integrated, solid state digital micro- processing modulating device, complete with sequence indication, fault reset, mode selection, and parameter set-point. It shall be mounted at the front of the boiler panel for easy access and viewing.
2. Controller shall provide for both flame safeguard and boiler control and shall perform the following functions:
 - a. Burner sequencing with safe start check, pre-purge, Electronic direct spark ignition, and post purge. Flame rod to prove combustion.
 - b. Flame Supervision - The control shall provide pre-purge and post-purge and shall maintain a running history of operating hours, number of cycles, and the most recent 15 faults. The control shall be connected to a touchscreen display that will retrieve this information.
 - c. Safety Shutdown with display of error.
 - d. Modulating control of the variable speed fan for fuel/air input relative to load requirements.
 - e. Gas pressure supervision, high and low.
 - f. Combustion Air Proving Supervision.
 - g. The supply temperature and set-point temperature shall be displayed at all times on the touch screen display.
 - h. Controller shall be equipped with a touch screen display for set up, trouble shooting, and operational display, and shall include ModBus communication capability of this information.
 - i. Include the programming of system circulating pump and provide the programming of 2 heating loops.
3. The parameter input control set-points shall be factory downloaded with jobsite conditions programmed at the time of initial jobsite operation.
4. The controls shall be panel mounted and so located on the boiler as to provide ease of servicing the boiler without disturbing the controls, and located to prevent possible damage by water according to UL requirements.
5. Electrical power supply shall be 120 volts, 60 cycle, single phase for the fan and 120 volts for control circuit requirements.
6. System shall be capable of staging up to up to 8 boilers in a lead/ lag configuration. The control shall include automatic selection of needed boilers based on energy demand, an adjustable outdoor reset schedule, domestic hot water priority, and a system display. The control shall force each boiler to a lower fire before allowing any boiler to operate at high fire, allowing for inverse efficiency (lower fire rate, higher efficiency). The control shall monitor supply and return water temperature and shall communicate between boilers via RS-485 wiring.

H. Venting Kits:

1. Exhaust: Refer to Division 23 Section "Breechings, Chimneys and Stacks." Complete system, ASTM A959, Type AL29-4C stainless steel, pipe, vent terminal, thimble, indoor plate, vent adapter, condensate trap and condensate neutralization (dilution) tank, and sealant.
2. Combustion-Air Intake: Complete system, stainless-steel, pipe, vent terminal with screen, inlet air coupling, and sealant.

I. Manufacturer's Field Services:

1. General: The boiler supplier's factory authorized service organization shall be responsible for performance of inspections, start up and testing of the package boiler, and accessory equipment and materials furnished under this Section. Submit a detailed written record of the start up performance, including burner setting data over the entire load range, to the Architect/Engineer before final acceptance. Necessary labor, equipment, and test apparatus shall be furnished by the authorized service organization. Equipment defects discovered by the tests shall be rectified either by the service organization or boiler manufacturer.
2. Equipment Inspection: Boiler representative shall provide 8 hours of jobsite assistance to inspect boilers and other equipment upon arrival, verifying completeness of equipment supplied and potential damages. Shipped-loose components, such as casing, shall be mounted on the boiler by the boiler provider after the Contractor has set the boiler in the building.
3. Pre-Start-up Walk-Through: Boiler representative shall spend 8 hours at the jobsite reviewing the installation with the Mechanical Subcontractor. The walk-through shall be conducted approximately 1 week prior to start-up.
4. Start-up shall be conducted by experienced and factory authorized technician in the regular employment of the authorized service organization, and shall include:
 - a. Demonstrate that boiler, burner, controls, and accessories comply with requirements of this Section as proposed by the boiler and accessories supplier. Pre-test items prior to scheduling the final testing that will be witnessed by the manufacturer's test engineer.
 - b. Readings at different firing rates (20, 50, 75 and 100 percent) of load for the modulating burner shall be taken, with a written report of the tests submitted to the Architect/Engineer. The reports shall include readings for each firing rate tested and include stack temperatures, O₂, CO, NO_x, and overall boiler efficiency.
 - c. Auxiliary Equipment and Accessories: Observe and check valves, draft fans, electric motors and other accessories and appurtenant equipment during the operational and capacity tests for leakage, malfunctioning, defects, and non-compliance with referenced standards or overloading as applicable.
 - d. Commissioning Requirements:
 - 1) Fireside inspection.
 - 2) Set up fuel train and combustion air system.
 - 3) Set up operating set points.
 - 4) Check safeties, including flame safeguard, LWCO, airflow, fuel pressures, and high limits.
 - 5) Set up and verify efficiencies at 20 percent, 50 percent, 75 percent, and 100 percent.
 - 6) Set up and verify burner turndown.
5. Training shall include safety procedures, maintenance procedures, control operations, and diagnostic procedures. Training shall be provided in a single 8 hour continuous session to accommodate Owner's operator's availability on site.

J. Operating & Maintenance Manuals:

1. Provide 2 Operating and Maintenance manuals including cut-away views of boiler and burner, schematics including fuel trains, general instructions for maintenance and inspections, complete spare parts lists and troubleshooting procedures.
2. A wiring diagram corresponding to the boiler shall be affixed to the boiler near the electrical panel.

- K. Warranty Data:
1. The pressure vessel shall be guaranteed against thermal shock for 20 years when utilized in a closed loop hydronic heating system with a temperature differential of 170 degrees F (94 degrees C) or less. The boiler pressure vessel shall be guaranteed accordingly without a minimum flow rate or return water temperature requirement. The boiler shall not require the use of flow switches or other devices to ensure minimum flow.
 2. The pressure vessel, tubes and tube sheets (heat exchanger) shall be guaranteed against flue gas corrosion and materials/workmanship for a period of 10 years.
 3. The condensate collection box shall be guaranteed for 20 years.
 4. Parts not covered by the above warranties shall carry a 1 year warranty from startup, or 18 months from shipment, whichever occurs first. This shall include the electrical components and burner components.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Before boiler installation, examine roughing-in for concrete equipment bases, anchor-bolt sizes and locations, and piping and electrical connections to verify actual locations, sizes, and other conditions affecting boiler performance, maintenance, and operations.
1. Final boiler locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.
- B. Examine mechanical spaces for suitable conditions where boilers will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 BOILER INSTALLATION

- A. Install boilers level on concrete housekeeping base, sized at least 4 inches (100 mm) larger than boiler base. Fasten boiler to base. Concrete base and installation requirements are specified in Division 03.
- B. Install, start, and test boilers and their accessories in accordance with the manufacturer's instructions and these Specifications. In the case of conflicting instructions, the more stringent shall apply.
- C. Install gas-fired boilers according to NFPA 54.
- D. Assemble and install boiler trim.
- E. Assemble and install boiler accessories
- F. Install electrical devices furnished with boiler but not specified to be factory mounted.
- G. Provide control wiring to field-mounted electrical devices.

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

- B. Install piping adjacent to boiler with clearances and fittings to allow service and maintenance.
- C. Connect hot-water piping to supply- and return-boiler tapplings with shutoff valve and union or flange at each connection.
- D. Pipe safety relief valves to above nearest floor drain with an air break. Piping shall be at least full size of connection. Do not combine piping from individual valves, unless recommended and sized by the boiler manufacturer.
- E. Pipe equipment drain connections to above the nearest floor drain with an air break. Piping shall be at least full size of connection. Provide an isolation valve at each connection if not factory-furnished.
- F. Boiler Venting:
 - 1. Install flue venting kit and sealed combustion-air intake.
 - 2. Connect full size to boiler connections.
 - 3. Comply with requirements in Division 23 Section "Breechings, Chimneys, and Stacks."
- G. See Division 22 – PLUMBING for gas piping. Connect gas piping to boiler gas-train inlet with union. Piping shall be at least full size of gas train connection. Provide a reducer if required.
- H. Ground equipment according to Division 26 Section "Grounding and Bonding."
- I. Connect wiring according to Division 26 Section "Wire and Cable."

3.4 START-UP, INSTRUCTION AND WARRANTY SERVICE

- A. The boiler manufacturer's representative shall provide start-up and instruction of each new boiler, including burner and boiler control system as specified herein. Start-up and instruction shall cover components assembled and/or furnished by the manufacturer, whether or not of their own manufacture.

3.5 DEMONSTRATION

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

END OF SECTION 235216

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SECTION 236200 - PACKAGED COMPRESSOR AND CONDENSER UNITS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Condensing unit package.
- B. Charge of refrigerant and oil.
- C. Controls and control connections.
- D. Refrigerant piping connections.
- E. Motor starters.
- F. Electrical power connections.

1.2 RELATED SECTIONS

- A. Division 03 Section "Cast-in-Place Concrete": Concrete bases.
- B. Division 23 Section "Common Motor Requirements for HVAC Equipment."
- C. Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment.": Placement of vibration isolators.
- D. Division 23 Section "Refrigerant Piping."
- E. Division 23 Section "Air Coils."
- F. Division 23 Section "Convection Heating and Cooling Units." : Fan-coil units.
- G. Division 23 Section "Indoor Central-Station Air-Handling Units."
- H. Division 23 Section "Instrumentation and Controls for Mechanical Systems" - Sequence of Operation.
- I. Division 26 "Electrical."

1.3 REFERENCES

- A. ARI 210/240 - Unitary Air-Conditioning and Air-Source Heat Pump Equipment.
- B. ARI 270 - Sound Rating of Outdoor Unitary Equipment.
- C. ARI 365 - Commercial and Industrial Unitary Air-Conditioning Condensing Units.
- D. ASHRAE 14 - Methods of Testing for Rating Positive Displacement Condensing Units.

- E. ASHRAE 15 - Safety Code for Mechanical Refrigeration.
- F. ASHRAE 90A - Energy Conservation in new Building Design.
- G. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
- H. NEMA MG 1 - Motors and Generators.
- I. UL 207 - Refrigerant-Containing Components and Accessories, Non-Electrical.
- J. UL 303 - Refrigeration and Air-Conditioning Condensing, and Air-Source Heat Pump Equipment.

1.4 SUBMITTALS

- A. Shop Drawings: Indicate components, assembly, dimensions, weights and loadings, required clearances, and location and size of field connections.
- B. Product Data: Provide rated capacities, weights specialties and accessories, electrical nameplate data, and wiring diagrams.

1.5 SUBMITTALS AT PROJECT CLOSEOUT

- A. Operation and Maintenance Data: Include start-up instructions, maintenance instructions, parts lists, controls, and accessories. ”

1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this Section with minimum 3 years' experience.

1.7 REGULATORY REQUIREMENTS

- A. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

1.8 DELIVERY, STORAGE, AND PROTECTION

- A. Transport, handle, store, and protect products.
- B. Comply with manufacturer's installation instructions for rigging, unloading, and transporting units.
- C. Protect units on site from physical damage. Protect coils.

1.9 WARRANTY

- A. Provide a 5 year warranty to include coverage for refrigerant compressors.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

1. Trane.
2. Daikin Applied.
3. Carrier.
4. York.
5. Substitutions: Not permitted

2.2 MANUFACTURED UNITS

- A. Units: Self-contained, packaged, factory assembled and pre-wired units suitable for outdoor use consisting of cabinet, compressors, condensing coil and fans, integral sub-cooling coil, controls, liquid receiver, wind deflector, and screens.
- B. Construction and Ratings: In accordance with ARI 210/240, ARI 365 and UL 207 and UL 303. Testing shall be in accordance with ASHRAE 14.
- C. Performance Ratings: Energy Efficiency Rating (EER) and Coefficient of Performance (COP) not less than prescribed by ASHRAE 90A.

2.3 CASING

- A. House components in welded steel frame with galvanized steel panels with weather resistant, baked enamel finish.
- B. Mount starters and controls in weatherproof panel provided with full opening access doors. Provide mechanical interlock to disconnect power when door is opened.
- C. Provide removable access doors or panels with quick fasteners and piano hinges.

2.4 CONDENSER COILS

- A. Coils: Aluminum fins mechanically bonded to seamless copper tubing. Provide sub-cooling circuits. Air test under water to 425 psig (2900 kPa), and dehydrate.
- B. Coil Guard: PVC coat steel wire.

2.5 FANS AND MOTORS

- A. Vertical discharge direct driven propeller type condenser fans with fan guard on discharge.
- B. Weatherproof motors suitable for outdoor use, single phase permanent split capacitor or 3 phase, with permanent lubricated ball bearings and built in current and thermal overload protection.
- C. Motors as indicated, in compliance with Division 23 Section "Common Motor Requirements for HVAC Equipment."

2.6 COMPRESSORS

- A. Mounting: Statically and dynamically balance rotating parts and mount on rubber-in-shear vibration isolators. Internally isolate hermetic units on springs.

- B. Motor: Constant speed suction gas cooled with electronic sensor and winding over temperature protection, designed for across-the-line starting. Furnish with starter.

2.7 REFRIGERANT CIRCUIT

- A. Provide each unit with two independent refrigerant circuits, factory supplied and piped. Refer to Division 23 Section "Refrigerant Piping." Section 15535 – Refrigerant Piping and Specialties.
- B. For Each Refrigerant Circuit, Provide:
 - 1. Filter dryer.
 - 2. Liquid line sight glass and moisture indicator.
 - 3. Thermal expansion valve for maximum operating pressure.
 - 4. Insulated suction line.
 - 5. Suction and liquid line service valves and gage ports.
 - 6. Liquid line solenoid valve.
 - 7. Charging valve.
 - 8. Discharge line check valve.
 - 9. Compressor discharge service valve.
 - 10. Condenser pressure relief valve.
- C. For heat pump units, provide reversing valve, suction line accumulator, flow control check valve, and solid-state defrost control utilizing thermistors.

2.8 CONTROLS

- A. On unit, mount weatherproof steel control panel, NEMA 250, containing power and control wiring, factory wired with single point power connection.
- B. For each compressor, provide across-the-line starter, non-recycling compressor overload, starter relay, and control power transformer or terminal for controls power. Provide manual reset current overload protection. For each condenser fan, provide across-the-line starter with starter relay.
- C. Provide Safety Controls Arranged So Any One Will Shut down Machine:
 - 1. High discharge pressure switch for each compressor.
 - 2. Low suction pressure switch for each compressor.
 - 3. Oil Pressure switch (manual reset).
- D. Provide the Following Operating Controls:
 - 1. Five minute off timer prevents compressor from short cycling.
 - 2. Periodic pump-out timer to pump down on high evaporator refrigerant pressure.
 - 3. Low ambient temperature controls.
 - 4. Hot gas bypass sized for minimum compressor loading on one compressor only, bypasses hot refrigerant gas to evaporator.
 - 5. Lead-lag switch to alternate compressor operation.
 - 6. Low ambient thermostat to lock out compressor at low ambient temperatures.
- E. Provide Controls to Permit Operation down to 0 °F Ambient Temperature:

1. Thermostat to cycle fan motors in response to outdoor ambient temperature.
 2. Head pressure switch to cycle fan motors in response to refrigerant condensing pressure.
 3. Solid state control to vary speed of one condenser fan motor in response to refrigerant condensing pressure.
 4. Electronic control consisting of mixing damper assembly, controlled to maintain constant refrigerant condensing pressure.
- F. Gages: Prepiped for suction and discharge refrigerant pressures and oil pressure for each compressor.
- G. For multiple units, provide remote mounted sequence panel to allow operation with lead-lag switching and time delay timer.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's installation instructions.
- B. Complete structural, mechanical, and electrical connections in accordance with manufacturer's installation instructions.
- C. Provide for connection to electrical service. Refer to Division 26.
- D. Install units on vibration isolation. Refer to Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."
- E. Install units on concrete base as indicated.
- F. Provide connection to refrigeration piping system and evaporators. Refer to Division 23 Section "Refrigerant Piping." Comply with ASHRAE 15.
- G. Furnish charge of refrigerant and oil.

3.2 DEMONSTRATION AND INSTRUCTIONS

- A. Division 01 Section "Closeout Procedures": Demonstrating installed work.
- B. Supply initial charge of refrigerant and oil for each refrigeration system. Replace losses of oil or refrigerant prior to end of correction period.
- C. Charge system with refrigerant and test entire system for leaks after completion of installation. Repair leaks, put system into operation, and test equipment performance.
- D. Shut-down system if initial start-up and testing takes place in winter and machines are to remain inoperative. Repeat start-up and testing operation at beginning of first cooling season.
- E. Provide cooling season start-up, and winter season shut-down for first year of operation.
- F. Inspect and test for refrigerant leaks every 2 months during first year of operation.

END OF SECTION 236200

SECTION 237300 – INDOOR CENTRAL-STATION AIR-HANDLING UNITS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Packaged Air Handling Units.
- B. Roof Curbs.

1.2 RELATED SECTIONS

- A. Division 23 Section “Common Motor Requirements for HVAC Equipment.”
- B. Division 23 Section “Identification for HVAC Piping and Equipment.”
- C. Division 23 Section “Vibration and Seismic Controls for HVAC Piping and Equipment.”
- D. Division 23 Section “Duct Insulation.”
- E. Division 23 Section “Air Coils.”
- F. Division 23 Section “HVAC Fans.”
- G. Division 23 Section “Particulate Air Filtration.”
- H. Division 23 Section “Air Duct Accessories” - Flexible duct connections.
- I. Division 23 Section “Packaged Compressor and Condenser Units.”
- J. Division 26 – Electrical.

1.3 REFERENCES

- A. AATCC TM 30 – Antifungal Activity, Assessment on Textile Materials: Mildew and Rot Resistance of Textile Materials.
- B. AATCC TM 100 – Antibacterial Finishes on Textile Materials: Assessment of.
- C. ABMA STD 9 - Load Ratings and Fatigue Life for Ball Bearings.
- D. ABMA STD 11 - Load Ratings and Fatigue Life for Roller Bearings.
- E. AMCA 99 - Standards Handbook.
- F. AMCA 210 - Laboratory Methods of Testing Fans for Rating.
- G. AMCA 300 - Reverberant Room Method for Sound Testing of Fans.
- H. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data.

- I. AMCA 500 - Test Methods for Louvers, Dampers and Shutters.
- J. ANSI/AFBMA 9 - Load Ratings and Fatigue Life for Ball Bearings.
- K. ANSI/UL 900 - Test Performance of Air Filter Units.
- L. ARI 410 - Standard for Forced-Circulation Air-Cooling and Air-Heating Coils.
- M. ARI 430 - Standard for Central-Station Air-Handling Units.
- N. ARI Guideline D - Application and Installation of Central Station Air-Handling Units.
- O. ARI 610 - Central System Humidifiers.
- P. ASHRAE 68 - Laboratory Method of Testing In-Duct Sound Power Measurement Procedure for Fans.
- Q. NEMA MG1 - Motors and Generators.
- R. NFPA 70 - National Electrical Code.
- S. NFPA 90A - Installation of Air Conditioning and Ventilation Systems.
- T. SMACNA - HVAC Duct Construction Standards - Metal and Flexible.
- U. UL 900 - Standard for Air Filter Units.
- V. UL - Fire Resistance Directory.
- W. UL 1995 - Heating and Cooling Equipment

1.4 SUBMITTALS

- A. Product Data:
 - 1. Published Literature: Indicate dimensions, weights, capacities, ratings, gauges and finishes of materials, operation and service clearances, and electrical characteristics and connection requirements. Indicate lift points and recommendations and center of gravity. Indicate unit shipping, installation and operating weights including dimensions.
 - 2. Filters: Data for filter media, filter performance data, filter assembly, and filter frames.
 - 3. Fans: Performance and fan curves with specified operating point clearly plotted, power, RPM.
 - 4. Sound Power Level Data: Fan outlet and casing radiation at rated capacity.
 - 5. Electrical Requirements: Power supply wiring including wiring diagrams for interlock and control wiring, clearly indicating factory-installed and field-installed wiring. Include recommended wire and fuse sizes or MCA, sequence of operation, connection points, safety and start-up instructions.
 - 6. Submit unit performance including: capacity, nominal and operating performance.
 - 7. Submit Mechanical Specifications for unit and accessories describing construction, components and options.

1.5 SUBMITTALS AT PROJECT CLOSEOUT

- A. Maintenance Data: Include instructions for lubrication, filter replacement, motor and drive replacement, spare parts lists, and wiring diagrams.

1.6 QUALITY ASSURANCE

- A. Air Handling Units: Product of manufacturer regularly engaged in production of components, who issues complete catalog data on product offering. Manufacturer shall have minimum 3 years' experience.
- B. Constant Volume Air Handling Units: Certify air volume, static pressure, fan speed, brake horsepower and selection procedures in accordance with ARI 430. If air handling units are not certified in accordance with ARI 430, Contractor shall be responsible for expenses associated with testing of units after installation to verify performance of fan(s). Any costs incurred to adjust fans to meet scheduled capacities shall be the sole responsibility of the Contractor.
- C. Variable Air Volume Air Handling Units with Variable Inlet Vanes: Certify air volume, static pressure, fan speed, brake horsepower and selection procedures in accordance with ARI 430. Certify units with inlet vanes in wide-open position. If air handling units are not certified in accordance with ARI 430, Contractor shall be responsible for expenses associated with testing of units after installation to verify performance of fan(s). Any costs incurred to adjust fans to meet scheduled capacities shall be the sole responsibility of the Contractor.
- D. Air Coils: Certify capacities, pressure drops and selection procedures in accordance with ARI 410-2001.

1.7 REGULATORY REQUIREMENTS

- A. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

1.8 DELIVERY, STORAGE, AND PROTECTION

- A. Transport, handle, store, and protect products.
- B. Units shall ship fully assembled up to practical shipping and rigging limitations. Units shipped not fully assembled shall have tags and airflow arrows on each section to indicate location and orientation in direction of airflow. Each section shall have lifting lugs to allow for field rigging and final placement of section.
- C. Deliver units to site with fan motors, sheaves, and belts completely assembled and mounted in units.
- D. Accept products on site in factory-fabricated protective containers, with factory-installed shipping skids and lifting lugs. Inspect for damage.
- E. Store in clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish.

1.9 ENVIRONMENTAL REQUIREMENTS

- A. Environmental conditions affecting products on site.
- B. Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

1.10 EXTRA MATERIALS

- A. Provide 2 sets of each type of disposable filters.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- 1. Daikin Applied
- 2. Trane.
- 3. Substitutions: Not permitted

2.2 INDOOR AIR HANDLING UNITS

A. General Description:

- 1. Configuration: Fabricate with fan and coil sections plus accessories, including:
 - a. Cooling coil section with drain pan.
 - b. Heating coil section with drain pan.
 - c. Filter section.
 - d. Combination filter/mixing box section.
 - e. Mixing box section.
 - f. Multi-zone damper section.
- 2. Performance Base: Sea level conditions.
- 3. Fabrication: Conform to AMCA 99 and ARI 430.

B. Casing:

- 1. Unit shall be double wall constructed in sections. Exterior wall shall be minimum 18 gauge galvanized steel. Interior wall shall be minimum 20 gauge solid galvanized steel for sections except intake plenums, discharge plenums and fan sections. Interior wall shall be minimum 20 gauge perforated plate galvanized steel for intake plenums, discharge plenums and fan sections. Portions of the interior of the unit exposed to the airstream shall be covered with steel to allow cleaning and prevent fiberglass erosion into the airstream. Foil facing on insulation shall not be acceptable as a substitute for double wall construction. If casing sections are not provided by the unit manufacturer with double wall construction, the Contractor shall be responsible for covering exposed insulation with galvanized steel. Unit shall be designed and constructed such that exterior panels are non-load bearing. Removal of exterior panels shall not affect the structural integrity of the unit. Units with welds on exterior surfaces or welds that have burned through from interior welds shall also receive a final shop coat of zinc-rich protective paint in manufacturer's standard color.
- 2. Insulate sections handling conditioned air with 2 inch (50 mm) thick 1-1/2 lb./cu. ft. (24 kg/m³) density matt faced fiberglass sandwiched between two sheets of solid galvanized steel. Fiberglass insulation shall not be exposed to the airstream. If any

insulation is exposed, the Contractor shall be responsible for covering it with galvanized steel.

3. As required for routine service access, unit shall be supplied with full height, galvanized, double wall, hinged, removable access doors. Access door shall have a full perimeter automotive type gasket to prevent air leakage, and Ventlock style handle that can be opened from unit interior. An 8 inch (203 mm) sealed glass and wire inspection window shall be installed in access doors to view unit operation.
4. Units shall have internal motor and drives and shall be provided with a full size removable service door on the drive side of the fan(s). Fan section access door shall contain an 8 inch (203 mm) square sealed glass and wire view window. If unit is provided with external motor, unit shall include a totally enclosed belt guard over drive components to prevent possible injury. Belt guard shall be provided with tachometer holes to facilitate RPM readings of the fan.
5. On units provided with heating or cooling coils and/or humidifiers, the drain pan shall extend under the complete coil section and/or humidifier section. On horizontal draw-thru units, a drain pan shall also be provided under the complete supply fan section. Provide drain connections on both sides of each drain pan. Drain pans shall be of sealed double wall galvanized construction with the manufacturer's standard insulation sandwiched between the pan layers. The cooling coil section of the air handling unit as well as the next section downstream of the cooling coil section shall be provided with drain pans.
6. Lights: Provide in accessible sections suitable for damp locations with wire guards, factory wired to weatherproof switch and pilot light and duplex outlet mounted on casing exterior. In humidifier sections, provide lights suitable for wet locations.
7. Bottom Inlet Units: Provide steel or aluminum walking grate on structural supports.
8. Strength: Provide structure to brace casings for suction pressure of 2.5 in. wg (600 Pa), with maximum deflection of 1 in 200.

C. Fans:

1. Performance Ratings: Conform to AMCA 210 and label with AMCA Certified Rating Seal.
2. Sound Ratings: AMCA 301; tested to AMCA 300 and label with AMCA Certified Sound Rating Seal.
3. Bearings: Self-aligning, grease lubricated, ball or roller bearings with lubrication fittings extended to exterior of casing with aluminum or copper tube and grease fitting rigidly attached to casing.
4. Mounting: Locate fan and motor internally on welded steel base coated with corrosion resistant paint. Factory mount motor on slide rails. Provide access to motor, drive, and bearings through removable casing panels or hinged access doors. Provide built-in inertia base of welded steel with bottom sheet and reinforcing grid for concrete ballast. Mount base on vibration isolators; refer to Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

D. Bearings and Drives:

1. Bearings: Heavy duty pillow block type, self-aligning, grease-lubricated ball bearings, with ABMA 9, L-50 life at 200,000 hours or roller bearings with ABMA 11, L-50 life at 200,000 hours.
2. Shafts: Solid, hot rolled steel, ground and polished, with key-way, and protectively coated with lubricating oil.
3. V-Belt Drive: Cast iron or steel sheaves, dynamically balanced, bored to fit shafts, and keyed. Matched belts, and drive rated as recommended by manufacturer or minimum

- 1.5 times nameplate rating of the motor. Minimum of 2 belts per motor.
 - a. Sheaves on fans with variable-frequency drives shall be fixed type.
 - b. Sheaves on fans without variable-frequency drives shall be as follows: Variable and adjustable pitch type for motors 15 hp (11.2 kW) and under, selected so required rpm is obtained with sheaves set at mid-position; fixed sheave for 20 hp (14.9 kW) and over.
 4. Belt Guard: Fabricate to SMACNA Standard; 0.106 inch (2.6 mm) thick, 3/4 inch (20 mm) diamond mesh wire screen welded to steel angle frame or equivalent, prime coated. Secure to fan or fan supports without short circuiting vibration isolation, with provision for adjustment of belt tension, lubrication, and use of tachometer with guard in place.
- E. Coils:
1. Casing: Provide access to both sides of coils. Enclose coils with headers and return bends fully contained within casing. Slide coils into casing through removable end panel with blank off sheets and sealing collars at connection penetrations.
 2. Drain Pans: 24 inch (600 mm) downstream of coil and down spouts for cooling coil banks more than 1 coil high.
 3. Air Coils: Certify capacities, pressure drops, and selection procedures in accordance with ARI 410. Refer to Division 23 Section "Air Coils".
 4. Fabrication:
 - a. Tubes: Seamless copper expanded into fins, brazed joints. Tubing diameter shall be 5/8 inch (15.9 mm) OD for hydronic (water) coils, 1/2 inch (12.7 mm) or 5/8 inch (15.9 mm) OD for refrigerant coils, and 5/8 inch (15.9 mm) OD or larger for steam coils. Tube wall thickness shall be at least 0.024 inch (0.61 mm) for hydronic (water) and refrigerant coils, and at least 0.031 inch (0.787 mm) for steam coils.
 - b. Fins: Aluminum.
 - c. Casing: Die formed channel frame of galvanized steel.
 5. Water Heating Coils:
 - a. Headers: Cast iron, seamless copper tube, or prime coated steel pipe with brazed joints.
 - b. Configuration: Drainable, with threaded plugs for drain and vent; serpentine type with return bends on smaller sizes and return headers on larger sizes.
 6. Refrigerant Coils:
 - a. Headers: Seamless copper tubes with silver brazed joints.
 - b. Liquid Distributors: Brass or copper venturi distributor with seamless copper distributor tubes.
 - c. Configuration: Down feed with bottom suction.
- F. Filters:
1. Filter Box: Section with filter guides, access doors from both sides, for side loading with gaskets and blank-off plates.
 2. Filter Media: UL 900 listed, Class I or Class II, approved by local authorities.
- G. Dampers:
1. Factory mounted outside air return air exhaust air dampers of galvanized steel with vinyl bulb edging and edge seals in galvanized frame, with galvanized steel axles in self-lubricating brass or stainless steel bearings, in opposed blade arrangement.
 2. Damper Leakage: Maximum 2 percent at 4 inch wg (1 kPa) differential pressure when

- sized for 2000 fpm (10 m/s) face velocity.
3. Face and Bypass Dampers: Factory mount in casing with access doors, of galvanized steel blades, with vinyl bulb edging and edge seals, galvanized steel frame, and axles in stainless steel sleeve bearings; arrange to match coil face with top bypass, blank-off and division sheets, internal linkage, access doors, and adjustable resistance plate.
 4. Multi-Zone Dampers: Factory mount in casing with service door, of galvanized steel blades with vinyl bulb edging and edge seals and frame with 1/2 inch (13 mm) diameter stainless steel shaft in oil impregnated bronze bearings, with end stops in frame; arrange for opposed blade operation, with adjustable resistance plates, hand quadrants, and sheet metal clips for duct connections.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Division 01 Section "Quality Requirements": Manufacturer's instructions.
- B. Install in accordance with ARI 435.
- C. Bolt sections together with gaskets. Isolate fan section with flexible duct connections; refer to Division 23 Section "Air Duct Accessories."
- D. Install flexible connections specified in Division 23 Section "Air Duct Accessories" between fan inlet and discharge ductwork. Ensure metal bands of connectors are parallel with minimum 1 inch (25 mm) flex between ductwork and fan while running.
- E. Install assembled unit on vibration isolators. Install isolated fans with resilient mountings and flexible electrical leads. Install restraining snubbers as required. Refer to Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment." Adjust snubbers to prevent tension in flexible connectors when fan is operating.
- F. Provide sheaves and belts required for final air balance. Coordinate with Division 23 Section "Testing, Adjusting, and Balancing for Mechanical Systems."
- G. Make connections to coils with unions or flanges.
- H. Hydronic Coils:
 1. Hydronic Coils: Connect water supply to leaving air side of coil (counterflow arrangement).
 2. Provide shut-off valve on supply line and lockshield balancing valve with memory stop on return line.
 3. Locate water supply at bottom of supply header and return water connection at top.
 4. Provide manual air vents at high points complete with stop valve.
 5. Ensure water coils are drainable and provide drain connection at low points.
 6. Provide drain pan under every coil.
- I. Refrigerant Coils: Provide sight glass in liquid line within 12 inches (300 mm) of coil.
- J. Extend coil drain and vent ports through the unit housing and terminate with ball valves and caps. Provide sealing collars or grommets at penetrations through unit housing to eliminate air

leakage.

- K. Support piping near the unit with isolators. Refer to Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."
- L. Insulate coil headers located outside air flow as specified for piping. Refer to Division 23 Section "HVAC Piping Insulation."
- M. Floor mounting:
 - 1. Provide concrete housekeeping pads (specified in Division 23 Section "Common Work Results for HVAC") for concrete floor slab construction, or pressure-treated lumber sleepers for wood floor construction. Coordinate pad size or sleepers and location with the approved equipment.
- N. Where ceiling mounting is indicated or specified, use suspended platform or strap hangers, brackets or self, whichever is indicated or most suitable for the equipment and its location. Construction materials, bracing, and fastening to building structure shall be as approved, or detailed on the Drawings
- O. Lights: Provide field-furnished 100-watt-equivalent compact fluorescent lamps in the light fixtures furnished within the unit sections.

3.2 TESTING

- A. After the entire installation is completed, ready for operation, test the systems. The Owner will provide electric current for the tests. Provide necessary labor, test pump, gauges, meters, other instruments and materials. Perform tests in the presence of the Architect. Dampers and fan speed controllers shall operate smoothly through their entire range. Unit shall operate without objectionable noise.

3.3 CLEANING

- A. The entire system installations including apparatus, motors, inside of ducts, and other components, shall be left in first-class condition including cleaning, oiling and packing.
- B. Provide filters at system start-up. Replace filters after air systems have been adjusted and balanced. Provide the Owner with 1 additional set of filters for air handling units.

3.4 ADJUSTMENTS

- A. After completion of the installation work called for in this Specification, furnish necessary Mechanics or Engineers for the adjustment and operation of the plant, to the end that the plant may be perfectly adjusted and turned over to the Owner in perfect working order. Further instruct the Owner's authorized representative in the care and operation of the installation, providing required framed instruction charts, directions, and other relevant information and documentation.

3.5 NAMEPLATES, TAGS AND CHARTS

- A. Provide engraved plastic nameplates to identify equipment, controls, and other components. Refer to Division 23 Section "Identification for HVAC Piping and Equipment." Provide

nameplates secured to each air handling unit indicating quantity and size of filters required.

3.6 ALTERATIONS

- A. Execute alterations, additions, removals, relocations or new work, and other work, as indicated or required to provide a complete installation in accordance with the intent of the Contract Documents.
- B. Any existing work disturbed or damaged by the alterations or new work shall be repaired or replaced to the Architect's satisfaction and at no additional cost to the Owner.
- C. Existing ductwork, piping, and other systems, indicated to be removed, shall be removed from the site. Cap off existing services remaining. The Owner retains the right to ownership of heating and ventilating equipment scheduled to be removed; store such equipment where requested by the Owner. Material not retained by the Owner shall be removed from the site.

3.7 CONTINUITY OF SERVICE

- A. Arrange to execute the work at such times and in such locations as may be required to provide uninterrupted service for the building or any of its locations. Any unavoidable conditions requiring reduced building capacity shall be arranged for by programming with the Owner's duly authorized representative at the building subject to the Architect's approval. If necessary, temporary work shall be installed to provide for the condition. Authorization for interrupting service shall be obtained in writing from the Owner. Any interruption of normal service shall be performed during an overtime period to be scheduled with the Owner. Costs for overtime work shall be included in the Bid.

END OF SECTION 237300

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SECTION 238126 – SPLIT-SYSTEM AIR CONDITIONERS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Air Conditioning Units.
- B. Controls and Control Panels.

1.2 REFERENCES

- A. ANSI/ASME - Boilers and Pressure Vessels Code.
- B. ANSI/NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
- C. ANSI/NFPA 90A - Installation of Air Conditioning and Ventilation Systems.
- D. UL - Underwriters' Laboratories.
- E. NFPA 70 - National Electric Code.

1.3 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Company specializing in manufacturing the Products specified in this Section with minimum 3 years experience.
- B. Installer Qualifications: Company specializing in performing the work of this Section with minimum 3 years experience.

1.4 REGULATORY REQUIREMENTS

- A. Conform to ANSI/NFPA 90A for the installation of Computer Room air conditioning units.

1.5 SUBMITTALS

- A. Submit product data for manufactured products and assemblies required for this project.
- B. Indicate water, drain, electrical and refrigeration rough-in connections on Shop Drawings or product data.

1.6 OPERATION AND MAINTENANCE DATA

- A. Submit operation and maintenance data.
- B. Include manufacturer's descriptive literature, operating instructions, installation instructions and maintenance and repair data.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

1. Daikin.
2. Fujitsu.
3. Mitsubishi.
4. Samsung.
5. Substitutions: Not permitted

2.2 GENERAL

- A. The system to consist of a compact wall-mounted packaged evaporator section and matching air-cooled outdoor unit.
- B. The units shall be listed by Electrical Testing Laboratories (ETL) and bear the ETL label.
- C. Wiring shall be in accordance with the National Electrical Code (N.E.C.).
- D. The units shall be rated in accordance with ARI Standard 210 and bear the ARI label.
- E. A full charge of refrigerant tubing shall be provided in the condensing unit. Tubing length shall be provided as required (coordinate with Drawings). A holding charge shall be provided in the evaporator.
- F. Unit shall be U.L. approved and shall bear a U.L. label.

2.3 INDOOR UNIT

- A. The indoor unit shall be completely factory assembled and wired.
- B. The casing shall have a white finish.
- C. The evaporator fan shall be a high performance, forward curve line flow fan direct driven by a single motor. The fan shall be statically and dynamically balanced and run on permanently lubricated bearings.
- D. An adjustable change vane shall be provided with the ability to direct the air flow from horizontal to vertical. An adjustable guide vane shall be provided to manually change the air direction from left to right.
- E. The evaporator coil shall be of nonferrous construction with smooth plate fins bonded to copper tubing. The tubing shall have inner grooves for high efficiency heat exchange. Tube joints shall be brazed with phoscopper or silver alloy. The coils shall be pressure tested at the factory.
- F. A condensate pan with drain shall be provided under the coil.
- G. A condensate pump shall be provided. The condensate pump shall fit within the evaporator housing and shall be completely concealed. The pump shall be supplied by the air conditioning unit manufacturer and shall be field installed in accordance with manufacturer's recommendations. The pump shall be provide with voltage and phase matching the associated indoor unit and shall have power wired via the indoor unit.
- H. The unit shall be powered from the outdoor unit. See "Outdoor Unit" in this Section for more information.

- I. The unit shall include washable filters.

2.4 OUTDOOR UNIT

- A. The outdoor unit shall be completely factory assembled, piped, wired, and shall carry a complete refrigerant charge.
- B. The casing shall be fabricated of galvanized steel, bonderized and finished with baked enamel.
- C. The unit shall be furnished with a direct drive, propeller type fan arranged for horizontal discharge.
- D. The motor shall have inherent protection, be of the permanently lubricated type and resiliently mounted for quiet operation.
- E. The fan shall be provided with a raised wire guard to prevent contact with moving parts.
- F. The compressor shall be of the high-performance serviceable rotary type with crankcase heater, accumulator and internal thermal overloads. The compressor shall be internally isolated with rubber mounts so as to avoid the transmission of vibration.
- G. The refrigeration system shall have the capability to operate with a maximum height difference of 23 feet and overall refrigerant tubing length of 65 feet between indoor and outdoor sections without the need for line size changes, traps, or additional oil. Refrigerant flow from the condenser to be controlled by means of a capillary tube.
- H. The condenser coil shall be of nonferrous construction with smooth plate fins bonded to copper tubing. The tubing shall have inner grooves for high efficiency heat exchange. The coil shall be protected with an integral metal guard.
- I. The unit shall be controlled by the microprocessor located in the matching indoor unit. The outdoor unit shall have the ability to provide power for the matching indoor unit. The unit electrical power shall be as scheduled on the Drawings.
- J. The unit shall be capable of low ambient operation, with outside air temperature as low as -40°F
- K. Support: 24" stand on concrete pad.

2.5 SYSTEM CONTROL

- A. The control system shall consist of two (2) microprocessors interconnected by a multi-wire cable. One microprocessor shall be factory wired and located within the indoor unit. It shall have the capability of sensing room temperature and indoor coil temperature; receive and process commands from the remote controller; and control the outdoor unit. Wireless remote controllers are not acceptable.
- B. The microprocessor within the wall-mounted remote monitor and controller shall display setpoint and room temperature; provide two (2) manually selected modes of cooling, normal and economy operation at 2 degrees F (1 degrees C) above setpoint; provide continuous or automatic start/stop of system operation; night setback operation of 4 degrees F (2 degrees C) above setpoint; and manual or automatic fan speed control. Automatic fan speed control shall

be based upon the temperature difference between setpoint and room temperature maintaining lowest speed possible.

2.6 REFRIGERANT PIPING

- A. Unit shall be provided with pre-charged and pre-insulated line sets as recommended by the manufacturer.

2.7 WARRANTY

- A. The units shall have a manufacturer's warranty for a period of 1 year from date of Substantial Completion.
- B. The compressor shall have a warranty of 5 years from date of Substantial Completion.
- C. If any part fails to function properly during the warranty period due to defects in workmanship or material, it shall be replaced or repaired.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that system is located per Drawings.
- B. Verify that proper power supply is available.

3.2 INSTALLATION

- A. Install units in accordance with manufacturer's instructions.
- B. Mount ground-mounted air-cooled condensing units 24 in. (0.61 m) above grade.
- C. Install condensing units so the fan blows in the same direction as the prevailing winds, unless otherwise directed by the manufacturer.
- D. Provide recessed wall mounting box for mounting the wired indoor controller. Fasten the box to wall framing stud, masonry, or other suitable structural surface approved by the Architect; fastening to gypsum wallboard is not acceptable. Provide interconnecting low-voltage and line-voltage wiring and conduits, concealed unless otherwise indicated. Wall mounting box, wiring, and conduits shall be in accordance with the requirements of Division 26 – Electrical.

END OF SECTION 238126

SECTION 238200 – CONVECTION HEATING AND COOLING UNITS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Cabinet Unit Heaters.
- B. Unit Heaters.

1.2 RELATED SECTIONS

- A. Division 23 Section “Common Motor Requirements for HVAC Equipment.”
- B. Division 23 Section “Hydronic Piping.”
- C. Division 23 Section “Hydronic Specialties.”
- D. Division 23 Section “Air-Cooled Refrigerant Condensing Units.”
- E. Division 23 Section “Instrumentation and Control for Mechanical Systems.”
- F. Division 26 “Electrical” - Equipment Wiring Systems: Electrical characteristics and wiring connections. Installation of room thermostats. Electrical supply to units.

1.3 REFERENCES

- A. NFPA 70 - National Electrical Code.

1.4 SUBMITTALS FOR REVIEW

- A. Product Data: Provide typical catalog of information including arrangements.
- B. Shop Drawings:
 - 1. Indicate cross sections of cabinets, grilles, bracing and reinforcing, and typical elevations.
 - 2. Submit schedules of equipment and enclosures typically indicating length and number of pieces of element and enclosure, corner pieces, end caps, cap strips, access doors, pilaster covers, and comparison of specified heat required to actual heat output provided.
 - 3. Indicate mechanical and electrical service locations and requirements.

1.5 SUBMITTALS AT PROJECT CLOSEOUT

- A. Project Record Documents: Record actual locations of components and locations of access doors in radiation cabinets required for access or valving.
- B. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner’s name and registered with manufacturer.
- C. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data, and parts listings.

1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this Section with minimum 3 years experience.

1.7 REGULATORY REQUIREMENTS

- A. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

1.8 EXTRA MATERIALS

- A. Provide 2 sets of filters.

PART 2 - PRODUCTS

2.1 CABINET UNIT HEATERS

- A. Manufacturers:
 - 1. Daikin Applied (formerly McQuay).
 - 2. Sterling Hydronics.
 - 3. Beacon-Morris.
 - 4. Dunham Bush.
 - 5. Daikin Applied (formerly McQuay)McQuay.
 - 6. Modine.
 - 7. Price Industries.
 - 8. Rittling.
 - 9. Trane.
 - 10. Substitutions: Approved equal. See Section 016000 - Product Requirements
- B. Coils: Evenly spaced aluminum fins mechanically bonded to copper tubes, designed for 100 psi (1380 kPa) and 220 degrees F (104 degrees C).
- C. Cabinet: 0.0598 inch (1.5 mm) steel with exposed corners and edges rounded, easily removed panels, glass fiber insulation and integral air outlet and inlet grilles.
- D. Finish: Factory applied baked enamel of color as selected by the Architect on visible surfaces of enclosure or cabinet.
- E. Fans: Centrifugal forward-curved double-width wheels, statically and dynamically balanced, direct driven.
- F. Motor:
 - 1. Provide ECM blower motor. Factory motor wiring shall be set for optimum fan performance.
 - 2. EC blower motor shall be 3 speeds, single phase with means for proportional field adjustment of each speed.
- G. Tap wound multiple speed permanent split capacitor or shaded pole with sleeve bearings, resiliently mounted.

- H. Control: Multiple speed switch, factory wired, located in cabinet.
- I. Filter: Easily removed 1 inch (25 mm) thick glass fiber throw-away type, located to filter air before coil.
- J. Capacity: As Scheduled, based on 65 degrees F (18 degrees C) entering air temperature.

2.2 UNIT HEATERS

- A. Manufacturers:
 - 1. Sterling Hydronics.
 - 2. Daikin Applied (formerly McQuay).
 - 3. Modine.
 - 4. Reznor.
 - 5. Trane.
 - 6. Substitutions: Approved equal. See Section 016000 - Product Requirements
- B. Coils: Seamless copper tubing, silver brazed to steel headers, and with evenly spaced aluminum fins mechanically bonded to tubing.
- C. Casing: 0.0478 inch (1.2 mm) steel with threaded pipe connections for hanger rods.
- D. Finish: Factory applied baked enamel.
- E. Fan: Direct drive propeller type, statically and dynamically balanced, with fan guard; horizontal models with permanently lubricated sleeve bearings; vertical models with grease lubricated ball bearings.
- F. Air Outlet: Adjustable pattern diffuser on projection models and 4-way double-deflection louvers on horizontal throw models.
- G. Motor: Permanently lubricated sleeve bearings on horizontal models, grease lubricated ball bearings on vertical models. Refer to Division 23.
- H. Control: Local Disconnect Switch.
- I. Capacity: As scheduled, based on 65 degrees F (18 degrees C) entering air temperature.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install equipment exposed to finished areas after walls and ceiling are finished and painted. Avoid damage.
- C. Protection: Provide finished cabinet units with protective covers during balance of construction.

- D. Unit Heaters: Hang from building structure, with pipe hangers anchored to building, not from piping. Mount as high as possible to maintain greatest headroom unless otherwise indicated. Do not mount higher than the manufacturer recommends; verify with manufacturer before mounting.
- E. Cabinet Unit Heaters: Install as indicated. Coordinate to assure correct recess size for recessed units.
- F. Hydronic Units: Provide with shut-off valve on supply and lockshield balancing valve on return piping. If not easily accessible, extend vent to exterior surface of cabinet for easy servicing. For cabinet unit heaters, fan coil units, and unit heaters, provide float operated automatic air vents with stop valve.

3.2 CLEANING

- A. After construction is completed, including painting, clean exposed surfaces of units. Vacuum clean coils and inside of cabinets.
- B. Touch-up marred or scratched surfaces of factory-finished cabinets, using finish materials furnished by manufacturer.

END OF SECTION 238200

SECTION 238316 – RADIANT-HEATING HYDRONIC PIPING

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. Radiant floor tubing.
- B. Manifolds and accessories.
- C. Cabinets and access panels.
- D. Manufacturer's calculations and tubing layouts.

1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions apply to work of this Section.
- B. Division 23, Basic Mechanical Materials and Methods Sections apply to work of this Section.

1.3 RELATED SECTIONS

- A. Division 23 Section "Hydronic Piping."
- B. Division 23 Section "Hydronic Specialties."
- C. Division 23 Section "Meters and Gauges for HVAC Piping."
- D. Division 23 Section "HVAC Water Treatment."
- E. Division 23 Section "Instrumentation and Controls for Mechanical Systems."
- F. Division 26 "Electrical"

1.4 DESCRIPTION OF WORK

- A. Extent of radiant floor heating work is indicated on the Drawings, and by requirements of this Section.
- B. Include tubing, manifolds, cabinets, panels, controls, supports, and accessories as required for complete operational systems.
- C. Provide manufacturer's calculations and layouts to verify tubing spacing, routing, fluid temperatures, floor surface temperatures, and other parameters, to provide the heat outputs, zoning, and general arrangements indicated on the Drawings and as scheduled. Layouts shall be computer drawn with a program such as AutoCad, using the Architect/Engineer's floor plans as backgrounds. Calculations shall be performed in a dedicated radiant-floor computer program such as Watts Radiant Works Pro, and shall indicate the following for each zone:
 - 1. Zone name corresponding to plan layout.
 - 2. Required heat (Btuh).

3. Radiant capacity (Btuh).
4. Panel load (Btuh).
5. Required intensity (Btuh/sq.ft).
6. Heated area (sq. ft).
7. Unheated area (sq. ft).
8. Tube spacing (in.).
9. Banded area (sq. ft.).
10. Banded spacing (inch).
11. Room temperature (degrees F.).
12. Maximum surface temperature (degrees F).
13. Supply fluid temperature (degrees F).
14. Fluid temperature drop (degrees F).
15. Flow (gpm).
16. Pressure drop (ft. wg).
17. Quantity of circuits/loops.
18. Circuit length (ft.).
19. Manifold distance (ft.).
20. Glycol type, and concentration (percent).
21. Slab thickness (inch).
22. Slab thickness above tube (inch).
23. Slab conductivity (Btu/(h-ft-degrees F).
24. Floor covering type.
25. Tubing type and size.

- D. Refer to other Division 21, 22, and 23 sections for boilers, water heaters, and other heat sources, pumps, piping and other hydronic appurtenances which are not work of this Section.
- E. Include starters, disconnects, and required electrical devices, except where specified as furnished, or factory installed, by manufacturer. Refer to Division 26 for the following work not work of this Section: Power supply wiring from power source to power connection for heat sources and pumps.

1.5 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in the manufacturing of hydronic radiant floor heating products, of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Tubing Warranty: For PEX tubing products, provide a minimum of a 20-year, non-prorated commercial warranty or a limited lifetime residential warranty.

1.6 CODES AND STANDARDS

- A. BOCA Compliance: Provide radiant floor heating tubing that is in accordance with the Building Officials and Code Administrators International, Inc., Report #87-51.
- B. ASTM Compliance: Provide radiant floor heating tubing that is in accordance with ASTM D380, ASTM D471 and ASTM D412.
- C. UL Compliance: Radiant floor tubing required to include a DIN standard oxygen barrier shall be listed and labeled by UL, and meet UL Guide MEKC, File MH17193. Electrical

components shall be listed and labeled by UL.

1.7 REFERENCES

- A. ASTM D380 - Standard Test Methods for Rubber Hose.
- B. ASTM D412 - Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers - Tension.
- C. ASTM D471 - Standard Test Method for Rubber Property—Effect of Liquids.
- D. ASTM F876 - Standard Specification for Crosslinked Polyethylene (PEX) Tubing.
- E. ASTM F877 - Standard Specification for Crosslinked Polyethylene (PEX) Plastic Hot- and Cold-Water Distribution Systems.

1.8 SUBMITTALS

- A. Product Data: Submit manufacturer's specifications for radiant floor heating products indicating dimensions, temperature capacities (both constant and intermittent), pressure ratings (both operating and burst), material composition, and bend radius.
- B. Shop Drawings: Submit Shop Drawings within 30 days of Bid Date, indicating radiant floor tube spacings and manifold locations on a per zone basis, appropriate construction details and field connection details. Include information on parts of the system being furnished by the manufacturer. Submit 3 copies of each.
- C. Provide manufacturer's calculations and layouts to verify tubing spacing, routing, fluid temperatures, floor surface temperatures, and other parameters, to provide the heat outputs, zoning, and general arrangements indicated on the Drawings and as scheduled. Layouts shall be computer drawn with a program such as AutoCad, using the Architect/Engineer's floor plans as backgrounds. Calculations shall be performed in a dedicated radiant-floor computer program such as Watts Radiant Works Pro, and shall indicate the following for each zone:
 - 1. Zone name corresponding to plan layout.
 - 2. Required heat (Btuh).
 - 3. Radiant capacity (Btuh).
 - 4. Panel load (Btuh).
 - 5. Required intensity (Btuh/sq. ft.).
 - 6. Heated area (sq. ft.).
 - 7. Unheated area (sq. ft.).
 - 8. Tubing type and size (in. nominal).
 - 9. Tube spacing (inch).
 - 10. Banded area (sq. ft.).
 - 11. Banded spacing (inch).
 - 12. Room temperature (degrees F).
 - 13. Maximum surface temperature (degrees F).
 - 14. Supply fluid temperature (degrees F).
 - 15. Fluid temperature drop (degrees F).
 - 16. Flow (gpm).
 - 17. Pressure drop (ft. wg).
 - 18. Quantity of circuits/loops.

19. Circuit length (ft.).
 20. Manifold distance (ft.).
 21. Glycol type, and concentration (percent).
 22. Slab thickness (inch).
 23. Slab thickness above tube (inch).
 24. Slab conductivity (Btu/(h-ft-degrees F)).
 25. Floor covering type, corresponding to Architect's finish schedule.
- D. Control Sequence: Submit control manufacturer's sequence of control for the radiant floor heating portions of this project. Provide a written sequence describing operation and logic, along with a schematic wiring diagram.
- E. Samples: Submit three 12 inch (305 mm) samples of each type and size of radiant floor tubing being furnished.
- F. Maintenance Data: Submit maintenance instructions, including repair of damaged components, corrosion protection instructions and a spare parts list. Include product data and drawings in accordance with requirements.
- G. Delivery, Storage and Handling:
1. Handle system components carefully to prevent damage, breaking or scoring. Do not install damaged system components without repairing or replacing with new. Project Architect/Engineer shall determine whether repair or replacement is required.
 2. Store radiant floor tubing and components so as to protect from physical damage and construction debris. Tubing shall be capable of withstanding exposure to direct sunlight without degradation for a period of at least 14 days prior to installation.
 3. Comply with manufacturer's instructions for unloading radiant floor heating materials and components, and moving them to their final locations.

PART 2 - PRODUCTS

2.1 MANUFACTURERS, RADIANT FLOOR TUBING, MANIFOLDS, AND FITTINGS

- A. Watts Radiant:
4500 E. Progress Place
Springfield, MO 65803
(800) 276-2419
Website: <http://www.wattsradiant.com/>
Area Representative:
Emerson-Swan, Inc.
300 Pond Street, P.O. Box 783
Randolph, MA 02368
(781) 986-2000
Website: <http://www.emersonswan.com/>
Contact Person: Frank Melberg

B. Viega North America:
301 N Main, 9th Floor
Wichita, KS 67202
800-976-9819
Website: <http://www.viega.net/>
Area Contact:
Sweeney Rogers Geraghty, Inc.
250 Richmond St
Raynham MA 02767
(508) 822-3939
Website: <http://srgirep.com/home>
Contact Person: Rachel Riley, P.E. 207-460-0076

C. Rehau Industries, Inc.:
615 -1st Avenue North East, Suite 135
Minneapolis, MN 55413
Website: <http://na.rehau.com/>
Area Representative:
Dino Pioli.
dino.pioli@rehau.com
(603) 732-7878

D. Uponor - Wirsbo product line:
5925 148th Street West
Apple Valley, MN 55124
(800) 321-4739
Website: <http://www.uponor-usa.com/>
Area Representative:
Urell, Inc.
86 Coolidge Ave., P.O. Box 321
Watertown, MA 02471
(617) 600-9440
Website: <http://urell.com/>
Contact Person: Josh Horan

E. Substitutions: Not permitted.

2.2 RADIANT FLOOR TUBING

- A. General: Provide tubing of lengths as required to satisfy the given load requirements at the given flow rates indicated on Drawings. Maximum operating temperature shall be as indicated in the radiant floor heating system's reset water temperature schedule in the sequence of operation – Division 23 Section "Instrumentation and Controls for HVAC."
- B. The heat transfer fluids shall be water or water/glycol mixture.
- C. PEX Tubing Composite with Aluminum Layer: Watts Radiant PEX-AL.
1. Cross-linked polyethylene, manufactured by PEX-a (Engel) or PEX-b (Silane) method. Material Standard: Manufactured in accordance with ASTM F876 and ASTM F877; tested for compliance by an independent third-party agency.
 2. Oxygen Diffusion Barrier: Adhesive-bonded aluminum oxygen diffusion barrier shall be

protected by inner and outer layers of PEX material, and shall not exceed an oxygen diffusion rate of 0.000000375 lb/cu. ft. (0.006 g/m³) per day at 104 degrees F (40 degrees C) water temperature in accordance with German DIN 4726.

3. Temperature/Pressure Ratings:
 - a. 73.4 degrees F (23 degrees C) at 160 psi (1.10 MPa)
 - b. 180 degrees F (82.2 degrees C) at 100 psi (0.69 MPa)
 - c. 200 degrees F (93.3 degrees C) at 80 psi (0.55 MPa).
4. Minimum Bend Radius (Cold Bending): No less than 5 times the outside diameter. Provide the tubing manufacturer's bend supports for bends where radius is less than stated.
5. PEX radiant floor tubing connections to manifolds shall be made with compression fittings comprised of brass compression nuts tightened around tubing and compression nut ring.

2.3 MANIFOLDS

- A. Stainless Steel Manifolds: Materials shall be of Type 304 stainless steel trunks with heavily-nickel-plated brass fittings, including threaded brass male NPT branches designed for solder-free connections. Manifold ends shall be fitted with brass plugs on both supply and return. Standard diameters are 1 inch (25.4 mm) and 1-1/2 inch (38.1 mm). Maximum operating pressure and temperature shall be 100 psig at 200 degrees F (689 kPa at 93 degrees C).
- B. Brass Manifolds: Materials shall be of brass trunks and threaded brass male NPT branches designed for solder-free connections. Manifold ends shall be fitted with brass plugs on both supply and return. Standard diameter is 1 inch (25.4 mm), with other diameters available upon request. Maximum operating pressure shall be 50 psig at 250 degrees F (345 kPa at 121 degrees C).
- C. Manifolds shall be fitted with mini ball valves or zone valves (electric or non-electric type) for flow control and/or isolation purposes as indicated on the Drawings or Schedules. Manifolds shall also be fitted with brass unions for acceptance of pressure test kits. Tubing and hose shall be attached to manifold branches by constant tension clamps and adhesive, according to manufacturer's recommendations.

2.4 ZONE VALVES MOUNTED ON MANIFOLDS

- A. Zone valves, mounted integral to the manifolds and serving a single loop of tubing, shall have replaceable thermal-wax-motor low-voltage control heads.

2.5 ACCESSORIES

- A. Provide the following:
 1. Zone Valve Control Heads: 2 for each model of control head on the project.
 2. Repair Kit: 1 for each size of radiant floor tubing on the project.
 3. Cable Tie: 1 every 18 inches (457 mm) of tubing.
 4. Staple: 1 every 18 inches (457 mm) of tubing for above-the-floor applications; 1 every 6 inches (152 mm) of tubing for below-the-floor applications.
 5. Manifold Mount Bracket: 4 per manifold set.
 6. Staple Gun: Minimum of 1 per project where staples are being used. Provide more if needed. Size of staple gun shall be determined by the diameter of tubing being installed.
 7. Hose Unwinder: Minimum of 1 per project. Provide more if necessary.

8. Pressure Test Kit: Minimum of 1 per project. Provide more if necessary.

2.6 CABINETS AND ACCESS PANELS

- A. Steel or aluminum wraparound cabinet sized to enclose manifolds, pumps and accessories, and controls as required. Steel or aluminum shall be galvanized, powder-coated, or painted, with surfaces exposed to view having a white finish. Where indicated to be recessed, cabinet shall be of depth to recess in a nominal 6 inch (150 mm) stud building partition. Provide cover with concealed piano hinge and latch with tumbler lock. Flush mount with frame to overlap adjacent wall surfaces when indicated as recessed. Surface mount when recessed mounting is not possible. If surface mounted, provide grommets or escutcheons at penetrations of the cabinet to seal dust-tight.
- B. If cabinet is installed in a potentially wet area such as locker rooms and kitchens, the cabinet shall be fully recessed in a building partition, with stainless steel cover or access panel.
- C. Panels shall be keyed alike. Furnish 3 keys to the Owner. Cabinets and access panels located in areas such as mechanical rooms, which have restricted access limited to service personnel, may be furnished with quarter-turn knob latches rather than locks at Contractor's option.
- D. Provide cabinets and access panels for piping manifolds and accessories, and for controls, as indicated and as required to enclose and protect.

2.7 TUBING LOCATIONS

- A. Concrete Slab: Secure tubing to rewire or rebar by mechanical attachments every 18 inches (457 mm) and at the midpoint of each turn or bend; with a minimum of 2 inches (50.8 mm) of concrete coverage above the top of the tubing.
- B. Concrete Cap: Secure tubing to existing concrete or insulation by mechanical attachments, every 18 inches (457 mm) and at the midpoint of each turn or bend; with a minimum of 3/4 inches (19 mm) concrete coverage above the top of the tubing for interior or light duty applications, and a minimum of 2 inches (50.8 mm) of concrete coverage above the top of the tubing for exterior or heavy-duty applications.
- C. Thinslab or Mudset: Staple or secure tubing by mechanical attachments every 18 inches (457 mm) and at the midpoint of each turn or bend; to a wooden subfloor with a minimum of 3/4 inches (19 mm) coverage above the top of the tubing.
- D. Sandwich: Secure tubing by mechanical attachments every 18 inches (457 mm) and at the midpoint of each bend or turn; to the top of the wooden subfloor in between wooden sleepers. Sleepers shall be slightly lower in profile than tubing (approximately 1/16 inch (1.6 mm)) to ensure good contact between the tubing and the surface above. Provide sleepers at spacings recommended by flooring manufacturer.
- E. Heat Transfer Plate Underfloor: Secure tubing to the bottom of the wooden subfloor, using manufacturer's preformed heat transfer plates to increase heat transfer and provide uniform top-surface floor temperatures. Provide continuous coverage of plates wherever tubing is installed.
- F. Staple Underfloor: Staple or secure tubing by mechanical attachments every 4 to 6 inches (102 to 152 mm), to the bottom of the wooden subfloor.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine areas and conditions under which the radiant floor tubing is to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in a manner acceptable to the installer.

3.2 INSTALLATION OF RADIANT FLOOR TUBING

- A. General: Install tubing as specified or as indicated by Architect/Engineer on Drawings, Schedules and in the Specifications in accordance with the manufacturer's installation instructions. Locate tubing in the floors, walls or ceilings as specified or as indicated; cover areas continuously wall to wall at specified spacings unless otherwise indicated. Provide bandings as specified or as indicated by Drawings and/or Schedules (for example, along exterior glass walls, under windows, in front of doors, and other locations of high load). Provide pressure testing of between 50 and 100 psig (345 kPa and 689 kPa) for a minimum of 24 hours prior to, and during, the concrete pour for slab and thinslab applications. Provide pressure testing of between 50 and 100 psig (345 kPa and 689 kPa) for a minimum of 24 hours before operation for staple and sandwich applications. Install access panels centered in front of each manifold set.

Minimum Bending Radius for PEX Radiant Floor Tubing:

3/8 inch (9.5 mm) I.D. 4 inch (102 mm) radius

1/2 inch (12.7 mm) I.D. 5 inch (127 mm) radius

5/8 inch (15.9 mm) I.D. 6 inch (152 mm) radius

3/4 inch (19 mm) I.D. 7 inch (178 mm) radius

- B. Radiant floor tubing that is installed in concrete shall be installed with continuous lengths of tubing. Splices, couplings or joints shall not be allowed in in-slab installations.
- C. The Mechanical Subcontractor shall be on site during the concrete pour over the radiant floor tubing.

3.3 ADJUSTING AND CLEANING

- A. General: After construction is completed, including painting, clean exposed surfaces and components inside cabinets and in Mechanical Rooms where accessible. Repair any damaged materials prior to system start-up.
- B. System Start-Up and Balancing: Provide system start-up and balancing to ensure proper operation. Check pumps for flows, valves for proper setting and operation, and water temperature and pressure levels in accordance with design, Specifications, and manufacturer's recommendations. System shall operate properly for 2 days before Contractor requests Owner and/or Architect/Engineer to visit the site to observe the installed system.

END OF SECTION 238316

SECTION 260010 - SUPPLEMENTAL REQUIREMENTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Supplemental requirements applicable to Work specified in Division 26.

1.2 REFERENCES

A. Abbreviations and Acronyms for Electrical Terms and Units of Measure:

1. 8PSJ or 8P8C: Miniature 8-position series jack, also called an 8-position 8-contact modular jack for some applications.
2. A: Ampere, unit of electrical current.
3. AC or ac: Alternating current.
4. AFCI: Arc-fault circuit interrupter.
5. AIC: Ampere interrupting capacity.
6. AL, Al, or ALUM: Aluminum.
7. ASD: Adjustable-speed drive.
8. ATS: Automatic transfer switch.
9. AWG: American wire gauge; see ASTM B258.
10. BAS: Building automation system.
11. BIL: Basic impulse insulation level.
12. BIM: Building information modeling.
13. CAD: Computer-aided design or drafting.
14. CATV: Community antenna television.
15. CB: Circuit breaker.
16. CO/ALR: Copper-aluminum, revised.
17. COPS: Critical operations power system.
18. CU or Cu: Copper.
19. CU-AL or AL-CU: Copper-aluminum.
20. dB: Decibel, a unitless logarithmic ratio of two electrical, acoustical, or optical power values.
21. dB(A-weighted) or dB(A): Decibel acoustical sound pressure level with A-weighting applied in accordance with IEC 61672-1.
22. dB(adjusted) or dBa: Decibel weighted absolute noise power with respect to 3.16 pW (minus 85 dBm).
23. dBm: Decibel absolute power with respect to 1 mW.
24. DC or dc: Direct current.
25. DCOA: Designated critical operations area.
26. DDC: Direct digital control (HVAC).
27. EGC: Equipment grounding conductor.
28. EMF: Electromotive force.
29. EMI: Electromagnetic interference.
30. EPM: Electrical preventive maintenance.
31. EPS: Emergency power supply.

- 32. EPSS: Emergency power supply system.
- 33. ESS: Energy storage system.
- 34. EV: Electric vehicle.
- 35. EVPE: Electric vehicle power export equipment.
- 36. EVSE: Electric vehicle supply equipment.
- 37. fc: Footcandle, a unit of illuminance equal to one lumen per square foot.
- 38. FLC: Full-load current.
- 39. ft: Foot.
- 40. GEC: Grounding electrode conductor.
- 41. GFCI: Ground-fault circuit interrupter.
- 42. GFPE: Ground-fault protection of equipment.
- 43. GND: Ground.
- 44. HACR: Heating, air conditioning, and refrigeration.
- 45. HDPE: High-density polyethylene.
- 46. HID: High-intensity discharge.
- 47. HP or hp: Horsepower.
- 48. HVAC: Heating, ventilating, and air conditioning.
- 49. Hz: Hertz.
- 50. IBT: Intersystem bonding termination.
- 51. inch: Inch. To avoid confusion, the abbreviation "in." is not used.
- 52. IP: Ingress protection rating (enclosures); Internet protocol (communications).
- 53. IR: Infrared.
- 54. IS: Intrinsically safe.
- 55. IT&R: Inspecting, testing, and repair.
- 56. ITE: Information technology equipment.
- 57. kAIC: Kiloampere interrupting capacity.
- 58. kcmil or MCM: One thousand circular mils.
- 59. kV: Kilovolt.
- 60. kVA: Kilovolt-ampere.
- 61. kVAr or kVAR: Kilovolt-ampere reactive.
- 62. kW: Kilowatt.
- 63. kWh: Kilowatt-hour.
- 64. LAN: Local area network.
- 65. lb: Pound (weight).
- 66. LCD: Liquid-crystal display.
- 67. LCDI: Leakage-current detector-interrupter.
- 68. LED: Light-emitting diode.
- 69. LNG: Liquefied natural gas.
- 70. LP-Gas: Liquefied petroleum gas.
- 71. LRC: Locked-rotor current.
- 72. MCC: Motor-control center.
- 73. MDC: Modular data center.
- 74. MG set: Motor-generator set.
- 75. MIDI: Musical instrument digital interface.
- 76. MLO: Main lugs only.
- 77. MVA: Megavolt-ampere.
- 78. mW: Milliwatt.
- 79. MW: Megawatt.
- 80. MWh: Megawatt-hour.
- 81. NC: Normally closed.
- 82. NiCd: Nickel cadmium.

83. NIU: Network interface unit.
84. NO: Normally open.
85. NPT: National (American) standard pipe taper.
86. OCPD: Overcurrent protective device.
87. ONT: Optical network terminal.
88. PC: Personal computer.
89. PCS: Power conversion system.
90. PCU: Power-conditioning unit.
91. PF or pf: Power factor.
92. PHEV: Plug-in hybrid electric vehicle.
93. PLC: Programmable logic controller.
94. PLFA: Power-limited fire alarm.
95. PoE: Power over Ethernet.
96. PV: Photovoltaic.
97. PVC: Polyvinyl chloride.
98. pW: Picowatt.
99. RFI: Radio-frequency interference (electrical); Request for interpretation (contract).
100. RMS or rms: Root-mean-square.
101. RPM or rpm: Revolutions per minute.
102. SCADA: Supervisory control and data acquisition.
103. SCR: Silicon-controlled rectifier.
104. SPD: Surge protective device.
105. sq.: Square.
106. SWD: Switching duty.
107. TCP/IP: Transmission control protocol/Internet protocol.
108. TEFC: Totally enclosed fan-cooled.
109. TR: Tamper resistant.
110. TVSS: Transient voltage surge suppressor.
111. UL: Underwriters Laboratories, Inc. (standards) or UL LLC (services).
112. UL CCN: UL Category Control Number.
113. UPS: Uninterruptible power supply.
114. USB: Universal serial bus.
115. UV: Ultraviolet.
116. V: Volt, unit of electromotive force.
117. V(ac): Volt, alternating current.
118. V(dc): Volt, direct current.
119. VA: Volt-ampere, unit of complex electrical power.
120. VAR: Volt-ampere reactive, unit of reactive electrical power.
121. VFC: Variable-frequency controller.
122. VOM: Volt-ohm-multimeter.
123. VPN: Virtual private network.
124. VRLA: Valve-regulated lead acid.
125. W: Watt, unit of real electrical power.
126. Wh: Watt-hour, unit of electrical energy usage.
127. WPT: Wireless power transfer.
128. WPTE: Wireless power transfer equipment.
129. WR: Weather resistant.

B. Abbreviations and Acronyms for Electrical Raceway Types:

1. EMT: Electrical metallic tubing.
2. EMT-A: Aluminum electrical metallic tubing.

3. EMT-S: Steel electrical metallic tubing.
4. EMT-SS: Stainless steel electrical metallic tubing.
5. ENT: Electrical nonmetallic tubing.
6. EPEC: Electrical HDPE underground conduit.
7. EPEC-40: Schedule 40 electrical HDPE underground conduit.
8. EPEC-80: Schedule 80 electrical HDPE underground conduit.
9. EPEC-A: Type A electrical HDPE underground conduit.
10. EPEC-B: Type B electrical HDPE underground conduit.
11. ERMC: Electrical rigid metal conduit.
12. ERMC-A: Aluminum electrical rigid metal conduit.
13. ERMC-S: Steel electrical rigid metal conduit.
14. ERMC-S-G: Galvanized-steel electrical rigid metal conduit.
15. ERMC-S-PVC: PVC-coated-steel electrical rigid metal conduit.
16. ERMC-SS: Stainless steel electrical rigid metal conduit.
17. FMC: Flexible metal conduit.
18. FMC-A: Aluminum flexible metal conduit.
19. FMC-S: Steel flexible metal conduit.
20. FMT: Steel flexible metallic tubing.
21. FNMC: Flexible nonmetallic conduit. See LFNC.
22. HDPE: See EPEC.
23. IMC: Steel electrical intermediate metal conduit.
24. LFMC: Liquidtight flexible metal conduit.
25. LFMC-A: Aluminum liquidtight flexible metal conduit.
26. LFMC-S: Steel liquidtight flexible metal conduit.
27. LFMC-SS: Stainless steel liquidtight flexible metal conduit.
28. LFNC: Liquidtight flexible nonmetallic conduit.
29. LFNC-A: Layered (Type A) liquidtight flexible nonmetallic conduit.
30. LFNC-B: Integral (Type B) liquidtight flexible nonmetallic conduit.
31. LFNC-C: Corrugated (Type C) liquidtight flexible nonmetallic conduit.
32. PVC: Rigid PVC conduit.
33. PVC-40: Schedule 40 rigid PVC conduit.
34. PVC-80: Schedule 80 rigid PVC Conduit.
35. PVC-A: Type A rigid PVC concrete-encased conduit.
36. PVC-EB: Type EB rigid PVC concrete-encased underground conduit.
37. RGS: See ERMC-S-G.
38. RMC: See ERMC.
39. RTRC: Reinforced thermosetting resin conduit.
40. RTRC-AG: Low-halogen, aboveground reinforced thermosetting resin conduit.
41. RTRC-AG-HW: Heavy wall, low-halogen, aboveground reinforced thermosetting resin conduit.
42. RTRC-AG-SW: Standard wall, low-halogen, aboveground reinforced thermosetting resin conduit.
43. RTRC-AG-XW: Extra heavy wall, low-halogen, aboveground reinforced thermosetting resin conduit.
44. RTRC-BG: Low-halogen, belowground reinforced thermosetting resin conduit.

C. Abbreviations and Acronyms for Electrical Cable Types:

1. AC: Armored cable.
2. CATV: Coaxial general-purpose cable.
3. CATVP: Coaxial plenum cable.
4. CATVR: Coaxial riser cable.

5. CI: Circuit integrity cable.
6. CL2: Class 2 cable.
7. CL2P: Class 2 plenum cable.
8. CL2R: Class 2 riser cable.
9. CL2X: Class 2 cable, limited use.
10. CL3: Class 3 cable.
11. CL3P: Class 3 plenum cable.
12. CL3R: Class 3 riser cable.
13. CL3X: Class 3 cable, limited use.
14. CM: Communications general-purpose cable.
15. CMG: Communications general-purpose cable.
16. CMP: Communications plenum cable.
17. CMR: Communications riser cable.
18. CMUC: Under-carpet communications wire and cable.
19. CMX: Communications cable, limited use.
20. DG: Distributed generation cable.
21. FC: Flat cable.
22. FCC: Flat conductor cable.
23. FPL: Power-limited fire-alarm cable.
24. FPLP: Power-limited fire-alarm plenum cable.
25. FPLR: Power-limited fire-alarm riser cable.
26. IGS: Integrated gas spacer cable.
27. ITC: Instrumentation tray cable.
28. ITC-ER: Instrumentation tray cable, exposed run.
29. MC: Metal-clad cable.
30. MC-HL: Metal-clad cable, hazardous location.
31. MI: Mineral-insulated, metal-sheathed cable.
32. MTW: Moisture-, heat-, and oil-resistant thermoplastic cable (machine tool wiring).
33. MV: Medium-voltage cable.
34. NM: Nonmetallic sheathed cable.
35. NMC: Nonmetallic sheathed cable with corrosion-resistant nonmetallic jacket.
36. NMS: Nonmetallic sheathed cable with signaling, data, and communications conductors, plus power or control conductors.
37. NPLF: Non-power-limited fire-alarm circuit cable.
38. NPLFP: Non-power-limited fire-alarm circuit cable for environmental air spaces.
39. NPLFR: Non-power-limited fire-alarm circuit riser cable.
40. NUCC: Nonmetallic underground conduit with conductors.
41. OFC: Conductive optical fiber general-purpose cable.
42. OFCG: Conductive optical fiber general-purpose cable.
43. OFCP: Conductive optical fiber plenum cable.
44. OFCR: Conductive optical fiber riser cable.
45. OFN: Nonconductive optical fiber general-purpose cable.
46. OFNG: Nonconductive optical fiber general-purpose cable.
47. OFNP: Nonconductive optical fiber plenum cable.
48. OFNR: Nonconductive optical fiber riser cable.
49. P: Marine shipboard cable.
50. PLTC: Power-limited tray cable.
51. PLTC-ER: Power-limited tray cable, exposed run.
52. PV: Photovoltaic cable.
53. RHH: Thermoset rubber, heat-resistant cable (high heat).
54. RHW: Thermoset rubber, moisture-resistant cable.

55. SA: Silicone rubber cable.
56. SE: Service-entrance cable.
57. SER: Service-entrance cable, round.
58. SEU: Service-entrance cable, flat.
59. SIS: Thermoset cable for switchboard and switchgear wiring.
60. TBS: Thermoplastic cable with outer braid.
61. TC: Tray cable.
62. TC-ER: Tray cable, exposed run.
63. TC-ER-HL: Tray cable, exposed run, hazardous location.
64. THW: Thermoplastic, heat- and moisture-resistant cable.
65. THHN: Thermoplastic, heat-resistant cable with nylon jacket outer sheath.
66. THHW: Thermoplastic, heat- and moisture-resistant cable.
67. THWN: Thermoplastic, moisture- and heat-resistant cable with nylon jacket outer sheath.
68. TW: Thermoplastic, moisture-resistant cable.
69. UF: Underground feeder and branch-circuit cable.
70. USE: Underground service-entrance cable.
71. XHH: Cross-linked polyethylene, heat-resistant cable.
72. XHHW: Cross-linked polyethylene, heat- and moisture-resistant cable.

D. Definitions:

1. Basic Impulse Insulation Level: Reference insulation level expressed in impulse crest voltage with a standard wave not longer than 1.5 times 50 microseconds and 1.5 times 40 microseconds.
2. Communications Jack: A fixed connecting device designed for insertion of a communications cable plug.
3. Communications Outlet: One or more communications jacks, or cables and plugs, mounted in a box or ring, with a suitable protective cover.
4. Designated Seismic System: A system component that requires design in accordance with ASCE/SEI 7, Ch. 13 and for which the Component Importance Factor is greater than 1.0.
5. Direct Buried: Installed underground without encasement in concrete or other protective material.
6. Enclosure: The case or housing of an apparatus, or the fence or wall(s) surrounding an installation, to prevent personnel from accidentally contacting energized parts or to protect the equipment from physical damage. Types of enclosures and enclosure covers include the following:
 - a. Cabinet: An enclosure that is designed for either surface mounting or flush mounting and is provided with a frame, mat, or trim in which a swinging door or doors are or can be hung.
 - b. Concrete Box: A box intended for use in poured concrete.
 - c. Conduit Body: A means for providing access to the interior of a conduit or tubing system through one or more removable covers at a junction or terminal point. In the United States, conduit bodies are listed in accordance with outlet box requirements.
 - d. Conduit Box: A box having threaded openings or knockouts for conduit, EMT, or fittings.
 - e. Cutout Box: An enclosure designed for surface mounting that has swinging doors or covers secured directly to and telescoping with the walls of the enclosure.
 - f. Device Box: A box with provisions for mounting a wiring device directly to the box.

- g. Extension Ring: A ring intended to extend the sides of an outlet box or device box to increase the box depth, volume, or both.
 - h. Floor Box: A box mounted in the floor intended for use with a floor box cover and other components to complete the floor box enclosure.
 - i. Floor-Mounted Enclosure: A floor box and floor box cover assembly with means to mount in the floor that is sealed against the entrance of scrub water at the floor level.
 - j. Floor Nozzle: An enclosure used on a wiring system, intended primarily as a housing for a receptacle, provided with a means, such as a collar, for surface-mounting on a floor, which may or may not include a stem to support it above the floor level, and is sealed against the entrance of scrub water at the floor level.
 - k. Junction Box: A box with a blank cover that joins different runs of raceway or cable and provides space for connection and branching of the enclosed conductors.
 - l. Outlet Box: A box that provides access to a wiring system having pryout openings, knockouts, threaded entries, or hubs in either the sides or the back, or both, for the entrance of conduit, conduit or cable fittings, or cables, with provisions for mounting an outlet box cover, but without provisions for mounting a wiring device directly to the box.
 - m. Pedestal Floor Box Cover: A floor box cover that, when installed as intended, provides a means for typically vertical or near-vertical mounting of receptacle outlets above the floor's finished surface.
 - n. Pull Box: A box with a blank cover that joins different runs of raceway and provides access for pulling or replacing the enclosed cables or conductors.
 - o. Raised-Floor Box: A floor box intended for use in raised floors.
 - p. Recessed Access Floor Box: A floor box with provisions for mounting wiring devices below the floor surface.
 - q. Recessed Access Floor Box Cover: A floor box cover with provisions for passage of cords to recessed wiring devices mounted within a recessed floor box.
 - r. Raised Ring: A sleeve, which is not necessarily round, used for positioning a recessed wiring device flush with the plaster, concrete, drywall, or other wall surface.
 - s. Ring Cover: A box cover, with raised center portion to accommodate a specific wall or ceiling thickness, for mounting wiring devices or luminaires flush with the surface.
 - t. Sleeves: Mechanical protection for cable/conduits that pass through a wall or floor.
 - u. Termination Box: An enclosure designed for installation of termination base assemblies consisting of bus bars, terminal strips, or terminal blocks with provision for wire connectors to accommodate incoming or outgoing conductors, or both.
- 7. Emergency Systems: Those systems legally required and classed as emergency by municipal, state, federal, or other codes, or by any governmental agency having jurisdiction that are designed to ensure continuity of lighting, electrical power, or both, to designated areas and equipment in the event of failure of the normal supply for safety to human life.
 - 8. Essential Electrical Systems: Those systems designed to ensure continuity of electrical power to designated areas and functions of a healthcare facility during disruption of normal power sources, and also to minimize disruption within the internal wiring system. (healthcare facilities)
 - 9. High-Performance Building: A building that integrates and optimizes on a life-cycle basis all major high-performance attributes, including energy conservation, environment, safety, security, durability, accessibility, cost-benefit, productivity, sustainability, functionality, and operational considerations.

10. Jacket: A continuous nonmetallic outer covering for conductors or cables.
11. Luminaire: A complete lighting unit consisting of a light source such as a lamp, together with the parts designed to position the light source and connect it to the power supply. It may also include parts to protect the light source or the ballast or to distribute the light.
12. Miniature 8-Position Series Jack (8PSJ): Also called an 8-position 8-contact (8P8C) modular jack. An unkeyed jack with up to eight contacts commonly used to terminate twisted-pair and multiconductor Ethernet cable. Shape and dimensions are specified by TIA-1096.
 - a. Caution: An 8PSJ is not the same thing as an FCC "registered jack" RJ45S, now called a miniature 8-position keyed jack (8PKJ). Ethernet cable plugs do not have rejection keys. Many manufacturers and suppliers incorrectly use "RJ45" as a generic term to describe any 8-position series plug or jack whether it has a rejection key or not.
13. Mode: The terms "Active Mode," "Off Mode," and "Standby Mode" are used as defined in the Energy Independence and Security Act (EISA) of 2007.
14. Multi-Outlet Assembly: A type of surface, flush, or freestanding raceway designed to hold conductors, receptacles, and switches, assembled in the field or at the factory.
15. Plenum: A compartment or chamber to which one or more air ducts are connected and that forms part of the air distribution system.
16. Provide: As used in this section, "provide" shall mean, "Furnish and install". "Furnish" shall mean "to purchase and deliver to the project site complete with every necessary appurtenance and support", and "install" shall mean "to unload at the delivery point at the site and perform every operation necessary to establish secure mounting and correct operation at the proper location in the project."
17. Receptacle: A fixed connecting device arranged for insertion of a power cord plug. Also called a power jack.
18. Receptacle Outlet: One or more receptacles mounted in a box with a suitable protective cover.
19. Sheath: A continuous metallic covering for conductors or cables.
20. UL Category Control Number: An alphabetic or alphanumeric code used to identify product categories covered by UL's Listing, Classification, and Recognition Services.
21. Voltage Class: For specified circuits and equipment, voltage classes are defined as follows:
 - a. Control Voltage: Having electromotive force between any two conductors, or between a single conductor and ground, that is supplied from a battery or other Class 2 or Class 3 power-limited source.
 - b. Line Voltage: (1) (controls) Designed to operate using the supplied low-voltage power without transformation. (2) (transmission lines, transformers, SPDs) The line-to-line voltage of the supplying power system.
 - c. Extra-Low Voltage: Not having electromotive force between any two conductors, or between a single conductor and ground, exceeding 30 V(ac rms), 42 V(ac peak), or 60 V(dc).
 - d. Low Voltage: Having electromotive force between any two conductors, or between a single conductor and ground, that is rated above 30 V but not exceeding 1000 V.
 - e. Medium Voltage: Having electromotive force between any two conductors, or between a single conductor and ground, that is rated about 1 kV but not exceeding 69 kV.
 - f. High Voltage: (1) (circuits) Having electromotive force between any two conductors, or between a single conductor and ground, that is rated above 69 kV

but not exceeding 230 kV. (2) (safety) Having sufficient electromotive force to inflict bodily harm or injury.

1.3 WORK BY OWNER

- A. The Owner will self-install all telecommunications (low voltage) wiring, with the exception of fire alarm wiring. Installation will occur during building construction. Owner will provide testing and make all final connections. Cooperate and coordinate with owner's IT staff to allow for the installation to occur during construction. Systems will be purchased or installed by the Owner include, but are not limited to:
- B. Veeder Root Monitoring System
 - 1. Low voltage wiring and connections.
- C. Radio antenna system.
 - 1. Microprocessor based integrated system.
 - 2. Two way voice communications between office and classrooms, plus all page.
 - 3. Synchronized central clock system.
 - 4. Capable of full interface to telephone system.
- D. Network equipment and software such as servers, Network Switches, HUBs, transceivers to activate the LAN.
- E. Interactive presentation devices such as TV's, Interactive White Boards (IWB) and Video Projectors.
- F. Work Stations, Laptops, Tablets
- G. All wiring, connectivity, terminations and testing for complete systems.

1.4 PROJECT/SITE CONDITIONS

- A. Coordinate with all other trades to ensure proper access and space requirements.
- B. Where project conditions occur necessitating departures from the drawings, submit for approval the details of and reasons for departures prior to implementing any change.
- C. Alterations
 - 1. Visit the site and become familiar with the existing conditions, and the requirements of the Plans and Specifications. No claim will be recognized for extra compensation due to failure of becoming familiar with the conditions and extent of the proposed work.
 - 2. Execute all alterations, additions, removals, relocations, or new work, etc., as indicated or required to provide a complete installation in accordance with the intent of the Drawings and Specifications.
 - 3. Repair or replace to the Owner's satisfaction, all existing work disturbed or damaged by the alterations in the existing 8 Bay garage.

4. Except as follows, Retain ownership and remove from site all existing materials, equipment, fixtures, wiring and devices disconnected and not reused; Pay all charges for proper disposal of materials:
 - a. Materials specifically indicated to be returned to Owner.
 - b. Deliver to Owner: Transformers, panelboards, lighting fixtures, starters, and all other equipment specified within the project electrical specifications and drawings.
 - c. Obtain receipt of delivery from Owner's Representative.
5. Do not reuse existing wiring except as specifically indicated. Existing conduit raceways may be reused, provided that the existing wires are removed and new wires are installed.
6. Ensure all circuits in existing buildings are re-energized where existing panelboards are replaced, or existing wiring is rerouted, disconnected, or disturbed. Provide and install new wiring as required to meet this condition. Verify breaker/fuse sizes on existing circuits and do not load wiring to beyond 75% of their ampacities.

1.5 COORDINATION

- A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions:
 1. Notify Architect and Owner no fewer than seven days in advance of proposed interruption of electrical service.
 2. Do not proceed with interruption of electrical service without Owner's written permission.
 3. Coordinate interruption with systems impacted by outage including, but not limited to, the following:
 - a. Exercising generators.
 - b. Emergency lighting.
 - c. Elevators.
 - d. Fire-alarm systems.
- B. Temporary electrical service and/or power and lighting shall be provided by Division 01.

1.6 PREINSTALLATION MEETINGS

- A. Electrical Preconstruction Conference: Schedule conference with Architect and Owner as required in specification, after notice to proceed. Agenda topics include, but are not limited to, the following:
 1. Electrical installation schedule.
 2. Status of power system studies.
 3. Value analysis proposals and requests for substitution of electrical equipment.
 4. Utility work coordination and class of service requests.
 5. Commissioning activities.

1.7 SEQUENCING

- A. Conduct and submit results of power system studies before submitting Product Data and Shop Drawings for electrical equipment.

1.8 ACTION SUBMITTALS

- A. As a requirement of this specification, the Contractor shall participate in the development of a set of common coordination drawings for the project.
- B. The mechanical HVAC contractor shall be responsible to manage the coordination drawing effort and submit the drawings as shop drawings for review and comment. The HVAC contractor shall develop the base floor plans and building sections and place his mechanical equipment ductwork and piping on them. He shall then coordinate and manage each Trade's effort while they place their information on the same drawings.
- C. Each trade: Plumbing, fire protection and electrical shall work with the Mechanical HVAC contractor to help produce the coordination drawings. Each trade shall be responsible to coordinate their own equipment, piping, conduit, tray and other associated materials with the other trades and place this information on the drawings.
- D. The coordination drawings may be Revit, CAD or hand drafted as selected by the mechanical HVAC contractor. Floor plans shall be prepared at a minimum scale of $1/4" = 1'$. Sections through an entire wing shall be prepared at a minimum scale of $1/4" = 1'$. Detail sections across corridors or other small areas shall be prepared at a minimum scale of $1" = 1'$.
- E. Coordination drawings shall be prepared for all new areas of the facility. The drawing detail shall be sufficient to insure coordination between the trades and also with the building structure. As a minimum the following shall be shown in plan and section:
 - 1. Building structure.
 - 2. All major equipment.
 - 3. All ceiling-mounted equipment in ceiling grid, i.e: lighting fixtures, HVAC diffusers, sprinklers, etc.
 - 4. Ceilings in elevation
 - 5. All duct work
 - 6. All major duct, pipe, conduit and tray runs
 - 7. All work in corridors
 - 8. Single pipe and conduits run outside of corridor areas when greater than 1 2" in diameter.
 - 9. As a minimum, indicate elevation of sprinkler piping in all areas.
- F. Mechanical HVAC, plumbing, fire protection and electrical construction shall not commence until coordination drawings have been reviewed and approved. The Contractor shall bring any coordination issues to the attention of the Architect. Review of the coordination drawings by the Architect does not relieve the Contractor of his/her responsibility to provide a properly coordinated construction project.

1.9 INFORMATIONAL SUBMITTALS

- A. Electrical Installation Schedule: At preconstruction meeting, and periodically thereafter as dates change, provide schedule for electrical installation Work to Owner and Architect including, but not limited to, milestone dates for the following activities:
 - 1. Submission of power system studies.
 - 2. Submission of specified coordination drawings.
 - 3. Submission of action submittals specified in Division 26.
 - 4. Orders placed for major electrical equipment.

5. Arrival of major electrical equipment on-site.
6. Preinstallation meetings specified in Division 26.
7. Utility service outages.
8. Utility service inspection and activation.
9. Mockup reviews.
10. Closing of walls and ceilings containing electrical Work.
11. System startup, testing, and commissioning activities for major electrical equipment.
12. System startup, testing, and commissioning activities for emergency lighting.
13. System startup, testing, and commissioning activities for automation systems (SCADA, BMS, lighting, HVAC, fire alarm, fire pump, etc.).
14. Pouring of concrete housekeeping pads for electrical equipment and testing of concrete samples.
15. Requests for special inspections.
16. Requests for inspections by authorities having jurisdiction.

B. Certificates:

1. Welding certificates.

1.10 CLOSEOUT SUBMITTALS

A. Facility EPM Program Binders:

1. Complete Set: On USB media that is clearly and permanently labeled with attached placard on lanyard to prevent misplacement.
2. Volumes 2 and 8: Reproducible hardcopy on archival quality, 28 lb (105 GSM), acid-free, bond paper.

B. Operation and Maintenance Data:

1. Provide emergency, operation, and maintenance manuals for each major system component, equipment, and device.
2. Include the following information:
 - a. Manufacturer's operating specifications.
 - b. User's guides for software and hardware.
 - c. Schedule of maintenance material items recommended to be stored at Project site.
 - d. Detailed instructions covering operation under both normal and abnormal conditions.
 - e. Time-current curves for overcurrent protective devices and manufacturer's written instructions for testing and adjusting their settings.
 - f. List of load-current and overload-relay heaters with related motor nameplate data.
 - g. List of lamp types and photoelectric relays used on Project, with ANSI and manufacturers' codes.
 - h. Manufacturer's instructions for setting field-adjustable components.
 - i. Manufacturer's instructions for testing, adjusting, and reprogramming microprocessor controls.
 - j. EPSS: Manufacturer's system checklists, maintenance schedule, and maintenance log sheets in accordance with NFPA 110.
 - k. Exterior pole inspection and repair procedures.

C. Software:

1. Program Software Backup: Provide USB media that is clearly and permanently labeled with attached placard on lanyard to prevent misplacement.
2. Provide to Owner upgrades and unrestricted licenses for installed and backup software, including operating systems and programming tools required for operation and maintenance.

1.11 FIELD CONDITIONS

- A. Field coordination with the utility will require additional work beyond the scope of the building. See electrical site plan drawing E80-1 for additional information on coordination of underground and overhead utility feeders connecting to existing buildings on site.
- B. An allowance of \$50,000 shall be included with the project for work to be completed by Central Maine Power (CMP).

PART 2 - PRODUCTS

2.1 SUBSTITUTION LIMITATIONS FOR ELECTRICAL EQUIPMENT

- A. Substitution requests for electrical equipment will be entertained under the following conditions:
 1. Substitution requests may be submitted for consideration prior to the Electrical Preconstruction Conference if accompanied by value analysis data indicating that substitution will comply with Project performance requirements while significantly increasing value for Owner throughout life of facility.
 2. Substitution requests may be submitted for consideration concurrently with submission of power system study reports when those reports indicate that substitution is necessary for safety of maintenance personnel and facility occupants.
 3. Contractor is responsible for sequencing and scheduling power system studies and electrical equipment procurement. After the Electrical Preconstruction Conference, insufficient lead time for electrical equipment delivery will not be considered a valid reason for substitution.

PART 3 - EXECUTION

3.1 WORKMANSHIP AND INSTALLATION

- A. Execute all work in a neat manner acceptable to the Local and State Electrical Inspector and Engineer. Follow manufacturer's installation recommendations.
- B. All electrical components and their attachments shall be properly supported and where required shall be designed for seismic forces.
- C. Lighting fixtures shall be supported from structural steel. Provide unistrut channels or equal to span between top cord of joists. Section 265119 "LED Interior Lighting".

- D. Perform all electrical work by licensed electricians well skilled in the trade and supervised by a Master Electrician.
- E. Replace or repair to new condition, defective equipment and equipment damaged during installation or testing.
- F. Transformers: Transformers within the building construction shall be mounted on Type DNP isolators. If the transformers are suspended, use Type HN isolators selected to achieve not less than 0.1" static deflection.
- G. Dimmers: Dimmer cabinets shall be mounted on Type DNP isolators.
- H. Isolation Mounts: All mounts shall be aligned squarely above or below mounting points for the supported equipment.
- I. Position isolated electrical equipment so that it is free standing and does not come in rigid contact with the building structure or other systems.

3.2 TESTING AND ADJUSTING

- A. The entire installation shall be free from short circuits and improper grounds. Test in the presence of the Architects or their representatives.
- B. Test feeders with the feeders disconnected from the branch circuit panels.
- C. Test each individual branch circuit at the panel. In testing for insulation resistance to ground, the power equipment shall be connected for proper operation. In no case shall the insulation resistance be less than that required by the National Electrical Code and the manufacturer's recommendations. Correct failure in a manner satisfactory to the Architect and Engineers.
- D. Completely test and adjust each system specified under Division 26 for proper operation.

3.3 SLEEVES, INSERTS AND OPENINGS

- A. Sleeves:
 - 1. Furnish and install all sleeves required for the work.
 - 2. Sleeves through exterior building walls or through concrete construction shall be rigid galvanized steel.
 - 3. Sleeves shall be sized to provide a total of not less than 1/2-inch clearance around conduit.
 - 4. Sleeves for setting into walls shall be flush with finished construction. Sleeves for setting into floor shall be embedded in concrete slab and extend approximately 2 inches above finished floors.
 - 5. All sleeved openings within building shall be sealed airtight using fire barrier caulking with a UL classification for use as a fire penetration seal for walls and floors with up to a 3-hour fire rating expanded.
 - 6. Sleeves shall be provided in all locations where cables and conduits penetrate walls and floors.

7. Selection of firestopping materials and installation shall be in accordance with specifications Division 07 Section "Through Penetration Firestop Systems" for Firestopping".

B. Manufactured Fire Stopping Sleeves (wiring device).

1. At fire/smoke walls where cable trays are shown, trays shall stop on each side of wall. Provide UL approved self sealing EZ-Path fire rated pathway wiring devices through the partition. Device shall have an intumescent insert material which automatically adjust to allow cable additions and removals, from 0 to 100% visual fill of conductors.
2. The device shall have an F Rating equal to the rating of the barrier in which the device is installed.
3. The devices shall be provided with steel wall plates allowing for single or multiple devices to be ganged together.
4. Install the devices in strict accordance with the approved shop drawings and the equipment manufacturer's recommendations, including applying the factory supplied gasketing material prior to the installation of the wall plates.
5. Nominal size: Square 3"x3"x10.5" long with capacity equal to a 4" conduit.
6. Devices shall be equal to Specified Technologies Inc.(STI), EZ-PATH Fire Rated Pathways.
7. At each location, provide minimum of two fire rated devices mounted side by side with shared wall flange. Provide additional devices as noted on plans.

3.4 DEVELOPMENT OF FACILITY EPM PROGRAM

- A. Facility EPM Program must be developed by qualified EPM specialist.
- B. Conduct Facility EPM Program analysis in accordance with NFPA 70B recommendations.
 1. Renovation Projects:
 - a. Facility diagrams must include connected existing equipment for entire facility where known. Areas of uncertainty should be clearly indicated.
 - b. Obtain copies of existing operation and maintenance data and existing Facility EPM Program information from Owner.
 - c. Facility EPM Program analysis should identify existing equipment that does not have available operation and maintenance data, and should explain the Owner's risks because this equipment is not included in Facility EPM Program.
 - d. Data for existing equipment outside scope of Project may be inserted in Facility EPM Program Binders without analysis.
 - e. Data for existing equipment impacted by scope of Project should be analyzed and documented similar to Project's new equipment data as much as possible.
- C. Compile operation and maintenance data from Facility EPM Program analysis and submit Facility EPM Program Binders.

3.5 INSTALLATION OF ELECTRICAL WORK

- A. Unless more stringent requirements are specified in the Contract Documents or manufacturers' written instructions, comply with NFPA 70 and NECA NEIS 1 for installation of Work specified in Division 26. Consult Architect for resolution of conflicting requirements.

3.6 FIELD QUALITY CONTROL

- A. Administrant for Low-Voltage Electrical Tests and Inspections:
 - 1. Administer and perform tests and inspections with assistance of factory-authorized service representative.
- B. Administrant for Field Tests and Inspections of Lighting Installations:
 - 1. Administer and perform tests and inspections with assistance of factory-authorized service representative.

3.7 CLOSEOUT ACTIVITIES

- A. Demonstration:
 - 1. With assistance from factory-authorized service representatives, demonstrate to Owner's maintenance and clerical personnel how to operate the following systems and equipment:
 - a. Lighting control devices specified in Section 260923 "Lighting Control Devices."
 - 2. Allow Owner to record demonstrations.
- B. Training:
 - 1. With assistance from factory-authorized service representatives as appropriate, train Owner's maintenance personnel on all applicable topics addressed within Electrical specifications.
 - 2. Allow Owner to record training sessions.

3.8 RECORD DRAWINGS

- A. Submit under provisions of Division 01 Sections "Operation and Maintenance Data" and "Project Record Documents".
- B. Keep a marked set of Drawings at the site as a record set indicating all revisions in the work as the work progresses. At the completion of the work, mark the Drawings "As-Built Drawings" with the Contractor's name and date, and deliver to the Architect.

3.9 PERFORMANCE REQUIREMENTS

- A. Conform to requirements of the latest edition of ANSI/NFPA 70 National Electrical Code (N.E.C.).
- B. Conform to requirements of all local, State and Federal laws and regulations, plus local electric utility company's rules, and the Fire Underwriters' requirements.
- C. Furnish products listed and classified by Underwriters' Laboratories, Inc. (U.L.) as suitable for purpose specified and shown.
- D. Secure and pay for all permits and certificates as required by local, State and Federal laws.
- E. Request inspections from authority having jurisdiction.

- F. Run separate circuits for lighting and receptacle outlets as indicated.
 - 1. Circuits shall be balanced and loads and capacities shall be in accordance with requirements of local electric light company and National Board of Fire Underwriters.
 - 2. Do not share neutral on branch circuits.
- G. The entire electrical system shall be permanently and effectively grounded in accordance with Code requirements.
- H. The Drawings indicate only diagrammatically the extent, layout and the general location and arrangement of equipment, conduit and wiring. Become familiar with all details of the work and verify all dimensions in the field so that the outlets and equipment will be properly located and readily accessible.
 - 1. Note that drawings do not show all junction boxes and fixture whips for lighting fixtures recessed in accessible ceilings. Although not specifically shown on the drawings, these fixtures shall be wired from junction boxes and maximum 6'-0" unsupported whips. Provide number of junction boxes as required allowing for the maximum 6'-0" whips. Wiring from fixture to fixture is not allowed. See Section 265119 "LED Interior Lighting".
 - 2. Lighting and Devices shown with same panel and circuit designation with no home run symbol may share same home runs to panelboards provided that the furthest device on the circuit does not exceed 2-1/2% voltage drop.
 - 3. Where home run symbols are shown, use separate run to panelboard for each symbol, and do not share home run with other devices having same panel and circuit designation.

END OF SECTION 260010

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SECTION 260519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Copper building wire.
 - 2. Nonmetallic underground conduit with conductors, Type NUCC.
 - 3. Metal-clad cable, Type MC.
 - 4. Fire-alarm wire and cable.
 - 5. Connectors and splices.
- B. Related Requirements:
 - 1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product, including construction, diameter, ampacity and bending radius.
- B. Product Schedule: Indicate type, use, location, and termination locations.

1.3 INFORMATIONAL SUBMITTALS

- A. Manufacturer's Installation Instructions: Indicate application conditions and limitations of use stipulated by product testing agency.

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. Manufacturers:
 - 1. General Cable
 - 2. Superior Essex Inc.
 - 3. Southwire Company
 - 4. Northern Cables
 - 5. Allied Wire & Cable
 - 6. Cerro Wire
 - 7. AFC Cable Systems

8. Encore Wire Corporation
9. The Okonite Co.
10. Approved Equal

C. 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."

D. Conductors: Copper, complying with ASTM B3 for bare annealed copper and with ASTM B8 for stranded conductors.

E. Conductor Insulation:

1. Type THHN and Type THWN-2: Comply with UL 83.

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. Manufacturers:

1. General Cable
2. Superior Essex Inc.
3. Southwire Company
4. Northern Cables
5. Allied Wire & Cable
6. Cerro Wire
7. AFC Cable Systems
8. Encore Wire Corporation
9. The Okonite Co.
10. Approved Equal

C.

D. 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."

E. Circuits:

1. Single circuit
2. Power-Limited Fire-Alarm Circuits: Comply with UL 1424.

F. Conductors: Maximum #10 AWG, Copper, complying with ASTM B3 for bare annealed copper and with ASTM B8 for stranded conductors.

G. Ground Conductor: Separate; Insulated.

- H. Conductor Insulation:
 - 1. Type TFN/THHN/THWN-2 rated 600V, 90° C: Comply with UL 83.
- I. Armor: Steel or Aluminum, interlocked.
- J. Jacket: PVC applied over armor.

2.3 FIRE-ALARM WIRE AND CABLE

- A. Manufacturers:
 - 1. Anixter
 - 2. Superior Essex Inc.
 - 3. Southwire Company
 - 4. Northern Cables
 - 5. Allied Wire & Cable
 - 6. AFC Cable Systems
 - 7. Encore Wire Corporation
 - 8. The Okonite Co.
 - 9. Approved Equal
- B. General Wire and Cable Requirements: NRTL listed and labeled as complying with NFPA 70, Article 760.
- C. Signaling Line Circuits: Twisted, shielded pair, size as recommended by system manufacturer, no smaller than No. 16 AWG.
- D. Non-Power-Limited Circuits: Solid-copper conductors with 600 V rated, 75 deg C, color-coded insulation, and complying with requirements in UL 2196 for a two-hour rating.
 - 1. Low-Voltage Circuits: No. 16 AWG, minimum, in pathway.
 - 2. Line-Voltage Circuits: No. 12 AWG, minimum, in pathway.
 - 3. Multiconductor Armored Cable: NFPA 70, Type MC, copper conductors, Type TFN/THHN conductor insulation, copper drain wire, copper armor with outer jacket with red identifier stripe, NRTL listed for fire-alarm and cable tray installation, plenum rated.

2.4 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. Manufacturers:
 - 1. General Cable
 - 2. Superior Essex Inc.
 - 3. Southwire Company
 - 4. Allied Wire & Cable
 - 5. Northern Cables
 - 6. Cerro Wire
 - 7. AFC Cable Systems

8. Encore Wire Corporation
 9. The Okonite Co.
 10. Approved Equal
- C. Jacketed Cable Connectors: For steel and aluminum jacketed cables, zinc die-cast with set screws, designed to connect conductors specified in this Section.
- D. Lugs: One piece, seamless, designed to terminate conductors specified in this Section.
1. Material: Copper.
 2. Type: One or Two hole with standard or long barrels as appropriate.
 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.
- B. Branch Circuits:
1. Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.
- C. ASD Output Circuits Cable: Extra-flexible stranded for all sizes.
- D. Power-Limited Fire Alarm and Control: Solid for No. 12 AWG and smaller.
- E. PV Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

- A. Service Entrance: Type THHN/THWN-2, single conductors in raceway.
- B. Exposed Feeders (use only where indicated on drawings): Type THHN/THWN-2, single conductors in raceway.
- C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspace: Type THHN/THWN-2, single conductors in raceway.
- D. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN/THWN-2, single conductors in raceway.
- E. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Metal-clad cable, Type MC.
- F. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN/THWN-2, single conductors in raceway.
- G. Cord Drops and Portable Appliance Connections: Type SO, hard service cord with stainless steel, wire-mesh, strain relief device at terminations to suit application.

3.3 INSTALLATION, GENERAL

- A. All branch circuit conductors shall be #12AWG or larger, unless otherwise specified on the drawings.
- B. All conductors on drawings are sized for Copper. Aluminum sizes (if specifically permitted by owner and with approval of engineer via submittals for sizes 4 AWG or larger only) must be adjusted to have the same ampacity and same or less impedance as the copper size indicated; increase the conduit and pull box sizes to accommodate the larger size aluminum conductors in accordance with NFPA 70; ensure that the pulling tension rating of the aluminum conductor is sufficient; relocate equipment, modify equipment terminations, re-size equipment, and resolve to the satisfaction of the Architect all problems that are the results of the use of aluminum conductors in lieu of copper.
- C. Except as otherwise specifically noted, all wiring throughout the building, including each of the systems specified, shall be enclosed in raceways and boxes.
- D. Unless specifically noted on drawings, wire sizes have not been derated. Where multiple circuits are installed in one conduit, appropriate deration of wire size in accordance with 310.15 must be accounted for.
- E. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.
- F. Complete raceway installation between conductor and cable termination points according to Section 260533 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.
- G. 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.
- H. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
- I. Pull all conductors into raceway at same time.
- J. Use suitable wire pulling lubricant for building wire #4 AWG and larger.
- K. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
- L. Support cables according to Section 260529 "Hangers and Supports for Electrical Systems."
- M. Complete cable tray systems installation according to Section 260536 "Cable Trays for Electrical Systems" prior to installing conductors and cables.

3.4 INSTALLATION OF FIRE-ALARM WIRE AND CABLE

- A. Comply with NFPA 72.

- B. Wiring Method: Install wiring in metal pathway according to Section 270528 "Pathways for Communications Systems."
 - 1. Install plenum cable in environmental airspaces, including plenum ceilings.
 - 2. Fire-alarm circuits and equipment control wiring associated with fire-alarm system must be installed in a dedicated pathway system.
 - a. Cables and pathways used for fire-alarm circuits, and equipment control wiring associated with fire-alarm system, may not contain any other wire or cable.
 - 3. Fire-Rated Cables: Use of two-hour, fire-rated fire-alarm cables, NFPA 70, Types MI and CI, is permitted.
 - 4. Signaling Line Circuits: Power-limited fire-alarm cables may not be installed in the same cable or pathway as signaling line circuits.
- C. Wiring within Enclosures: Separate power-limited and non-power-limited conductors as recommended by manufacturer. Install conductors parallel with or at right angles to sides and back of the enclosure. Bundle, lace, and train conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with fire-alarm system to terminal blocks. Mark each terminal according to system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.
- D. Cable Taps: Use numbered terminal strips in junction, pull, and outlet boxes; cabinets; or equipment enclosures where circuit connections are made.
- E. Color-Coding: Color-code fire-alarm conductors differently from the normal building power wiring. Use one color-code for alarm circuit wiring and another for supervisory circuits. Color-code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visible alarm-indicating devices. Paint fire-alarm system junction boxes and covers red.

3.5 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.
- C. Clean conductor surfaces before installing lugs and connectors.
- D. Use split bolt connectors, insulation piercing connectors or U.L. approved insulated connectors for copper conductor splices and taps, #6 AWG and larger. Tape uninsulated conductors and connector with electrical tape to 150 percent of insulation rating of conductor.
- E. Use solderless pressure connectors with insulating covers for copper conductor splices and taps, #8 AWG and smaller.

- F. Use insulated spring wire connectors with plastic caps for copper conductor splices and taps, 10 AWG and smaller.
- G. Wiring at Outlets: Install conductor at each outlet, with at least 6 inch (150 mm) of slack.
- H. Comply with requirements in Section 284621.11 "Addressable Fire-Alarm Systems" for connecting, terminating, and identifying wires and cables.

3.6 IDENTIFICATION

- A. Identify and color-code conductors and cables according to Section 260553 "Identification for Electrical Systems."
- B. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

3.7 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.8 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Section 078413 "Penetration Firestopping."

3.9 FIELD QUALITY CONTROL

- A. Tests and Inspections:
 - 1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and all conductors over #8AWG for compliance with requirements.
 - a. Insulation Resistance test:
 - 1) Applied potential shall be 500 volts dc for 300 volt rated cable and 1000 volts dc for 600 volt rated cable.
 - 2) Take readings after 1 minute and until the reading is constant for 15 seconds.
 - 3) Minimum insulation-resistance values shall not be less than 25 Megohms for 300 volt rated cable and 100 Megohms for 600 volt rated cable.
 - 2. Perform each of the following visual and electrical tests:
 - a. Inspect exposed sections of conductor and cable for physical damage and correct connection according to the single-line diagram.
 - b. Test bolted connections for high resistance using one of the following:
 - 1) A low-resistance ohmmeter.
 - 2) Calibrated torque wrench.

- 3) Thermographic survey.
 - c. Inspect compression-applied connectors for correct cable match and indentation.
 - d. Inspect for correct identification.
 - e. Inspect cable jacket and condition.
 - f. Insulation-resistance test on each conductor for ground and adjacent conductors. Apply a potential of 500 V(dc) for 300 V rated cable and 1000 V(dc) for 600 V rated cable for a one-minute duration.
 - g. Continuity test on each conductor and cable.
 - h. Uniform resistance of parallel conductors.
- 3. Inspect all wire and cable for:
 - a. Physical damage and proper connection.
 - b. Measure tightness of bolted connections and compare torque measurements with manufacturer's recommended values.
 - c. Verify continuity of each branch circuit conductor.
 - d. Verify proper operation of each circuit.
- B. Cables will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports to record the following:
 - 1. Procedures used.
 - 2. Results that comply with requirements.
 - 3. Results that do not comply with requirements, and corrective action taken to achieve compliance with requirements.

END OF SECTION 260519

SECTION 260526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Grounding and bonding conductors.
 - 2. Grounding and bonding connectors.
 - 3. Intersystem bonding bridge.
 - 4. Grounding and bonding busbars.
 - 5. Grounding (earthing) electrodes.
- B. Related Requirements:
 - 1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.

1.2 ACTION SUBMITTALS

- A. Product Data:
 - 1. For each type of product indicated.
- B. Shop Drawings: Plans showing dimensioned locations of grounding features described in "Field Quality Control" Article, including the following:
 - 1. Test wells.
 - 2. Rod electrodes.
- C. Field Quality-Control Submittals:
 - 1. Field quality-control reports including overall resistance to ground and at each electrode.

1.3 CLOSEOUT SUBMITTALS

- A. Manufacturer's Instructions: Include Instructions for protection, examination, preparation, and installation of exothermic connectors.
- B. Operation and Maintenance Data:
 - 1. In addition to items specified in Section 260010 "Supplemental Requirements for Electrical," include the following:
 - a. Plans showing locations of grounding features described in "Field Quality Control" Article, including the following:
 - 1) Test wells.
 - 2) Rod electrodes.

PART 2 - PRODUCTS

2.1 GROUNDING AND BONDING CONDUCTORS

- A. Equipment Grounding Conductor:
 - 1. General Characteristics: 600 V, THHN/THWN-2 copper wire or cable, green color, in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- B. Isolated Equipment Grounding Conductor:
 - 1. General Characteristics: 600 V, THHN/THWN-2 copper wire or cable, green color with one or more yellow stripes, in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- C. ASTM - Bare Copper Grounding and Bonding Conductor:
 - 1. Erico, Eritech, Caltrain, Grainer, Harger, or approved equal
 - 2. Referenced Standards: Complying with one or more of the following:
 - a. Soft or Annealed Copper Wire: ASTM B3
 - b. Concentric-Lay Stranded Copper Conductor: ASTM B8.
 - c. Tin-Coated Soft or Annealed Copper Wire: ASTM B33.
 - d. 19-Wire Combination Unilay-Stranded Copper Conductor: ASTM B787/B787M.

2.2 GROUNDING AND BONDING CLAMPS

- A. Description: Clamps suitable for attachment of grounding and bonding conductors to grounding electrodes, pipes, tubing, and rebar. Grounding and bonding clamps specified in this article are also suitable for use with communications applications; see Section 270526 "Grounding and Bonding for Communications Systems," for selection and installation guidelines.
- B. Source Limitations: Obtain products from single manufacturer.
- C. 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. Listing Criteria:
 - a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.
 - b. Grounding and Bonding Equipment for Communications: UL CCN KDSH; including UL 467.
- D. UL KDER and KDSH - Hex-Fitting-Type Pipe and Rod Grounding and Bonding Clamp:
 - 1. Thomas and Betts/Blackburn, Graybar, Grainger, or approved equal.
 - 2. General Characteristics:
 - a. Two pieces with zinc-plated bolts.
 - b. Clamp Material: Silicon bronze.
 - c. Listed for outdoor use.
- E. UL KDER - Exothermically Welded Connection:

1. Erico, Cadweld, or approved equal.
2. General Characteristics: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

2.3 GROUNDING AND BONDING BUSHINGS

- A. Description: Bonding bushings connect conduit fittings, tubing fittings, threaded metal conduit, and unthreaded metal conduit to metal boxes and equipment enclosures and have one or more bonding screws intended to provide electrical continuity between bushing and enclosure. Grounding bushings have provision for connection of bonding or grounding conductor and may or may not also have bonding screws.
- B. Source Limitations: Obtain products from single manufacturer.
- C. 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. Listing Criteria:
 - a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.
- D. UL KDER - Bonding Bushing:
 1. Bridgeport, Graybar, Eaton, or approved equal.
 2. General Characteristics: Threaded bushing with insulated throat.
- E. UL KDER - Grounding Bushing:
 1. Bridgeport, Graybar, Eaton, or approved equal.
 2. General Characteristics: Threaded bushing with insulated throat and mechanical-type wire terminal.

2.4 INTERSYSTEM BONDING BRIDGE GROUNDING CONNECTORS

- A. Description: Devices that provide means for connecting communications systems grounding and bonding conductors at service equipment or at disconnecting means for buildings or structures.
- 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. Listing Criteria:
 - a. Grounding and Bonding Equipment for Communications: UL CCN KDSH; including UL 467.
- C. UL KDSH - One-Piece Intersystem Bonding Bridge Grounding Connector:
 1. Eritch, Southwire, or approved equal.

2. General Characteristics: Zinc-alloy one-piece construction; six terminating points; gangable.
- D. UL KDSH - Two-Piece Intersystem Bonding Bridge Grounding Connector:
1. Eritch, Southwire, or approved equal.
 2. General Characteristics: Zinc-alloy body and polycarbonate cover; four terminating points.

2.5 GROUNDING (EARTHING) ELECTRODES

- A. Description: Grounding electrodes include rod electrodes, ring electrodes, metal underground water pipes, metal building frames, concrete-encased electrodes, and pipe and plate electrodes.
- B. Source Limitations: Obtain products from single manufacturer.
- C. 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. Listing Criteria:
 - a. Grounding and Bonding Equipment: UL CCN KDER; including UL 467.
- D. UL KDER - Rod Electrode:
1. Erico, Eritech, or approved equal.
 2. General Characteristics: Copper-clad; 3/4 inch by 10 ft (19 mm by 3 m).
- E. UL KDER - Plate Electrode:
1. Erico, Eritech, or approved equal.
 2. General Characteristics: 1/4 inch (6 mm) thick, hot-dip galvanized.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine facility's grounding electrode system and equipment grounding for compliance with requirements for maximum ground-resistance level and other conditions affecting performance of grounding and bonding of electrical system.
- B. Inspect test results of grounding system measured at point of electrical service equipment connection.
- C. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- D. Proceed with connection of electrical service equipment only after unsatisfactory conditions have been corrected.
- E. Verify that final backfill and compaction has been completed before driving rod electrodes.

3.2 SELECTION OF BUSBARS

- A. Grounding Bus: Install in electrical equipment rooms, in rooms housing service equipment, and elsewhere as indicated.
 - 1. Install bus horizontally, on insulated spacers 2 inch (50 mm) minimum from wall, 6 inch (150 mm) above finished floor unless otherwise indicated.
 - 2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down; connect to horizontal bus.

3.3 SELECTION OF GROUNDING AND BONDING CONDUCTORS

- A. Conductors: Install solid conductor for 8 AWG and smaller, and stranded conductors for 6 AWG and larger unless otherwise indicated.
- B. Custom-Length Insulated Equipment Bonding Jumpers: 6 AWG, 19-strand, Type THHN.
- C. Bonding Cable: 28 kcmil, 14 strands of 17 AWG conductor, 1/4 inch (6 mm) in diameter.
- D. Bonding Conductor: 4 AWG or 6 AWG, stranded conductor.
- E. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inch (41 mm) wide and 1/16 inch (1.6 mm) thick.
- F. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inch (41 mm) wide and 1/16 inch (1.6 mm) thick.
- G. Underground Grounding Conductors: Install bare copper conductor, 4/0 AWG minimum.
 - 1. Bury at least 30 inch (750 mm) below grade.
 - 2. Duct-Bank Grounding Conductor: Bury 12 inch (300 mm) above duct bank when indicated as part of duct-bank installation.

3.4 SELECTION OF CONNECTORS

- A. Conductor Terminations and Connections:
 - 1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
 - 2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.
 - 3. Connections to Ground Rods at Test Wells: Bolted connectors.
 - 4. Connections to Structural Steel: Welded connectors.

3.5 INSTALLATION

- A. Comply with manufacturer's published instructions.
- B. Reference Standards:
 - 1. Ground Bonding Common with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest

- point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.
 2. Consult Architect for resolution of conflicting requirements.
- C. Special Techniques:
1. Conductors:
 - a. Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
 2. Connections: Make connections so possibility of galvanic action or electrolysis is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact are galvanically compatible.
 - a. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer in order of galvanic series.
 - b. Make connections with clean, bare metal at points of contact.
 - c. Make aluminum-to-steel connections with stainless steel separators and mechanical clamps.
 - d. Make aluminum-to-galvanized-steel connections with tin-plated copper jumpers and mechanical clamps.
 - e. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.
 - f. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.
 - 1) Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate adjacent parts.
 - 2) Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
 - 3) Use exothermic-welded connectors for outdoor locations; if disconnect-type connection is required, use bolted clamp.
 - g. Grounding and Bonding for Piping:
 - 1) Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use bolted clamp connector or bolt lug-type connector to pipe flange by using one of lug bolts of flange. Where dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
 - 2) Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with bolted connector.
 - 3) Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.
 - h. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install bonding jumper to bond across flexible duct connections to achieve continuity.
 - i. Grounding for Steel Building Structure: Install driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 ft (18 m) apart.
 3. Electrodes:

- a. Ground Rods: Drive rods until tops are 2 inch (50 mm) below finished floor or final grade unless otherwise indicated.
 - 1) Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.
 - 2) Use exothermic welds for below-grade connections.
 - b. For grounding electrode system, install at least three rods spaced at least one-rod length from each other and located at least same distance from other grounding electrodes, and connect to service grounding electrode conductor.
 - c. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes are specified in Section 260543 "Underground Ducts and Raceways for Electrical Systems," and must be at least 12 inch (300 mm) deep, with cover.
 - 1) Install at least one test well for each service unless otherwise indicated. Install at ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.
- 4. Grounding at Service:
 - a. Equipment grounding conductors and grounding electrode conductors must be connected to ground bus. Install main bonding jumper between neutral and ground buses.
- 5. Grounding Underground Distribution System Components:
 - a. Duct-Bank Grounding Conductor: Bury 12 inch (300 mm) above duct bank when indicated as part of duct-bank installation.
 - b. Comply with IEEE C2 grounding requirements.
 - c. Grounding Manholes and Handholes: Install driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inch (100 mm) will extend above finished floor. If necessary, install ground rod before manhole is placed and provide 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inch (50 mm) above to 6 inch (150 mm) below concrete. Seal floor opening with waterproof, nonshrink grout.
 - d. Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with 4 AWG minimum, stranded, hard-drawn copper bonding conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields in accordance with manufacturer's published instructions with splicing and termination kits.
- 6. Equipment Grounding:
 - a. Install insulated equipment grounding conductors with feeders and branch circuits.
 - b. Provide separate, insulated 600V conductor within each feeder and branch circuit raceway. Terminate each end on suitable lug, bus, or bushing.
 - c. Equipment grounding conductors shall be continuous where possible. Where splices are required, provide approved compression connectors in an approved pattern. Insulate connectors to equivalent thickness of conductors.
 - d. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
 - 1) Feeders and branch circuits.
 - 2) Lighting circuits.
 - 3) Receptacle circuits.
 - 4) Single-phase motor and appliance branch circuits.

- 5) Three-phase motor and appliance branch circuits.
- 6) Flexible raceway runs.
- 7) Metal-clad cable runs.
- 8) Busway Supply Circuits: Install insulated equipment grounding conductor from grounding bus in switchgear, switchboard, or distribution panel to equipment grounding bar terminal on busway.
- 9) Water Entrance: Install ground wire from water entrance to main entrance switchboard. Provide additional ground wire from main service to building structural steel and 20-50 feet of ½" minimum re-bar or 4/0 copper conductor in concrete footing, as required by NEC. Enclose wire in PVC-40 where exposed.
- 10) Metal siding not attached to grounded structure: Bond to ground.
- 11) Transformer secondaries: provide grounding system for neutrals of dry type transformer secondaries as indicated and required.
- e. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.
- f. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.

3.6 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with calibrated torque wrench in accordance with manufacturer's published instructions.
3. Test completed grounding system at each location where maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, at ground test wells, and at individual ground rods. Make tests at ground rods before conductors are connected.
 - a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
 - b. Perform tests by fall-of-potential method in accordance with IEEE Std 81.
 - c. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.
4. Prepare dimensioned Drawings locating each test well, ground rod and ground-rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to record of tests and observations. Include number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

B. Nonconforming Work:

1. Grounding system will be considered defective if it does not pass tests and inspections.
 2. Remove and replace defective components and retest.
- C. Collect, assemble, and submit test and inspection reports.
1. Report measured ground resistances that exceed the following values:
 - a. Power and Lighting Equipment or System with Capacity of 500 kVA and Less: 10 Ω .
 - b. Power Distribution Units or Panelboards Serving Electronic Equipment: 3 Ω .
 - c. Pad-Mounted Equipment: 5 Ω .
 - d. Manhole Grounds: 10 Ω .

3.7 PROTECTION

- A. After installation, protect grounding and bonding cables and equipment 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 260526

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SECTION 260529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Support, anchorage, and attachment components.
 - 2. Fabricated metal equipment support assemblies.
- B. Related Requirements:
 - 1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.

1.2 ACTION SUBMITTALS

- A. Product Data:
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the following:
 - a. Slotted support systems, hardware, and accessories.
 - b. Clamps.
 - c. Hangers.
 - d. Sockets.
 - e. Eye nuts.
 - f. Fasteners.
 - g. Anchors.
 - h. Saddles.
 - i. Brackets.
 - 2. Include rated capacities and furnished specialties and accessories.
 - 3. Hangers. Include product data for components.
 - 4. Slotted support systems.
 - 5. Equipment supports.
 - 6. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.

1.3 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Preformed steel channels and angles with minimum 13/32 inch (10 mm) diameter holes at a maximum of 8 inch (200 mm) on center in at least one surface.
 - 1. Flexstrut, Unistrut, Graybar, or approved equal.
 - 2. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
 - 3. Material for Channel, Fittings, and Accessories: Galvanized steel.
 - 4. Channel Width: Selected for applicable load criteria.
 - 5. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
 - 6. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
 - 7. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
 - 8. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Aluminum Slotted Support Systems: Extruded-aluminum channels and angles with minimum 13/32 inch (10 mm) diameter holes at a maximum of 8 inch (200 mm) on center in at least one surface.
 - 1. Flexstrut, Unistrut, Graybar, or approved equal.
 - 2. Standard: Comply with MFMA-4 factory-fabricated components for field assembly.
 - 3. Channel Material: 6063-T5 aluminum alloy.
 - 4. Fittings and Accessories Material: 5052-H32 aluminum alloy.
 - 5. Channel Width: Selected for applicable load criteria.
 - 6. Nonmetallic Coatings: Manufacturer's standard PVC, polyurethane, or polyester coating applied according to MFMA-4.
 - 7. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
 - 8. Protect finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for nonarmored electrical conductors or cables in riser conduits. Plugs must have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body must be made of malleable iron.
- E. Structural Steel for Fabricated Supports and Restraints: ASTM A36/A36M steel plates, shapes, and bars; black and galvanized.
- F. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

1. Clamps for Attachment to Steel Structural Elements: MSS SP-58 units are suitable for attached structural element.
2. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM F3125/F3125M, Grade A325 (Grade A325M).
3. Toggle Bolts: All steel springhead type.
4. Hanger Rods: Threaded steel.

2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

- A. Description: Welded or bolted structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.
- B. Materials: Comply with requirements in Section 055000 "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.1 SELECTION

- A. Comply with the following standards for selection and installation of hangers and supports, except where requirements on Drawings or in this Section are stricter:
 1. NECA NEIS 101
- B. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping materials and installation for penetrations through fire-rated walls, ceilings, and assemblies.
- C. Comply with requirements for raceways and boxes as specified in Section 260533 "Raceway and Boxes for Electrical Systems."
- D. Maximum Support Spacing and Minimum Hanger Rod Size for Raceways: Space supports for EMT, IMC, and ERM as required by NFPA 70. Minimum rod size must be 1/4 inch (6 mm) in diameter.
- E. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
 1. Secure raceways and cables to these supports with two-bolt conduit clamps.
- F. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2 inch (38 mm) and smaller raceways serving branch circuits and communication systems above suspended ceilings, and for fastening raceways to trapeze supports.

3.2 INSTALLATION OF SUPPORTS

- A. Comply with NECA NEIS 101 for installation requirements except as specified in this article.

- B. Raceway Support Methods: In addition to methods described in NECA NEIS 1, EMT and ERMCM may be supported by openings through structure members, in accordance with NFPA 70.
- C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination must be weight of supported components plus 200 lb (90 kg).
- D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
 - 1. To Wood: Fasten with lag screws or through bolts.
 - 2. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
 - 3. To Existing Concrete: Expansion anchor fasteners.
 - 4. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts.
 - 5. To Light Steel: Sheet metal screws.
 - 6. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate.
- E. Drill holes for expansion anchors in concrete at locations and to depths that avoid the need for reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Comply with installation requirements in Section 055000 "Metal Fabrications" for site-fabricated metal supports.
- B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- C. Field Welding: Comply with AWS D1.1/D1.1M. Submit welding certificates.

3.4 CONCRETE BASES

- A. Construct concrete bases of dimensions indicated, but not less than 4 inch (100 mm) larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.
- B. Use 3000 psi (20.7 MPa), 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Section 033000 "Cast-in-Place Concrete."
- C. Anchor equipment to concrete base as follows:

1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
2. Install anchor bolts to elevations required for proper attachment to supported equipment.
3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.5 PAINTING

- A. Touchup:
 1. Comply with requirements in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting" for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.
- B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A780.

END OF SECTION 260529

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SECTION 260533 - RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Type EMT-S raceways and elbows.
2. Type ERMC-A and Type ERMC-SS raceways, elbows, couplings, and nipples.
3. Type ERMC-S raceways, elbows, couplings, and nipples.
4. Type FMT raceways.
5. Type PVC raceways and fittings.
6. Fittings for conduit, tubing, and cable.
7. Threaded metal joint compound.
8. Surface metal raceways and fittings.
9. Wireways and auxiliary gutters.
10. Metallic outlet boxes, device boxes, rings, and covers.
11. Termination boxes.
12. Junction boxes, pull boxes, and miscellaneous enclosures.
13. Cover plates for device boxes.
14. Hoods for outlet boxes.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for nonmetallic underground conduit with conductors (Type NUCC).
3. Section 260543 "Underground Ducts and Raceways for Electrical Systems" for exterior duct banks, manholes, and underground utility construction.
4. Section 270528 "Pathways for Communications Systems" for conduits, wireways, surface pathways, innerduct, boxes, faceplate adapters, enclosures, cabinets, and handholes serving communications systems.
5. Section 270543 "Underground Pathways and Structures for Communication Systems" for exterior communications duct banks, manholes, and underground utility construction.

1.2 ACTION SUBMITTALS

A. Product Data: For the following:

1. Wireways and auxiliary gutters.
2. Surface metal raceways.
3. Surface nonmetallic raceways.
4. Floor boxes.
5. Cabinets, cutout boxes, and miscellaneous enclosures.
6. Expansion Fittings.
7. Fire-stop seals and fillers.
8. Multi-outlet assemblies and accessories

- 9. Boxes larger than 12x12x6 inches
- 10. Boxes with hinged covers
- 11. Underfloor duct, fittings, and devices and related installation instructions

- B. Submit Shop Drawings, Owner's Manuals, and Operating Instructions in accordance with documents.

1.3 INFORMATIONAL SUBMITTALS

- A. Manufacturers' Instructions:
 - 1. For Type ERMCS-PVC.

1.4 PROJECT RECORD DOCUMENTS

- A. Accurately record actual locations and mounting heights of outlets if not as shown on Drawings, plus pull and junction boxes larger than 12"x12"x6" and boxes used for panel feeders.
- B. Accurately record routing of all underground and other conduits 2" and larger.

1.5 PROJECT CONDITIONS

- A. Verify field measurements are as shown on Drawings.
- B. Verify locations of boxes and outlets in work areas prior to rough in.
- C. Verify routing and termination locations of conduit prior to rough-in.
- D. Electrical boxes are shown on Drawings in approximate locations unless dimensioned. Install at location required for box to serve intended purpose. Generally, pull boxes are not shown on Drawings. Provide as required.
- E. Conduit routing is shown on Drawings in approximate locations unless dimensioned. Route as required to meet project conditions.
- F. Where conduit routing is not shown, and destination only is indicated, determine exact routing and lengths required.

1.6 COORDINATION

- A. Locate outlets so that they are readily accessible and do not interfere with other work.
- B. Provide access panels where required.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, protect, and handle products to site.

- B. Accept conduit on site. Inspect for damage.
- C. Protect conduit from corrosion and entrance of debris by storing above grade. Provide appropriate covering.
- D. Protect PVC conduit from sunlight.

PART 2 - PRODUCTS

2.1 TYPE EMT-S RACEWAYS AND ELBOWS

- A. Performance Criteria:
 - 1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
 - 2. General Characteristics: UL 797 and UL Category Control Number FJMX.
- B. Steel Electrical Metal Tubing (EMT-S) and Elbows:
 - 1. Material: Steel.
 - 2. Options:
 - a. Exterior Coating: Zinc
 - b. Interior Coating: Zinc
 - c. Minimum Trade Size: Metric designator 21 (trade size 3/4).
 - d. Colors: As indicated on Drawings.

2.2 TYPE EPEC RACEWAYS AND FITTINGS

- A. Performance Criteria:
 - 1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
 - 2. General Characteristics: UL 651A and UL Category Control Number EAZX.

2.3 TYPE ERMCA AND TYPE ERMCSS RACEWAYS, ELBOWS, COUPLINGS, AND NIPPLES

- A. Performance Criteria:
 - 1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
 - 2. General Characteristics: UL 6A and UL Category Control Number DYWV.

2.4 TYPE ERMCS RACEWAYS, ELBOWS, COUPLINGS, AND NIPPLES

- A. Performance Criteria:
 - 1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
 - 2. General Characteristics: UL 6 and UL Category Control Number DYIX.

- B. Galvanized-Steel Electrical Rigid Metal Conduit (ERMC-S-G), Elbows, Couplings, and Nipples:
 - 1. Hubbell, or approved equal
 - 2. Exterior Coating: Zinc.
 - 3. Options:
 - a. Interior Coating: Zinc.
 - b. Minimum Trade Size: Metric designator 21 (trade size 3/4).
 - c. Colors: As indicated on Drawings.

2.5 TYPE FMT RACEWAYS

- A. Performance Criteria:
 - 1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
 - 2. General Characteristics: UL 1652 and UL Category Control Number ILJW.
 - 3. Utilize FMC for permanent connections to motors.
- B. Steel Flexible Metallic Tubing (FMT):
 - 1. Hubbell, or approved equal
 - 2. Options:
 - a. Minimum Trade Size: Metric designator 21 (trade size 3/4).
 - b. Colors: As indicated on Drawings.

2.6 TYPE PVC RACEWAYS AND FITTINGS

- A. Performance Criteria:
 - 1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
 - 2. General Characteristics: UL 651 and UL Category Control Number DZYR.
- B. Schedule 40 Rigid PVC Conduit (PVC-40) and Fittings:
 - 1. Carlon or approved equal
 - 2. Dimensional Specifications: Schedule 40.
 - 3. Options:
 - a. Minimum Trade Size: Metric designator 21 (trade size 3/4).
 - b. Markings: For use with maximum 90 deg C wire.
- C. Schedule 80 Rigid PVC Conduit (PVC-80) and Fittings:
 - 1. Carlon or approved equal
 - 2. Dimensional Specifications: Schedule 80.
 - 3. Options:
 - a. Minimum Trade Size: Metric designator 21 (trade size 3/4).
 - b. Markings: For use with maximum 90 deg C wire.
- D. Type A Rigid PVC Concrete-Encased Conduit (PVC-A) and Fittings:
 - 1. Carlon or approved equal
 - 2. Dimensional Specifications: Type A.

- 3. Options:
 - a. Minimum Trade Size: Metric designator 21 (trade size 3/4).
- E. Type EB Rigid PVC Concrete-Encased Underground Conduit (PVC-EB) and Fittings:
 - 1. Carlon or approved equal
 - 2. Dimensional Specifications: Type EB.
 - 3. Options:
 - a. Minimum Trade Size: Metric designator 53 (trade size 2).

2.7 FITTINGS FOR CONDUIT, TUBING, AND CABLE

- A. Performance Criteria:
 - 1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
- B. Fittings for Type ERM, Type IMC, Type PVC, Type EPEC, and Type RTRC Raceways:
 - 1. Legrand, Hubbell, or approved equal
 - 2. General Characteristics: UL 514B and UL Category Control Number DWTT.
 - 3. Options:
 - a. Material: Steel.
 - b. Coupling Method: Compression coupling.
 - c. Conduit Fittings for Hazardous (Classified) Locations: UL 1203.
 - d. Expansion and Deflection Fittings: UL 651 with flexible external bonding jumper.
- C. Fittings for Type EMT Raceways:
 - 1. Legrand, Hubbell, or approved equal
 - 2. General Characteristics: UL 514B and UL Category Control Number FKAV.
 - 3. Options:
 - a. Material: Steel.
 - b. Coupling Method: Compression coupling.
 - c. Conduit Fittings for Hazardous (Classified) Locations: UL 1203.
 - d. Expansion and Deflection Fittings: UL 651 with flexible external bonding jumper.
- D. Fittings for Type FMC Raceways:
 - 1. Legrand, Hubbell, or approved equal
 - 2. General Characteristics: UL 514B and UL Category Control Number ILNR.
- E. Fittings for Type LFMC and Type LFNC Raceways:
 - 1. Legrand, Hubbell, or approved equal
 - 2. General Characteristics: UL 514B and UL Category Control Number DXAS.

2.8 WIREWAYS AND AUXILIARY GUTTERS

- A. Performance Criteria:
 - 1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
 - 2. General Characteristics: UL 870 and UL Category Control Number ZOYX.

- B. Metal Wireways and Auxiliary Gutters:
 - 1. General Electric, Square D., Siemens or approved equal.
 - 2. Additional Characteristics:
 - a. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
 - b. Finish: Manufacturer's standard enamel finish.
 - 3. Options:
 - a. Degree of Protection: Type 1 unless otherwise indicated.
 - b. Wireway Covers: Hinged type unless otherwise indicated.

2.9 METALLIC OUTLET BOXES, DEVICE BOXES, RINGS, AND COVERS

- A. Performance Criteria:
 - 1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
 - 2. General Characteristics: UL 514A and UL Category Control Number QCIT.
 - 3. Covers for flush floor devices and poke-through fittings shall meet UL scrub water standards for installation in carpet and tile floors.
- B. Metallic Outlet Boxes:
 - 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. Hubbell, Leviton, Legrand, or approved equal.
 - 3. Options:
 - a. Material: Sheet steel.
 - b. Sheet Metal Depth: Minimum 1.5 inch (38 mm).
 - c. Cast-Metal Depth: Minimum 1.8 inch (44.5 mm).
 - d. Luminaire Outlet Boxes and Covers: Nonadjustable, listed and labeled for attachment of luminaire weighing up to 50 lb (23 kg).
 - e. Paddle Fan Outlet Boxes and Covers: Nonadjustable, designed for attachment of paddle fan weighing up to 70 lb (32 kg).
- C. 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.
 - 2. Hubbell, Leviton, Legrand, or approved equal.
- D. Metallic Device Boxes:
 - 1. Description: Box with provisions for mounting wiring device directly to box.
 - 2. Hubbell, Leviton, Legrand, or approved equal.
 - 3. Options:
 - a. Material: Sheet steel.
- E. Metallic Concrete Boxes and Covers:
 - 1. Description: Box intended for use in poured concrete.

2. Coordinate with Division 05 structural requirements and details.

2.10 TERMINATION BOXES

- A. Description: Enclosure for termination base consisting of lengths of bus bars, terminal strips, or terminal blocks with provision for wire connectors to accommodate incoming or outgoing conductors or both.
- B. Performance Criteria:
 1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
 2. General Characteristics: UL 1773 and UL Category Control Number XCKT.
- C. Termination Boxes and Termination Bases for Installation on Line Side of Service Equipment:
 1. Additional Characteristics: Listed and labeled for installation on line side of service equipment.
- D. Termination Boxes and Termination Bases for Installation on Load Side of Service Equipment:
 1. Additional Characteristics: Listed and labeled for installation on load side of service equipment.

2.11 JUNCTION BOXES, PULL BOXES, AND MISCELLANEOUS ENCLOSURES

- A. Performance Criteria:
 1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
 2. General Characteristics:
 - a. Non-Environmental Characteristics: UL 50.
 - b. Environmental Characteristics: UL 50E.
- B. 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. Hubbell, or approved equal
 3. Additional Characteristics: UL Category Control Number BGUZ.
 4. Options:
 - a. Degree of Protection: Type 1
- C. Indoor Cast-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. Hubbell, or approved equal
 3. Additional Characteristics: UL Category Control Number BGUZ.
 4. Options:
 - a. Degree of Protection: Type 1
- D. Outdoor 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. Hubbell, or approved equal
 3. Additional Characteristics: UL Category Control Number BGUZ.
 4. Options:
 - a. Degree of Protection: Type 4X.
- E. Indoor and Outdoor Polymeric Junction and Pull Boxes:
1. Description: Box with a blank cover that serves the purpose of joining different runs of raceway or cable.
 2. Hubbell, or approved equal
 3. Additional Characteristics: UL Category Control Number BGUZ.
 4. Options:
 - a. Degree of Protection: Type 4X

2.12 HOODS FOR OUTLET BOXES

- A. Performance Criteria:
1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
 2. General Characteristics:
 - a. Reference Standards:
 - 1) UL 514D and UL Category Control Numbers QCIT and QCMZ.
 - 2) Receptacle, hood, cover plate, gaskets, and seals comply with UL 498 Supplement SA when mated with box or enclosure complying with UL 514A, UL 514C, or UL 50E.
 - b. Mounts to box using fasteners different from wiring device.
- B. Retractable or Reattachable Hoods for Outlet Boxes:
1. Options:
 - a. Provides ivory **clear**, weatherproof, "while-in-use" cover.

PART 3 - EXECUTION

3.1 SELECTION OF RACEWAYS

- A. Unless more stringent requirements are specified in Contract Documents or manufacturers' written instructions, comply with NFPA 70 for selection of raceways. Consult Architect for resolution of conflicting requirements.
- B. Raceway Fittings: Select fittings in accordance with NEMA FB 2.10 guidelines.
1. ERMC and IMC: Provide threaded type fittings unless otherwise indicated.

3.2 SELECTION OF BOXES AND ENCLOSURES

- A. Unless more stringent requirements are specified in Contract Documents or manufacturers' written instructions, comply with NFPA 70 for selection of boxes and enclosures. Consult Architect for resolution of conflicting requirements.

3.3 INSTALLATION OF RACEWAYS

A. Installation Standards:

1. Except as otherwise specifically noted, all wiring throughout the building, including each of the systems specified, shall be enclosed in minimum $\frac{3}{4}$ " conduit.
2. Install exposed only where specifically indicated.
3. Arrange supports to prevent misalignment during wiring installation.
4. Route conduit parallel and perpendicular to walls.
5. Do not cross conduits in slab.
6. Route conduit in and under slab from point-to-point.
 - a. Install only where specifically indicated or required.
 - b. Obtain approval from the Architect before installation.
7. Maintain adequate clearance between conduit and piping.
8. Use conduit hubs or sealing locknuts to fasten conduit to sheet metal boxes in damp and wet locations and to cast boxes.
9. Avoid moisture traps; provide junction box with drain fitting at low points in conduit system.
10. Provide suitable fittings to accommodate expansion and deflection where conduit crosses seismic, control and expansion joints.
11. Use suitable caps to protect installed conduit against entrance of dirt and moisture.
12. Use sleeves when passing through floors and walls.
13. When serving roof top equipment, conduit shall enter within the weather-proof curbing. Maintain watertight roofing system.
14. Ground and bond conduit under provisions of Division 26 Section "Grounding and Bonding."
15. Identify conduit under provisions of Division 26 Section "Electrical Identification."
16. Group Related Conduits:
 - a. Support using conduit rack of Power-Strut or approved equal.
 - b. Parallel runs shall be neatly clustered with all bends and offsets of uniform pattern.
 - c. Provide space on each for 25 percent additional conduit.
17. Substantially support conduits with approved clips or hangers spaced not to exceed ten feet (10') on centers except $\frac{1}{2}$ " rigid conduit and $\frac{1}{2}$ " and $\frac{3}{4}$ " electrical metallic tubing shall have supports spaced not to exceed six feet (6').
18. Unless more stringent requirements are specified in Contract Documents or manufacturers' written instructions, comply with NFPA 70 for installation of raceways. Consult Architect for resolution of conflicting requirements.
19. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.
20. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for hangers and supports.
21. Comply with NECA NEIS 101 for installation of steel raceways.
22. Comply with NECA NEIS 102 for installation of aluminum raceways.
23. Comply with NECA NEIS 111 for installation of nonmetallic raceways.
24. Install raceways square to the enclosure and terminate at enclosures without hubs with locknuts on both sides of enclosure wall. Install locknuts hand tight, plus one-quarter turn more.
25. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to metric designator 35 (trade size 1-1/4) and insulated throat metal bushings on metric designator 41 (trade size 1-1/2) and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits,

26. Raceway Terminations at Locations Subject to Moisture or Vibration:
 - a. Provide insulating bushings or insulated throat connectors in accordance with code requirements to protect conductors, including conductors smaller than No. 4 AWG. Install insulated throat metal grounding bushings on service conduits.
- B. General Requirements for Installation of Raceways:
 1. Complete raceway installation before starting conductor installation.
 2. Provide stub-ups through floors with coupling threaded inside for plugs, set flush with finished floor. Plug coupling until conduit is extended above floor to final destination or a minimum of 2 ft (0.6 m) above finished floor.
 3. Install no more than equivalent of three 90-degree bends in conduit run except for control wiring conduits, for which no more than equivalent of two 90-degree fewer bends are permitted. Support within 12 inch (300 mm) of changes in direction.
 4. Make bends in raceway using large-radius preformed ells except for parallel bends. Field bending must be in accordance with NFPA 70 minimum radii requirements. Provide only equipment specifically designed for material and size involved.
 5. Conceal conduit within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
 6. Support conduit within 12 inch (300 mm) of enclosures to which attached.
 7. Install raceway sealing fittings at accessible locations in accordance with NFPA 70 and fill them with listed sealing compound. For concealed raceways, install fitting in flush steel box with blank cover plate having finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings in accordance with NFPA 70.
 8. Join nonmetallic conduit using cement as recommended by manufacturer. Wipe nonmetallic conduit dry and clean before joining. Apply full even coat of cement to entire area inserted in fitting. Allow joint to cure for minimum 20 minutes, before burying in trench.
 9. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal interior of raceways at the following points:
 - a. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
 - b. Where an underground service raceway enters a building or structure.
 - c. Conduit extending from interior to exterior of building.
 - d. Conduit extending into pressurized duct and equipment.
 - e. Conduit extending into pressurized zones that are automatically controlled to maintain different pressure set points.
 - f. Where otherwise required by NFPA 70.
 10. Do not install raceways or electrical items on "explosion-relief" walls or rotating equipment.
 11. Do not install conduits within 2 inch (50 mm) of the bottom side of a metal deck roof.
 12. Keep raceways at least 6 inch (150 mm) away from parallel runs of flues and steam, hot-water pipes, or any surface exceeding a surface temperature of 104°F. Install horizontal raceway runs above water and steam piping.
 13. Cut conduit perpendicular to the length. For conduits metric designator 53 (trade size 2) and larger, use roll cutter or a guide to make cut straight and perpendicular to the length. Ream inside of conduit to remove burrs.
 14. Install pull wires in empty raceways. Provide polypropylene or monofilament plastic line with not less than 200 lb (90 kg) tensile strength. Leave at least 12 inch (300 mm) of slack at both ends of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.

- C. Expansion-Joint Fittings:
1. Install in runs of aboveground PVC that are located where environmental temperature change may exceed 30 deg F (17 deg C) and that have straight-run length that exceeds 25 ft (7.6 m). Install in runs of aboveground ERMC and EMT conduit that are located where environmental temperature change may exceed 100 deg F (55 deg C) and that have straight-run length that exceeds 100 ft (30 m).
 2. Install type and quantity of fittings that accommodate temperature change listed for the following locations:
 - a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F (70 deg C) temperature change.
 - b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F (86 deg C) temperature change.
 - c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F (70 deg C) temperature change.
 - d. Attics: 135 deg F (75 deg C) temperature change.
 3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F (0.06 mm per meter of length of straight run per deg C) of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F (0.0115 mm per meter of length of straight run per deg C) of temperature change for metal conduits.
 4. Install expansion fittings at locations where conduits cross building or structure expansion joints.
 5. Install expansion-joint fitting with position, mounting, and piston setting selected in accordance with manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

3.4 INSTALLATION OF BOXES AND ENCLOSURES

- A. Provide boxes in wiring and raceway systems wherever required for pulling of wires, making connections, and mounting of devices or fixtures.
- B. Install electrical boxes as shown on Drawings, and as required for splices, taps, wire pulling, equipment connections and compliance with regulatory requirements.
1. Except where specifically noted, boxes on finished surfaces shall be flush mounted with finished cover plate.
 2. Consult Architect prior to installing in finished areas.
 3. Install electrical boxes to maintain headroom and to present neat mechanical appearance.
- C. Install pull boxes and junction boxes above accessible ceilings and in unfinished areas only.
- D. In Non-accessible Ceiling Areas: Install outlet and junction boxes no more than 6 inches from ceiling access panels or from removable recessed luminaires such that they are accessible.
- E. In accessible Ceiling Areas: Install outlet and junction boxes such that they are accessible from ceiling access panels or from removable recessed luminaires.
- F. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.

- G. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box, whether installed indoors or outdoors.
- H. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.
- I. Locate boxes so that cover or plate will not span different building finishes.
- J. Support boxes in recessed ceilings independent of ceiling tiles and ceiling grid.
- K. 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.
- L. Fasten junction and pull boxes to, or support from, building structure. Do not support boxes by conduits.
- M. Set metal floor boxes level and flush with finished floor surface.
- N. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.
- O. Do not install aluminum boxes, enclosures, or fittings in contact with concrete or earth.
- P. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to ensure a continuous ground path.
- Q. Use 4" square box with plaster ring for single device outlets.
- R. Use cast outlet box in exterior locations exposed to the weather and wet locations.
- S. Use cast floor boxes for installations in slab on grade; formed steel boxes are acceptable for other installations.
- T. Underfloor and Cellular Duct:
 - 1. Mount at depth required for final finished floor elevation using rough slab below duct to assure accurate alignment and final elevation.
 - 2. Increase depth of slab as required to coordinate with specific duct and inserts provided.

3.5 FIRESTOPPING

- A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.6 FIELD QUALITY CONTROL

- A. No wire shall be installed until work which might cause damage to wires or conduits has been completed.
- B. Conduits shall be thoroughly cleaned of water or other foreign matter before wire is installed.

3.7 PROTECTION

- A. Protect coatings, finishes, and cabinets from damage and deterioration.
 - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 - 2. Repair damage to PVC coatings or paint finishes with matching touchup coating recommended by manufacturer.

3.8 CLEANING

- A. Boxes: Remove construction dust and debris from device boxes, outlet boxes, and floor-mounted enclosures before installing wallplates, covers, and hoods.

END OF SECTION 260533

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SECTION 260543 - UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Type EPEC raceways and fittings.
2. Type ERMC-SS raceways, elbows, couplings, and nipples.
3. Type ERMC-S raceways, elbows, couplings, and nipples.
4. Type IMC raceways.
5. Type PVC raceways and fittings.
6. Type RTRC-BG raceways and fittings.
7. Fittings for conduit, tubing, and cable.
8. Electrically conductive corrosion-resistant compounds for threaded conduit.
9. Solvent cements.
10. Duct accessories.
11. Handholes and boxes for exterior underground wiring.
12. Manholes for exterior underground wiring.
13. Utility structure accessories.
14. Duct sealing.

B. Related Requirements:

1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
2. Section 013100 "Project Management and Coordination" for preinstallation conference procedures.
3. Section 260519 "Low-Voltage for Electrical Power Conductors and Cables" for nonmetallic underground conduit with conductors (Type NUCC).

1.2 DEFINITIONS

- A. Duct: A single raceway or multiple raceways, installed singly or as components of a duct bank.
- B. Duct Bank: Two or more ducts installed in parallel, direct buried or with additional casing materials such as concrete.
- C. Handhole: An underground chamber containing electrical cables, sized such that personnel are not required to enter in order to access the cables.
- D. Manhole: An underground chamber containing electrical cables and equipment, sized to provide access with working space clearances.
- E. Trafficways: Locations where vehicular or pedestrian traffic is a normal course of events.

1.3 PREINSTALLATION MEETINGS

- A. Preinstallation Coordination Meeting(s): For underground ducts and raceways. Conduct meeting(s) at Project site. It is recommended to hold this meeting with representatives from the Utility to coordinate removal of existing underground feeders and relocation.
 - 1. Attendees: Installers, fabricators, representatives of manufacturers, and administrators for field tests and inspections. Notify Architect and Construction Manager of scheduled meeting dates.

1.4 ACTION SUBMITTALS

- A. Product Data:
 - 1. Type EPEC raceways and fittings.
 - 2. Type ERMC-SS raceways, elbows, couplings, and nipples.
 - 3. Type ERMC-S raceways, elbows, couplings, and nipples.
 - 4. Type IMC raceways.
 - 5. Type PVC raceways and fittings.
 - 6. Type RTRC-BG raceways and fittings.
 - 7. Fittings for conduit, tubing, and cable.
 - 8. Electrically conductive corrosion-resistant compounds for threaded conduit.
 - 9. Solvent cements.
 - 10. Duct accessories.
 - 11. Handholes and boxes for exterior underground wiring.
 - 12. Manholes for exterior underground wiring.
 - 13. Utility structure accessories.
 - 14. Duct sealing.
- B. Shop Drawings:
 - 1. Electric Utility Duct Banks and Structures:
 - a. Include plans, elevations, sections, and details, including attachments to other Work.
 - b. Indicate locations of private property boundaries and utility easements.
 - c. Include information required for approval by electric utility and for obtaining public space utility work permits.
 - 2. Precast or Factory-Fabricated Concrete Structures:
 - a. Include plans, elevations, sections, and details, including attachments to other Work.
 - b. Include duct entry provisions, including locations and duct sizes, and methods and materials for waterproofing duct entry locations.
 - c. Include reinforcement details.
 - d. Include frame and cover design and manhole chimneys.
 - e. Include ladder and/or step details.
 - f. Include grounding details.
 - g. Include dimensioned locations of cable rack inserts, pulling-in and lifting irons, sumps, and other accessories.
 - h. Include joint details.
 - 3. Factory-Fabricated Handholes and Boxes Other Than Precast Concrete:
 - a. Include dimensioned plans, sections, and elevations, and fabrication and installation details.

- b. Include duct entry provisions, including locations and duct sizes, and methods and materials for waterproofing duct entry locations.
 - c. Include cover design.
 - d. Include grounding details.
 - e. Include dimensioned locations of cable rack inserts, pulling-in and lifting irons, and other accessories.
- C. Field quality-control reports.

1.5 INFORMATIONAL SUBMITTALS

- A. Certificates: For concrete and steel used in precast concrete manholes and handholes, as required by ASTM C858.
- B. Manufacturers' published instructions.
- C. Field Reports:
 - 1. Factory Test Reports: For handholes and boxes.
 - 2. Manufacturer's field reports for field quality-control support.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Spare Parts: Furnish to Owner spare parts necessary for repairing or adding more cables to manholes or handholes that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Cable-Support Stanchions, Arms, and Associated Fasteners: Five percent of quantity of each item installed.
 - 2. Insulators: Five percent of quantity of each item installed.

PART 2 - PRODUCTS

2.1 TYPE EPEC RACEWAYS AND FITTINGS

- A. Performance Criteria:
 - 1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
 - 2. General Characteristics: UL 651A and UL CCN EAZX.
 - 3. For detailed requirements for specifying the following raceway types and associated fittings, see Specification 260533 – Raceway and Boxes for Electrical Systems:
 - a. Schedule 40 Electrical HDPE Underground Conduit (EPEC-40)
 - b. Schedule 80 Electrical HDPE Underground Conduit (EPEC-80)
 - c. Type A Electrical HDPE Underground Conduit (EPEC-A)
 - d. Type B Electrical HDPE Underground Conduit (EPEC-B)

2.2 TYPE ERM-C and ERM-SS RACEWAYS, ELBOWS, COUPLINGS, AND NIPPLES

- A. Performance Criteria:
1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
 2. General Characteristics: UL 6 and UL CCN DYIX.
 3. For detailed requirements for specifying the following raceway types and associated fittings, see Specification 260533 – Raceway and Boxes for Electrical Systems:
 - a. Galvanized-Steel Electrical Rigid Metal Conduit (ERMC-S-G), Elbows, Couplings, and Nipples
 - b. PVC-Coated-Steel Electrical Rigid Metal Conduit (ERMC-S-PVC), Elbows, Couplings, and Nipples
 - c. Type IMC Raceways
 - d. Stainless Steel Electrical Rigid Metal Conduit (ERMC-SS), Elbows, Couplings, and Nipples

2.3 TYPE PVC RACEWAYS AND FITTINGS

- A. Performance Criteria:
1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
 2. General Characteristics: UL 651 and UL CCN DZYR.
 3. For detailed requirements for specifying the following raceway types and associated fittings, see Specification 260533 – Raceway and Boxes for Electrical Systems:
 - a. Schedule 40 Rigid PVC Conduit (PVC-40) and Fittings
 - b. Schedule 80 Rigid PVC Conduit (PVC-80) and Fittings
 - c. Type A Rigid PVC Concrete-Encased Conduit (PVC-A) and Fittings
 - d. Type EB Rigid PVC Concrete-Encased Underground Conduit (PVC-EB) and Fittings
 - e. Type RTRC-BG Raceways and Fittings

2.4 DUCT ACCESSORIES

- A. Duct Spacers: Factory-fabricated, rigid, PVC interlocking spacers; sized for type and size of duct with which used, and selected to provide minimum duct spacing indicated while supporting duct during concreting or backfilling.
1. Legrand, Graybar, Eaton, or approved equal.
- B. Underground-Line Warning Tape: In accordance with Section 260553 "Identification for Electrical Systems."
- C. Concrete Warning Planks: Nominal 12 by 24 by 3 inch (300 by 600 by 75 mm) in size, manufactured from 6000 psi (41 MPa) concrete.
1. Color: Red dye added to concrete during batching.
 2. Mark each plank with "ELECTRIC" in 2 inch (50 mm) high, 3/8 inch (10 mm) deep letters.

2.5 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

- A. Performance Criteria:
 - 1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
 - 2. General Characteristics:
 - a. ASTM C858 for design and manufacturing processes.
 - b. SCTE 77.
- B. Precast Concrete Handholes and Boxes:
 - 1. Description: Factory-fabricated, reinforced-concrete, monolithically poured walls and bottom unless open-bottom enclosures are indicated. Frame and cover must form top of enclosure and must have load rating consistent with that of handhole or box.
 - 2. Hubbell, Grainger or approved equivalent
 - 3. Configuration: Units must be designed for flush burial and have open bottom unless otherwise indicated.
 - 4. Frame and Cover:
 - a. Weatherproof cast-iron frame, with cast-iron cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.
 - b. Cover Finish: Nonskid finish must have minimum coefficient of friction of 0.50.
 - c. Cover Legend: Molded lettering, "ELECTRIC".
 - 5. Extensions and Slabs: Designed to mate with bottom of enclosure. Same material as enclosure.
 - a. Extension must provide increased depth of 12 inch (300 mm).
 - b. Slab: Same dimensions as bottom of enclosure, and arranged to provide closure.
 - 6. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at installation location with ground-water level at grade.
 - 7. Knockout Panels: Precast openings in walls, arranged to match dimensions and elevations of approaching duct, plus additional 12 inch (300 mm) vertically and horizontally to accommodate alignment variations.
 - a. Knockout panels must be located no less than 6 inch (150 mm) from interior surfaces of walls, floors, or frames and covers of handholes, but close enough to corners to facilitate racking of cables on walls.
 - b. Knockout panel opening must have cast-in-place, welded-wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct.
 - c. Knockout panels must be framed with at least two additional No. 3 steel reinforcing bars in concrete around each opening.
 - d. Knockout panels must be 1-1/2 to 2 inch (38 to 50 mm) thick.
- C. Polymer Concrete Handholes and Boxes with Polymer Concrete Cover:
 - 1. Description: Molded of sand, concrete, and aggregate, bound together with polymer resin, and reinforced with steel or fiberglass or combination.
 - 2. Hubbell-Quazite, Grainger, or approved equivalent
 - 3. Configuration: Units must be designed for flush burial and have open bottom unless otherwise indicated.
 - 4. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and installed location.
 - a. Cover Finish: Nonskid finish must have minimum coefficient of friction of 0.50.
 - b. Cover Legend: Molded lettering, "ELECTRIC".
 - 5. Conduit Entrance Provisions: Conduit-terminating fittings must mate with entering ducts for secure, fixed installation in enclosure wall.

6. Duct Entrance Provisions: Duct-terminating fittings must mate with entering duct for secure, fixed installation in enclosure wall.
7. Handholes 12 inch wide by 24 inch long (300 mm wide by 600 mm long) and larger must have factory-installed inserts for cable racks and pulling-in irons.
8. Options:
 - a. Color: Gray.

2.6 MANHOLES FOR EXTERIOR UNDERGROUND WIRING

- A. Performance Criteria:
 1. Regulatory Requirements: Listed and labeled in accordance with NFPA 70 and marked for intended location and use.
 2. General Characteristics:
 - a. ASTM C858 for design and manufacturing processes.
 - b. SCTE 77.
- B. Precast Concrete Manholes:
 1. Description: One-piece units and units with interlocking mating sections, complete with accessories, hardware, and features.
 2. Old Castle, Hubbell, Shea, or approved equal
 3. Knockout Panels: Precast openings in walls, arranged to match dimensions and elevations of approaching duct, plus additional 12 inch (300 mm) vertically and horizontally to accommodate alignment variations.
 - a. Splayed location.
 - b. Knockout panels must be located no less than 6 inch (150 mm) from interior surfaces of walls, floors, or roofs of manholes, but close enough to corners to facilitate racking of cables on walls.
 - c. Knockout panel opening must have cast-in-place, welded-wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct.
 - d. Knockout panel must be framed with at least two additional No. 3 steel reinforcing bars in concrete around each opening.
 - e. Knockout panels must be 1-1/2 to 2 inch (38 to 50 mm) thick.
 4. Ground Rod Sleeve: Provide 3 inch (75 mm) PVC sleeve in manhole floors 2 inch (50 mm) from wall adjacent to, but not underneath, duct entering structure.
 5. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at installation location with ground-water level at grade.
 6. Source Quality Control: Test and inspect in accordance with ASTM C1037.

2.7 UTILITY STRUCTURE ACCESSORIES

- A. Description: Utility equipment and accessory items used for utility structure access and utility support, listed and labeled for intended use and application, and complying with the following local utility company requirements:
 1. See CMP standard requirements for underground vaults.
- B. Manufacturer must be approved by utility company.

- C. Manhole Frames, Covers, and Chimney Components: Comply with structural design loading specified for manhole.
 - 1. Frame and Cover: Weatherproof, gray cast iron complying with ASTM A48/A48M, Class 30B with milled cover-to-frame bearing surfaces; diameter, 26 inch (660 mm).
 - a. Cover Finish: Nonskid finish must have minimum coefficient of friction of 0.50.
 - b. Special Covers: Recess in face of cover designed to accept finish material in paved areas.
 - 2. Cover Legend: Cast in; selected to suit system.
 - a. Legend:
 - 1) "ELECTRIC-LV" for duct systems with power wires and cables for systems operating at 600 V and less.
 - 2) "ELECTRIC-HV" for duct systems with medium-voltage cables.
 - 3. Manhole Chimney Components: Precast concrete rings with dimensions matched to those of roof opening.
 - a. Mortar for Chimney Ring and Frame and Cover Joints: Comply with ASTM C270, Type M, except for quantities less than 2.0 cu. ft (60 L) where packaged mix complying with ASTM C387/C387M, Type M, may be used.
- D. Manhole Sump Frame and Grate: ASTM A48/A48M, Class 30B, gray cast iron.
- E. Pulling Eyes in Concrete Walls: Eyebolt with reinforcing-bar fastening insert, 2 inch (50 mm) diameter eye, and 1-by-4 inch (25-by-100 mm) bolt.
 - 1. Working Load Embedded in 6 inch (150 mm), 4000 psi (27.6 MPa) Concrete: 13,000 lbf (58 kN) minimum tension.
- F. Pulling-in and Lifting Irons in Concrete Floors: 7/8 inch (22 mm) diameter, hot-dip galvanized, bent steel rod; stress relieved after forming; fastened to reinforcing rod; and with exposed triangular opening.
 - 1. Ultimate Yield Strength: 40,000 lbf (180 kN) shear and 60,000 lbf (270 kN) tension.
- G. Bolting Inserts for Concrete Utility Structure Cable Racks and Other Attachments: Flared, threaded inserts of noncorrosive, chemical-resistant, nonconductive thermoplastic material; 1/2 inch (13 mm) ID by 2-3/4 inch (69 mm) deep, flared to 1-1/4 inch (31 mm) minimum at base.
 - 1. Tested Ultimate Pullout Strength: 12,000 lbf (53 kN) minimum.
- H. Ground Rod Sleeve: 3 inch (75 mm) PVC sleeve in manhole floors 2 inch (50 mm) from wall adjacent to, but not underneath, ducts routed from facility.
- I. Expansion Anchors for Installation after Concrete Is Cast: Zinc-plated, carbon-steel-wedge type with stainless steel expander clip with 1/2 inch (13 mm) bolt, 5300 lbf (24 kN) rated pullout strength, and minimum 6800 lbf (30 kN) rated shear strength.
 - 1. Stanchions: T-section or channel with provisions to connect to other sections or channels to form continuous unit; 1-1/2 inch (38 mm) in width by nominal 24 inch (600 mm) long; punched with 14 hook holes on 1-1/2 inch (38 mm) centers for cable-arm attachment.
 - 2. Arms: 1-1/2 inch (38 mm) wide, lengths ranging from 3 inch (75 mm) with 450 lb (204 kg) minimum capacity to 18 inch (450 mm) with 250 lb (114 kg) minimum capacity. Arms must have slots along full length for cable ties and be arranged for secure mounting in horizontal position at vertical locations on stanchions.
 - 3. Insulators: High-glaze, wet-process porcelain arranged for mounting on cable arms.

- J. Nonmetallic Cable Rack Assembly: Components fabricated from nonconductive, fiberglass-reinforced polymer.
 - 1. Stanchions: Nominal 36 inch (900 mm) high by 4 inch (100 mm) wide, with provisions to connect to other sections to form continuous unit, with minimum of nine holes for arm attachment.
 - 2. Arms: Arranged for secure, drop-in attachment in horizontal position at locations on cable stanchions, and capable of being locked in position. Arms must be available in lengths ranging from 3 inch (75 mm) with 450 lb (204 kg) minimum capacity to 20 inch (500 mm) with 250 lb (114 kg) minimum capacity. Top of arm must be nominally 4 inch (100 mm) wide, and arm must have slots along full length for cable ties.
- K. Fixed Manhole Ladders: Arranged for attachment to roof or wall of manhole. Ladder and mounting brackets and braces must be fabricated from nonconductive, structural-grade, fiberglass-reinforced resin.
- L. Cover Hooks: Heavy duty, designed for lifts 60 lbf (270 N) and greater. Two ladders(s) are required.

2.8 DUCT SEALING

- A. Duct-Sealing Compound: Nonhardening, safe for contact with human skin, not deleterious to cable insulation, and workable at temperatures as low as 35 deg F (2 deg C). Compound must be capable of withstanding temperature of 300 deg F (150 deg C) without slump and adhering to clean surfaces of plastic ducts, metallic conduit, conduit and duct coatings, concrete, masonry, lead, cable sheaths, cable jackets, insulation materials, and common metals. Duct sealing compound must be removable without damaging ducts or cables.
- B. Inflatable Duct-Sealing System: Wraparound inflatable bladder that seals ducts that are empty or containing conductors against air and water infiltration. System is suitable for use in steel, plastic, or concrete ducts and penetrations.

2.9 SOURCE QUALITY CONTROL

- A. Product Data: Prepare and submit catalog cuts, brochures, diagrams, schedules, and performance data illustrating size, physical appearance, and other characteristics of product.
 - 1. Duct-bank materials, including spacers and miscellaneous components.
 - 2. Ducts, conduits, and their accessories, including elbows, end bells, bends, fittings, and solvent cement.
 - 3. Accessories for manholes, handholes, boxes, and other utility structures.
 - 4. Underground-line warning tape.
- B. Manufacturer's Published Instructions: Prepare and submit installation, testing, and operating instructions for product.
- C. Factory Tests for Handholes and Boxes:
 - 1. Factory Tests and Inspections: Perform the following tests and inspections on handholes and boxes, by, or under supervision of, qualified electrical testing laboratory recognized by authorities having jurisdiction, before delivering to site. Affix label with name and date of manufacturer's certification of system compliance.

- a. Precast Concrete Utility Structures: Test and inspect in accordance with ASTM C1037.
 - b. Polymer Concrete and Nonconcrete Handhole and Pull-Box Prototypes: Test prototypes of handholes and boxes for compliance with SCTE 77. Strength tests must be for specified tier ratings of products supplied. Testing machine pressure gages must have current calibration certification, complying with ISO 9000 and ISO 10012, and traceable to NIST standards.
- 2. Nonconforming Work:
 - a. Equipment that does not pass tests and inspections will be considered defective.
- 3. Factory Test Reports: Prepare and submit factory test and inspection reports.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Coordinate layout and installation of duct, duct bank, manholes, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in field. Notify Architect if there is conflict between areas of excavation and existing structures or archaeological sites to remain.
- B. Coordinate elevations of duct and duct-bank entrances into manholes, handholes, and boxes with final locations and profiles of duct and duct banks, as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations as required to suit field conditions and to ensure that duct and duct bank will drain to manholes and handholes, and as approved by Architect.
- C. Clear and grub vegetation to be removed, and protect vegetation to remain in accordance with Section 311000 "Site Clearing." Remove and stockpile topsoil for reapplication in accordance with Section 311000 "Site Clearing."

3.2 SELECTION OF UNDERGROUND DUCTS

- A. Duct for Electrical Cables More Than 600 V: PVC-80, concrete encased unless otherwise indicated.
- B. Duct for Electrical Feeders 600 V and Less: PVC-80, direct buried unless otherwise indicated.
- C. Duct for Electrical Branch Circuits: PVC-80, direct buried unless otherwise indicated.
- D. Underground Ducts Crossing Walks and Driveways: PVC-80 direct buried.
- E. Underground Ducts Crossing Roadways: PVC-80, encased in reinforced concrete.
- F. Stub-ups: Concrete encased, PVC-80.

3.3 SELECTION OF UNDERGROUND ENCLOSURES

- A. Handholes and Boxes:
 - 1. Units in Roadways and Other Deliberate Traffic Paths: Precast concrete, AASHTO HB 17, H-20 structural load rating.
 - 2. Units in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Precast concrete, AASHTO HB 17, H-10, Precast concrete, AASHTO HB 17, H-20 structural load rating.
 - 3. Units in Sidewalk and Similar Applications with Safety Factor for Nondeliberate Loading by Vehicles: Precast concrete, AASHTO HB 17, H-10 or Polymer concrete units, SCTE 77, Tier 8 structural load rating.
 - 4. Units Subject to Light-Duty Pedestrian Traffic Only: Fiberglass-reinforced polyester resin, structurally tested in accordance with SCTE 77 with 3000 lbf (13 345 N) vertical loading.
 - 5. Cover design load must not exceed load rating of handhole or box.
- B. Manholes: Precast or cast-in-place concrete.
 - 1. Units Located in Roadways and Other Deliberate Traffic Paths by Heavy or Medium Vehicles: H-20 structural load rating in accordance with AASHTO HB 17.
 - 2. Units Not Located in Deliberate Traffic Paths by Heavy or Medium Vehicles: H-10 load rating in accordance with AASHTO HB 17.

3.4 EARTHWORK

- A. Excavation and Backfill: Comply with Section 312000 "Earth Moving," but do not use heavy-duty, hydraulic-operated, compaction equipment.
- B. Restoration: Restore area after construction vehicle traffic in immediate area is complete.
- C. Restore surface features at areas disturbed by excavation, and re-establish original grades unless otherwise indicated. Replace removed sod immediately after backfilling is completed.
- D. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Section 329200 "Turf and Grasses" and Section 329300 "Plants."
- E. Cut and patch existing pavement in path of underground duct, duct bank, and underground structures in accordance with "Cutting and Patching" Article in Section 017300 "Execution."

3.5 INSTALLATION OF DUCTS AND DUCT BANKS

- A. Reference Standards:
 - 1. Unless more stringent requirements are specified in Contract Documents or manufacturers' published instructions, comply with NEMA TCB 2 for installation of underground ducts and duct banks.
 - 2. Consult Architect for resolution of conflicting requirements.
- B. Special Techniques:
 - 1. Where indicated on Drawings, install duct, spacers, and accessories into duct-bank configuration shown. Duct installation requirements in this Section also apply to duct bank.

2. Steel raceway, bends, and fittings in single duct run or duct bank must be of same type.
3. Slope: Pitch duct minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope duct from high point between two manholes to drain in both directions.
4. Install expansion fitting near center of straight line duct with calculated expansion of more than 3/4 inch (19 mm).
5. Curves and Bends:
 - a. Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with minimum radius of 48 inch (1200 mm), both horizontally and vertically, at other locations unless otherwise indicated.
 - b. Field bending must be in accordance with NFPA 70 minimum radii requirements, except bends over 45 degrees must be made with minimum radius of 48 inch (1200 mm). Use only equipment specifically designed for material and size involved. Use PVC heating bender for bending PVC conduit.
 - c. Duct must have maximum of 180 degrees of bends between pull points.
6. Joints: Use solvent-cemented joints in nonmetallic duct and fittings and make watertight in accordance with manufacturer's published instructions. Stagger couplings so those of adjacent duct do not lie in same plane. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with minimum 3 inch (75 mm) of concrete for minimum of 12 inch (300 mm) on each side of coupling.
 - a. Install insulated grounding bushings on steel raceway terminations that are less than 12 inch (300 mm) below grade or floor level and do not terminate in hubs.
7. Installation Adjacent to High-Temperature Steam Lines: Where duct is installed parallel to underground steam lines, perform calculations showing duct will not be subject to environmental temperatures above 104 deg F (40 deg C). Where environmental temperatures are calculated to rise above 104 deg F (40 deg C), and anywhere duct crosses above underground steam line, install insulation blankets listed for direct burial to isolate duct bank from steam line to maintain maximum environmental temperature of 104 deg F (40 deg C).
8. Duct Terminators for Entrances to Cast-in-Place Manholes and Concrete Handholes: Use manufactured, cast-in-place duct terminators, with entrances into structure spaced approximately 6 inch (150 mm) o.c. for 4 inch (100 mm) duct, and vary proportionately for other duct sizes.
 - a. Begin change from regular spacing to terminator spacing 10 ft (3 m) from terminator, without reducing duct line slope and without forming trap in line.
9. Building Wall Penetrations: Make transition from underground duct to steel raceway at least 10 ft (3 m) outside building wall, without reducing duct line slope away from building and without forming trap in line. Use fittings manufactured for transition to steel raceway type installed. Install steel raceway penetrations of building walls as specified in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."
10. Install manufactured steel raceway elbows for stub-ups at poles unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.
 - a. Couple steel elbows to ducts with adapters designed for this purpose, and encase coupling with minimum 3 inch (75 mm) of concrete for minimum of 12 inch (300 mm) on each side of coupling.
11. Sealing: Provide temporary closure at terminations of duct with pulled cables. Seal spare duct at terminations. Use sealing compound and plugs to withstand at least 15 psig (1.03 MPa) hydrostatic pressure.
12. Pulling Cord: Install 200 lbf (1000 N) test nylon cord in empty ducts.
13. Concrete-Encased Ducts and Duct Bank:

- a. Excavate trench bottom to provide firm and uniform support for duct. Prepare trench bottoms as specified in Section 312000 "Earth Moving" for pipes 6 inch (150 mm) or less in nominal diameter.
- b. Width: Excavate trench minimum 3 inch (75 mm) wider than duct on each side.
- c. Depth: Install so top of duct envelope is at least 24 inch (600 mm) below finished grade in areas not subject to deliberate traffic, and at least 30 inch (750 mm) below finished grade in deliberate traffic paths for vehicles unless otherwise indicated. Install so top of duct envelope is below local frost line.
- d. Support duct on duct spacers coordinated with duct size, duct spacing, and outdoor temperature.
- e. Spacer Installation: Place spacers close enough to prevent sagging and deforming of duct, with not less than four spacers per 20 ft (6 m) of duct. Place spacers within 24 inch (600 mm) of duct ends. Stagger spacers approximately 6 inch (150 mm) between tiers. Secure spacers to earth and to duct to prevent floating during concreting. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
- f. Minimum Space between Ducts: 3 inch (75 mm) between edge of duct and exterior envelope wall, 2 inch (50 mm) between ducts for like services, and 4 inch (100 mm) between power and communications ducts.
- g. Elbows:
 - 1) Use manufactured duct elbows for stub-ups and at changes of direction in duct unless otherwise indicated. Extend encasement throughout length of elbow.
 - 2) Use manufactured steel elbows for stub-ups, at building entrances, and at changes of direction in duct run.
- h. Stub-ups to Outdoor Equipment: Extend concrete-encased steel raceway horizontally minimum of 60 inch (1500 mm) from edge of equipment base.
 - 1) Stub-ups must be minimum 4 inch (100 mm) above finished floor and minimum 3 inch (75 mm) from conduit side to edge of slab.
- i. Stub-ups to Indoor Equipment: Extend concrete-encased steel raceway horizontally minimum of 60 inch (1500 mm) from edge of wall. Install insulated grounding bushings on terminations at equipment.
 - 1) Stub-ups must be minimum 4 inch (100 mm) above finished floor and no less than 3 inch (75 mm) from conduit side to edge of slab.
- j. Reinforcement: Reinforce concrete-encased duct where crossing disturbed earth and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.
- k. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.
- l. Concrete Cover: Install minimum of 3 inch (75 mm) of concrete cover between edge of duct to exterior envelope wall, 2 inch (50 mm) between duct of like services, and 4 inch (100 mm) between power and communications ducts.
- m. Place minimum 6 inch (150 mm) of engineered fill above concrete encasement of duct.
- n. Concreting Sequence: Pour each run of envelope between manholes or other terminations in one continuous operation.

- 1) Start at one end and finish at other, allowing for expansion and contraction of duct as its temperature changes during and after pour. Use expansion fittings installed in accordance with manufacturer's published instructions, or use other specific measures to prevent expansion-contraction damage.
 - 2) If more than one pour is necessary, terminate each pour in vertical plane and install 3/4 inch (15 mm) reinforcing-rod dowels extending minimum of 18 inch (450 mm) into concrete on both sides of joint near corners of envelope.
 - o. Pouring Concrete: Comply with requirements in "Concrete Placement" Article in Section 033000 "Cast-in-Place Concrete." Place concrete carefully during pours to prevent voids under and between duct and at exterior surface of envelope. Do not allow heavy mass of concrete to fall directly onto ducts. Allow concrete to flow around duct and rise up in middle, uniformly filling open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-installation application.
14. Direct-Buried Duct and Duct Bank:
- a. Excavate trench bottom to provide firm and uniform support for duct. Comply with requirements in Section 312000 "Earth Moving" for preparation of trench bottoms for pipes less than 6 inch (150 mm) in nominal diameter.
 - b. Width: Excavate trench 12 inch (300 mm) wider than duct on each side.
 - c. Depth: Install top of duct at least 36 inch (900 mm) below finished grade unless otherwise indicated.
 - d. Set elevation of top of duct bank below frost line.
 - e. Place minimum 3 inch (75 mm) of sand as bed for duct. Place sand to minimum of 6 inch (150 mm) above top level of duct.
 - f. Support ducts on duct spacers coordinated with duct size, duct spacing, and outdoor temperature.
 - g. Spacer Installation: Place spacers close enough to prevent sagging and deforming of duct, with not less than four spacers per 20 ft (6 m) of duct. Place spacers within 24 inch (600 mm) of duct ends. Stagger spacers approximately 6 inch (150 mm) between tiers. Secure spacers to earth and to ducts to prevent floating during concreting. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
 - h. Install duct with minimum of 3 inch (75 mm) between ducts for like services and 6 inch (150 mm) between power and communications duct.
 - i. Install manufactured duct elbows for stub-ups, at building entrances, and at changes of direction in duct direction unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.
 - j. After installing first tier of duct, backfill and compact. Start at tie-in point and work toward end of duct run, leaving ducts at end of run free to move with expansion and contraction as temperature changes during this process. Repeat procedure after placing each tier. After placing last tier, hand place backfill to 4 inch (100 mm) over duct and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, make final duct connections at end of run and complete backfilling with normal compaction. Comply with requirements in Section 312000 "Earth Moving" for installation of backfill materials.
15. Warning Planks: Bury warning planks approximately 12 inch (300 mm) above direct-buried duct, placing them 36 inch (900 mm) o.c. Align planks along width and along centerline of duct or duct bank. Provide additional plank for each 12 inch (300 mm)

- increment of duct-bank width over nominal 18 inch (450 mm). Space additional planks 12 inch (300 mm) apart, horizontally across width of ducts.
16. Underground-Line Warning Tape: Bury nonconducting underground line specified in Section 260553 "Identification for Electrical Systems" no less than 12 inch (300 mm) above concrete-encased duct and duct banks and approximately 12 inch (300 mm) below grade. Align tape parallel to and within 3 inch (75 mm) of centerline of duct bank. Provide additional warning tape for each 12 inch (300 mm) increment of duct-bank width over nominal 18 inch (450 mm). Space additional tapes 12 inch (300 mm) apart, horizontally across width of ducts.
 17. Ground ducts and duct banks in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

3.6 INSTALLATION OF CONCRETE MANHOLES, HANDHOLES, AND BOXES

A. Reference Standards:

1. Precast Concrete Handholes: Comply with ASTM C891 unless otherwise indicated.
2. Consult Architect for resolution of conflicting requirements.

B. Special Techniques:

1. Cast-in-Place Manholes:
 - a. Finish interior surfaces with smooth-troweled finish.
 - b. Knockouts for Future Duct Connections: Form and pour concrete knockout panels 1-1/2 to 2 inch (38 to 50 mm) thick, arranged as indicated.
 - c. Comply with requirements in Section 033000 "Cast-in-Place Concrete" for cast-in-place concrete, formwork, and reinforcement.
2. Precast Concrete Handholes and Manholes:
 - a. Install units level and plumb and with orientation and depth coordinated with connecting duct to minimize bends and deflections required for proper entrances.
 - b. Unless otherwise indicated, support units on level bed of crushed stone or gravel graded from 1 inch (25 mm) sieve to No. 4 (4.75 mm) sieve and compacted to same density as adjacent undisturbed earth.
 - c. Field-cut openings for conduits in accordance with enclosure manufacturer's published instructions. Cut wall of enclosure with tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.
3. Elevations:
 - a. Manhole Roof: Install with rooftop at least 15 inch (375 mm) below finished grade.
 - b. Manhole Frame: In paved areas and trafficways, set frames flush with finished grade. Set other manhole frames 1 inch (25 mm) above finished grade.
 - c. Install handholes with bottom below frost line.
 - d. Handhole Covers: In paved areas and trafficways, set surface flush with finished grade. Set covers of other handholes 1 inch (25 mm) above finished grade.
 - e. Where indicated, cast handhole cover frame integrally with handhole structure.
4. Drainage: Install drains in bottom of manholes where indicated. Coordinate with drainage provisions indicated.
5. Manhole Access: Circular opening in manhole roof; sized to match cover size.
 - a. Manholes with Fixed Ladders: Offset access opening from manhole centerlines to align with ladder.

- b. Install chimney, constructed of precast concrete collars and rings, and cast-iron frame to connect cover with manhole roof opening. Provide moisture-tight joints and waterproof grouting for frame and chimney.
- 6. Hardware: Install removable hardware, including pulling eyes, cable stanchions, and cable arms, and insulators, as required for installation and support of cables and conductors and as indicated.
- 7. Fixed Manhole Ladders: Arrange to provide for safe entry with maximum clearance from cables and other items in manholes.
- 8. Field-Installed Bolting Anchors in Manholes and Concrete Handholes: Do not drill deeper than 3-7/8 inch (97 mm) for manholes and 2 inch (50 mm) for handholes, for anchor bolts installed in field. Use minimum of two anchors for each cable stanchion.
- 9. Ground manholes, handholes, and boxes in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

3.7 INSTALLATION OF HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

A. Reference Standards:

- 1. Consult Architect for resolution of conflicting requirements.

B. Special Techniques:

- 1. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting duct, to minimize bends and deflections required for proper entrances. Use box extension if required to match depths of duct, and seal joint between box and extension as recommended by manufacturer.
- 2. Unless otherwise indicated, support units on level bed of crushed stone or gravel, graded from 1/2 inch (12.5 mm) sieve to No. 4 (4.75 mm) sieve and compacted to same density as adjacent undisturbed earth.
- 3. Elevation: In paved areas and trafficways, set cover flush with finished grade. Set covers of other handholes 1 inch (25 mm) above finished grade.
- 4. Install handholes and boxes with bottom below frost line.
- 5. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in enclosure.
- 6. Field cut openings for duct in accordance with enclosure manufacturer's published instructions. Cut wall of enclosure with tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.
- 7. For enclosures installed in asphalt paving and subject to occasional, nondeliberate, heavy-vehicle loading, form and pour concrete ring encircling, and in contact with enclosure entry, and with top surface screeded to top of box cover frame. Bottom of ring must rest on compacted earth.
 - a. Concrete: 3000 psi (20 kPa), 28-day strength, complying with Section 033000 "Cast-in-Place Concrete," with troweled finish.
 - b. Dimensions: 10 inch wide by 12 inch deep (250 mm wide by 300 mm deep) unless otherwise noted on drawings.
- 8. Ground handholes and boxes in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

3.8 FIELD QUALITY CONTROL

- A. Tests and Inspections:
 - 1. Demonstrate capability and compliance with requirements on completion of installation of underground duct, duct bank, and utility structures.
 - 2. Pull solid aluminum or wood test mandrel through duct to prove joint integrity and adequate bend radii, and test for out-of-round duct. Provide minimum 12 inch (300 mm) long mandrel equal to duct size minus 1/4 inch (6 mm). If obstructions are indicated, remove obstructions and retest.
 - 3. Test manhole and handhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Section 260526 "Grounding and Bonding for Electrical Systems."
- B. Nonconforming Work:
 - 1. Underground ducts, raceways, and structures will be considered defective if they do not pass tests and inspections.
 - 2. Correct deficiencies and retest as specified above to demonstrate compliance.
- C. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports.

3.9 CLEANING

- A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of duct until duct cleaner indicates that duct is clear of dirt and debris. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.
- B. Clean internal surfaces of manholes, including sump, and building interiors affected by Work.
 - 1. Sweep floor, removing dirt and debris.
 - 2. Remove foreign material.

END OF SECTION 260543

SECTION 260544 - SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Round sleeves.
 - 2. Rectangular sleeves.
 - 3. Sleeve-seal systems.
 - 4. Sleeve-seal fittings.
 - 5. Grout.
 - 6. Pourable sealants.
 - 7. Foam sealants.
- B. Related Requirements:
 - 1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
 - 2. Section 078413 "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

1.2 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 ROUND SLEEVES

- A. Steel Wall Sleeves:
 - 1. Grainger, Armstrong, Garlock or approved equal
 - 2. General Characteristics: ASTM A53/A53M, Type E, Grade B, Schedule 40, zinc coated, plain ends and integral waterstop.
- B. Cast-Iron Wall Sleeves:
 - 1. Grainger, Armstrong, Garlock or approved equal
 - 2. General Characteristics: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop.
- C. PE or PP Molded Sleeves:
 - 1. Platt Electric Supply, Carlon, or approved equal.
 - 2. General Characteristics: Removable, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

2.2 SLEEVE-SEAL SYSTEMS

- A. Metraflex, Roxtec, or approved equal.
- B. General Characteristics: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable or between raceway and cable.
- C. Options:
 - 1. Sealing Elements: EPDM rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 - 2. Pressure Plates: Carbon steel.
 - 3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

2.3 SLEEVE-SEAL FITTINGS

- A. Metraflex, Garlock, or approved equal.
- B. General Characteristics: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit must have plastic or rubber waterstop collar with center opening to match piping OD.

2.4 GROUT

- A. General Characteristics: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.
 - 1. Standard: ASTM C1107/C1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
 - 2. Design Mix: 5000 psi (34.5 MPa), 28-day compressive strength.
 - 3. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 INSTALLATION OF SLEEVES FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

- A. Sleeves for Conduits Penetrating Above-Grade, Non-Fire-Rated, Concrete and Masonry-Unit Floors and Walls:
 - 1. Interior Penetrations of Non-Fire-Rated Walls and Floors:
 - a. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall or floor so no voids remain. Tool exposed surfaces smooth; protect material while curing.
 - b. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 079200 "Joint Sealants."
 - 2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
 - 3. Size pipe sleeves to provide 1/4 inch (6.4 mm) annular clear space between sleeve and raceway or cable, unless sleeve-seal system is to be installed.

4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
- B. Sleeves for Conduits Penetrating Non-Fire-Rated Wall Assemblies:
 1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
 2. Seal space outside of sleeves with approved joint compound for wall assemblies.
- C. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.
- D. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel or cast-iron pipe sleeves and mechanical sleeve-seal systems. Size sleeves to allow for 1 inch (25 mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
- E. Underground, Exterior-Wall and Floor Penetrations:
 1. Install steel or cast-iron pipe sleeves with integral waterstops. Size sleeves to allow for 1 inch (25 mm) annular clear space between raceway or cable and sleeve for installing sleeve-seal system. Install sleeve during construction of floor or wall.

3.2 INSTALLATION OF SLEEVE-SEAL SYSTEMS

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at raceway entries into building.
- B. Install type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

END OF SECTION 260544

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SECTION 260553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Labels.
 - 2. Bands and tubes.
 - 3. Tapes and stencils.
 - 4. Tags.
 - 5. Signs.
 - 6. Cable ties.
 - 7. Miscellaneous identification products.
- B. Related Requirements:
 - 1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.

1.2 ACTION SUBMITTALS

- A. Product Data:
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for electrical identification products.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Comply with ASME A13.1 and IEEE C2.
- B. Comply with 29 CFR 1910.144 for color identification of hazards; 29 CFR 1910.145 for danger, caution, warning, and safety instruction signs and tags; and the following:
 - 1. Fire-protection and fire-alarm equipment, including raceways, must be finished, painted, or suitably marked safety red.
 - 2. Ceiling-mounted hangers, supports, cable trays, and raceways must be finished, painted, or suitably marked safety yellow where less than 7.7 ft (2.3 m) above finished floor.
- C. Signs, labels, and tags required for personnel safety must comply with the following standards:
 - 1. Safety Colors: NEMA Z535.1.
 - 2. Facility Safety Signs: NEMA Z535.2.
 - 3. Safety Symbols: NEMA Z535.3.
 - 4. Product Safety Signs and Labels: NEMA Z535.4.
 - 5. Safety Tags and Barricade Tapes for Temporary Hazards: NEMA Z535.5.

- D. Comply with NFPA 70E and Section 260573.19 "Arc-Flash Hazard Analysis" requirements for arc-flash warning labels.
- E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, must comply with UL 969.
- F. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
 - 1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

2.2 COLOR AND LEGEND REQUIREMENTS

- A. Raceways and Cables Carrying Circuits at 1000 V or Less:
 - 1. Black letters on orange field.
 - 2. Legend: Indicate voltage and system or service type.
- B. Color-Coding for Phase- and Voltage-Level Identification, 1000 V or Less: Use colors listed below for ungrounded service, feeder and branch-circuit conductors.
 - 1. Color must be factory applied or field applied for sizes larger than 8 AWG if authorities having jurisdiction permit.
 - 2. Colors for 208Y/120 V Circuits:
 - a. Phase A: Black.
 - b. Phase B: Red.
 - c. Phase C: Blue.
 - d. Neutral: White
 - 3. Colors for 240 V Circuits:
 - a. Phase A: Black.
 - b. Phase B: Red.
 - c. Neutral: White or White with Red Stripe
 - 4. Colors for 480Y/277 V Circuits:
 - a. Phase A: Brown.
 - b. Phase B: Orange.
 - c. Phase C: Yellow.
 - d. Neutral: Gray or White with Orange Stripe
 - 5. Color for Equipment Grounds: Green.
 - 6. Colors for Isolated Grounds: Green with two or more yellow stripes.
- C. Raceways and Cables Carrying Circuits at More Than 1000 V:
 - 1. Black letters on orange field.
 - 2. Legend: "DANGER - CONCEALED HIGH VOLTAGE WIRING."
- D. Warning Label Colors:
 - 1. Identify system voltage with black letters on orange background.
- E. Warning labels and signs must include, but are not limited to, the following legends:
 - 1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."

2. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 3 FEET MINIMUM."
 3. Multiple Equipment Voltages: "DANGER – MULTIPLE VOLTAGE SOURCES. ISOLATE ALL SOURCES BEFORE SERVICING"
 4. Arc Flash Hazard: "WARNING – ARC FLASH AND SHOCK HAZARD. APPROPRIATE PPE AND TOOLS REQUIRED WHEN WORKING ON THIS EQUIPMENT."
- F. Equipment Identification Labels:
1. Black letters on white field.

2.3 LABELS

- A. Vinyl Wraparound Labels: Preprinted, flexible labels laminated with clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing label ends. Minimum ¼ inch black letters on white background.
- B. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeves, with diameters sized to suit diameters and that stay in place by gripping action. Minimum ¼ inch black letters on white background.
- C. Self-Adhesive Wraparound Labels: Preprinted, 3 mil (0.08 mm) thick, vinyl flexible label with acrylic pressure-sensitive adhesive.
 1. Self-Lamination: Clear; UV-, weather- and chemical-resistant; self-laminating, protective shield over legend. Labels sized such that clear shield overlaps entire printed legend. Minimum ¼ inch black letters on white background.
 2. Marker for Labels:
 - a. Machine-printed, permanent, waterproof, black ink recommended by printer manufacturer.
- D. Self-Adhesive Labels: Polyester or Vinyl, thermal, transfer-printed, 3 mil (0.08 mm) 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 inch (37 by 150 mm) for raceway and conductors.
 - b. 3-1/2 by 5 inch (76 by 127 mm) for equipment.
 - c. As required by authorities having jurisdiction.

2.4 BANDS AND TUBES

Utilize bands and tubes only where conductors are not available in colors indicated, due to size, prewired cable, or other reason: Install identifying bands ¾" wide of appropriate colors as noted in this specification within six inches (6") and twelve inches (12") of each end and at a maximum of five foot (5') intervals along wireways, at back of panelboards, and wherever conductors are accessible.

- A. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeves, 2 inch (50 mm) long, with diameters sized to suit diameters and that stay in place by gripping action.
- B. Heat-Shrink Preprinted Tubes: Flame-retardant polyolefin tubes with machine-printed identification labels, sized to suit diameter and shrunk to fit firmly. Full shrink recovery occurs at maximum of 200 deg F (93 deg C). Comply with UL 224.

2.5 TAPES AND STENCILS

Use tape labels only for identification of individual wall switches, receptacles, and control device stations.

- A. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.
- B. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; not less than 3 mil (0.08 mm) thick by 1 to 2 inch (25 to 50 mm) wide; compounded for outdoor use.
- C. Underground-Line Warning Tape:
 - 1. Tape:
 - a. Recommended by manufacturer for method of installation and suitable to identify and locate underground electrical and communications utility lines.
 - b. Printing on tape must be permanent and may not be damaged by burial operations.
 - c. Tape material and ink must be chemically inert and not be subject to degradation when exposed to acids, alkalis, and other destructive substances commonly found in soils.
 - 2. Color and Printing:
 - a. Comply with APWA Uniform Color Code using NEMA Z535.1 safety colors.
 - b. Inscriptions for Red Tapes: "CAUTION BURIED ELECTRIC LINE BELOW"
 - c. Inscriptions for Orange Tapes: "CAUTION BURIED FIBER OPTIC LINE BELOW" or "CAUTION BURIED COMMUNICATION LINE BELOW"
 - 3. Tape Type I:
 - a. Pigmented polyolefin, bright colored, continuous-printed on one side with inscription of utility, compounded for direct-burial service.
 - b. Width: 3 inch (75 mm).
 - c. Thickness: 4 mil (0.1 mm).
 - d. Weight: 18.5 lb/1000 sq. ft (9.0 kg/100 sq. m).
 - e. Tensile in accordance with ASTM D882: 30 lbf (133.4 N) and 2500 psi (17.2 MPa).
- D. Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height must be 2 inch (25 mm) .

2.6 TAGS

- A. Metal Tags: Brass or aluminum, 2 by 2 by 0.05 inch (50 by 50 by 1.3 mm), with stamped legend, punched for use with self-locking cable tie fastener.

- B. Nonmetallic Preprinted Tags: Polyethylene tags, .015 inch (0.38 mm) thick, color-coded for phase and voltage level, with factory printed permanent designations; punched for use with self-locking cable tie fastener.
 - a. Machine-printed, permanent, waterproof, black ink marker recommended by printer manufacturer.

2.7 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 (6.4 mm) grommets in corners for mounting.
 - 3. Nominal Size: 7 by 10 inch (180 by 250 mm).
- B. Metal-Backed Butyrate Signs:
 - 1. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs, with 0.0396 inch (1 mm) galvanized-steel backing, punched and drilled for fasteners, and with colors, legend, and size required for application.
 - 2. 1/4 inch (6.4 mm) grommets in corners for mounting.
 - 3. Nominal Size: 10 by 14 inch (250 by 360 mm).
- C. Laminated Acrylic or Melamine Plastic Signs:
 - 1. Engraved legend.
 - 2. Thickness:
 - a. For signs up to 20 sq. inch (129 sq. cm), minimum 1/16 inch (1.6 mm) thick.
 - b. For signs larger than 20 sq. inch (129 sq. cm), 1/8 inch (3.2 mm) thick.
 - c. Engraved legend with black letters on white face.
 - d. Punched or drilled for mechanical fasteners with 1/4 inch (6.4 mm) grommets in corners for mounting or Self-adhesive.
 - e. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.

2.8 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 (5 mm).
 - 2. Tensile Strength at 73 deg F (23 deg C) in accordance with ASTM D638: 12,000 psi (82.7 MPa).
 - 3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).
 - 4. Color: Black, except where used for color-coding.

2.9 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Retain paint system applicable for surface material and location (exterior or interior).

- B. Fasteners for Labels and Signs: Self-tapping, stainless steel screws or stainless steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Self-Adhesive Identification Products: Before applying electrical identification products, clean substrates of substances that could impair bond, using materials and methods recommended by manufacturer of identification product.

3.2 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. Install identifying devices before installing acoustical ceilings and similar concealment.
- C. Verify identity of item before installing identification products.
- D. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and operation and maintenance manual.
- E. Apply identification devices to surfaces that require finish after completing finish work.
- F. Install signs with approved legend to facilitate proper identification, operation, and maintenance of electrical systems and connected items.
- G. All circuit conductors of the same color shall be connected to the same ungrounded feeder conductor throughout the installation.
- H. Conductors of different system voltage shall not enter the same raceway, box, gutter, or other types of enclosures unless specifically noted on drawings or by equipment manufacturer. If required, utilize alternate wire color coding for neutrals noted in this specification.
- I. Power and lighting circuits in panelboard gutters, pull boxes, outlet and junction boxes, and at load connection: Provide wire markers on each conductor and Identify with branch circuit or feeder number.
- J. For system control wires at control panel and load connection, provide wire markers on each conductor and identify with number as indicated on manufacturer's schematic and interconnection diagrams or manufacturer's shop drawings.
- K. For Fire Alarm System: Coordinate with fire alarm specification Section 284621.11.
- L. System Identification for Raceways and Cables under 1000 V: Identification must completely encircle cable or conduit. Place identification of two-color markings in contact, side by side.

1. Secure tight to surface of conductor, cable, or raceway.
- M. System Identification for Raceways and Cables over 1000 V: Identification must completely encircle cable or conduit. Place adjacent identification of two-color markings in contact, side by side.
1. Secure tight to surface of conductor, cable, or raceway.
- N. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.
- O. Emergency Operating Instruction Signs: Install instruction signs with white legend on red background with minimum 3/8 inch (10 mm) high letters for emergency instructions at equipment used for power transfer.
- P. Elevated Components: Increase sizes of labels, signs, and letters to those appropriate for viewing from floor.
- Q. Accessible Fittings for Raceways: Identify cover of junction and pull box of the following systems with wiring system legend and system voltage. System legends must be as follows:
1. "EMERGENCY POWER."
 2. "POWER."
 3. "UPS."
 4. "INVERTER"
- R. Vinyl Wraparound Labels:
1. Secure tight to surface of raceway or cable at location with high visibility and accessibility.
 2. Attach labels that are not self-adhesive type with clear vinyl tape, with adhesive appropriate to location and substrate.
- S. Self-Adhesive Wraparound Labels: Secure tight to surface at location with high visibility and accessibility.
- T. Marker Tapes: Secure tight to surface at location with high visibility and accessibility.
- U. Self-Adhesive Vinyl Tape: Secure tight to surface at location with high visibility and accessibility.
- V. Tape and Stencil: Comply with requirements in painting Sections for surface preparation and paint application.
- W. Floor Marking Tape: Apply stripes to finished surfaces following manufacturer's instructions.
- X. Underground Line Warning Tape:
1. During backfilling of trenches, install continuous underground-line warning tape directly above cable or raceway at 6 to 8 inch (150 to 200 mm) below finished grade. Use multiple tapes where width of multiple lines installed in common trench or concrete envelope exceeds 16 inch (400 mm) overall.
 2. Install underground-line warning tape for direct-buried cables and cables in raceways.
- Y. Metal Tags:

1. Place in location with high visibility and accessibility.
 2. Secure using UV-stabilized cable ties.
- Z. Nonmetallic Preprinted Tags:
1. Place in location with high visibility and accessibility.
 2. Secure using UV-stabilized cable ties.
- AA. Baked-Enamel Signs:
1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to location and substrate.
 2. Unless otherwise indicated, provide single line of text with 1/2 inch (13 mm) high letters on minimum 1-1/2 inch (38 mm) high sign; where two lines of text are required, use signs minimum 2 inch (50 mm) high.
- BB. Metal-Backed Butyrate Signs:
1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to location and substrate.
 2. Unless otherwise indicated, provide single line of text with 1/2 inch (13 mm) high letters on 1-1/2 inch (38 mm) high sign; where two lines of text are required, use labels 2 inch (50 mm) high.
- CC. Laminated Acrylic or Melamine Plastic Signs:
1. Attach signs that are not self-adhesive type with mechanical fasteners appropriate to location and substrate.
 2. Unless otherwise indicated, provide single line of text with 1/2 inch (13 mm) high letters on 1-1/2 inch (38 mm) high sign; where two lines of text are required, use labels 2 inch (50 mm) high.
- DD. Cable Ties: General purpose, for attaching tags, except as listed below:
1. Outdoors: UV-stabilized nylon.
 2. In Spaces Handling Environmental Air: Plenum rated.

3.3 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 of high visibility. Identify by system and circuit designation.
- C. Accessible Fittings for Raceways and Cables within Buildings: Identify cover of junction and pull box of the following systems with self-adhesive labels containing wiring system legend and system voltage. System legends must be as follows:
 1. "EMERGENCY POWER."
 2. "POWER."
 3. "UPS."
 4. "INVERTER"

- D. Power-Circuit Conductor Identification, 1000 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use vinyl wraparound labels to identify phase.
 - 1. Locate identification at changes in direction, at penetrations of walls and floors, at 50 ft (15 m) maximum intervals in straight runs, and at 25 ft (7.6 m) maximum intervals in congested areas.
- E. Power-Circuit Conductor Identification, More Than 1000 V: For conductors in vaults, pull and junction boxes, manholes, and handholes, use nonmetallic preprinted tags colored and marked to indicate phase, and separate tag with circuit designation.
- F. Control-Circuit Conductor Identification: For conductors and cables in pull and junction boxes, manholes, and handholes, use self-adhesive labels with conductor or cable designation, origin, and destination.
- G. Control-Circuit Conductor Termination Identification: For identification at terminations, provide heat-shrink preprinted tubes or self-adhesive labels with conductor designation.
- H. Conductors to Be Extended in Future: Attach marker tape to conductors and list source.
- I. Auxiliary Electrical Systems Conductor Identification: Self-adhesive vinyl tape that is uniform and consistent with system used by manufacturer for factory-installed connections.
 - 1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
- J. Locations of Underground Lines: Underground-line warning tape for power, lighting, communication, and control wiring and optical-fiber cable.
- K. Concealed Raceways and Duct Banks, More Than 1000 V, within Buildings: Apply floor marking tape to the following finished surfaces:
 - 1. Floor surface directly above conduits running beneath and within 12 inch (300 mm) of floor that is in contact with earth or is framed above unexcavated space.
 - 2. Wall surfaces directly external to raceways concealed within wall.
 - 3. Accessible surfaces of concrete envelope around raceways in vertical shafts, exposed in building, or concealed above suspended ceilings.
- L. Workspace Indication: Apply floor marking tape or tape and stencil to finished surfaces. Show working clearances in direction of access to live parts. Workspace must comply with NFPA 70 and 29 CFR 1926.403 unless otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.
- M. Instructional Signs: Self-adhesive labels, including color code for grounded and ungrounded conductors.
- N. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive labels, Baked-enamel warning signs, or Metal-backed, butyrate warning signs.
 - 1. Apply to exterior of door, cover, or other access.
 - 2. For equipment with multiple power or control sources, apply to door or cover of equipment, including, but not limited to, the following:
 - a. Power-transfer switches.
 - b. Controls with external control power connections.

- O. Arc Flash Warning Labeling: Self-adhesive labels.
- P. Operating Instruction Signs: Self-adhesive labels, Baked-enamel warning signs, or Metal-backed, butyrate warning signs.
- Q. Emergency Operating Instruction Signs: Self-adhesive labels, Baked-enamel warning signs, or Metal-backed, butyrate warning signs with white legend on red background with minimum 3/8 inch (10 mm) high letters for emergency instructions at equipment used for power transfer.
- R. Equipment Identification Labels:
 - 1. Indoor Equipment: Self-adhesive labels, Baked-enamel warning signs, or Metal-backed, butyrate warning signs.
 - 2. Outdoor Equipment: Laminated acrylic or melamine sign or Stenciled legend 4 inch (100 mm) high.
 - 3. Equipment to Be Labeled:
 - a. Panelboards: Typewritten directory of circuits in location provided by panelboard manufacturer. Panelboard identification must be in form of self-adhesive, engraved, laminated acrylic or melamine label.
 - b. Enclosures and electrical cabinets.
 - c. Access doors and panels for concealed electrical items.
 - d. Switchboards.
 - e. Transformers: Label that includes tag designation indicated on Drawings for transformer, feeder, and panelboards or equipment supplied by secondary.
 - f. Substations.
 - g. Emergency system boxes and enclosures.
 - h. Enclosed switches.
 - i. Enclosed circuit breakers.
 - j. Enclosed controllers.
 - k. Variable-speed controllers.
 - l. Push-button stations.
 - m. Power-transfer equipment.
 - n. Contactors.
 - o. Battery-inverter units.
 - p. Battery racks.
 - q. Monitoring and control equipment.

END OF SECTION 260553

SECTION 260923 - LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Time switches.
 - 2. Outdoor photoelectric switches.
 - 3. Daylight-harvesting controls.
 - 4. Business occupancy and vacancy (occupant) sensors.
- B. Related Requirements:
 - 1. Section 260010 "Supplemental Requirements for Electrical" specifies additional coordination, scheduling, sequencing, submittal, and installation requirements applicable to the Work for electrical, communications, and electronic safety and security systems on the Project, including wiring methods.
 - 2. Section 260526 "Grounding and Bonding for Electrical Systems" specifies grounding and bonding of lighting control devices referenced by this Section.
 - 3. Section 260529 "Hangers and Supports for Electrical Systems" specifies hangers and supports referenced by this Section.
 - 4. Section 260553 "Identification for Electrical Systems" specifies electrical equipment labels and warning signs referenced by this Section.
 - 5. Section 262726 "Wiring Devices" for wall-box dimmers and manual light switches.

1.2 DEFINITIONS

- A. DPDT: Double pole double throw.
- B. DPST: Double pole single throw.
- C. N.C.: Normally closed.
- D. N.O.: Normally open.
- E. PIR: Passive infrared.
- F. SPDT: Single pole double throw.
- G. SPST: Single pole single throw.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Product Listing: Include copy of unexpired approval letter, on letterhead of qualified electrical testing agency, certifying product's compliance with specified listing criteria.

- a. If listed manufacturer differs from selling manufacturer, indicate relationship between entities on submittal. Clearly indicate which entity warrants product performance and fitness for purpose.
 - b. Listing criteria identified in approval letter must match specified listing criteria. UL label indicating approval of equipment's enclosure is not considered approval of equipment for intended application.
 - c. Product identification in approval letter must match product branding and model numbers in submittal. Approval letters for discontinued or superseded products are unacceptable for submitted product.
- B. Shop Drawings: Prepare and submit the following:
 - 1. Show installation details for the following:
 - a. Occupancy sensors.
 - b. Vacancy sensors.
 - 2. Interconnection diagrams showing field-installed wiring.
 - 3. Diagrams for power, signal, and control wiring.
- C. Field quality-control reports.

1.4 INFORMATIONAL SUBMITTALS

- A. Manufacturer's published instructions.
- B. Field Reports:
 - 1. Manufacturer's field reports for field quality-control support.
 - 2. Field reports for software and firmware upgrades.

1.5 CLOSEOUT SUBMITTALS

- A. Warranty documentation.

1.6 QUALIFICATIONS

- A. Electrical Power Testing (EPT) Technician III: Possessing active NICET EPT Level III certification. Able to manage switching procedures, conduct tests of complex equipment, analyze test and equipment data, plan a job, and lead a team. Has experience performing NFPA 70B, IEEE, and NETA electrical tests.
- B. Electrical Power Testing (EPT) Technician IV: Possessing active NICET EPT Level IV certification. Able to conduct tests of complex metering and relay systems; evaluate tests, test equipment, test results, and power system performance; recommend actions to maintain or improve system performance; and lead multiteam projects.
- C. Electrical Power Testing and Inspecting Agency: Entities possessing active credentials from qualified electrical testing laboratory recognized by authorities having jurisdiction.
 - 1. On-site electrical testing supervisors must possess active NICET EPT Technician III certification.

- D. Lighting Testing and Inspecting Agency: Entity possessing active qualifications specified in Section 014000 "Quality Requirements" with documented training and experience with testing and inspecting lighting installations in accordance with applicable IES standards.

1.7 WARRANTY

- A. Provide manufacturer's standard warranty.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Regulatory Requirements:
 - 1. Products or components 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. Must comply with CCR Title 24.

2.2 OUTDOOR PHOTOELECTRIC SWITCHES

- A. UL WJFX - Solid-State Outdoor Photoelectric Switch, Flexible Mounting:
 - 1. Lutron, Siemens, Leviton, Sensor Switch, WattStopper, Nexlight, Lithonia, Lightolier, ETC Architectural Control Systems, Hubbell, Crestron Electronics, or approved equal
 - 2. Source Limitations: Obtain products from single manufacturer.
 - 3. 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. Plug-in, Locking-Type Photocontrols: UL CCN WJFX, including UL 773.
 - 4. Standard Features:
 - a. Solid state, with SPST to operate connected relay, contactor coils, or microprocessor input; and compatible with drivers and LED lamps.
 - b. 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.
 - c. Light-Level Monitoring Range: 1.5 to 10 fc (16.14 to 108 lx), with an adjustment for turn-on and turn-off levels within that range.
 - d. Time Delay: Fifteen-second minimum, to prevent false operation.
 - e. Surge Protection: Metal-oxide varistor.
 - f. Mounting: Twist lock complies with ANSI C136.10, with base-and-stem mounting or stem-and-swivel mounting accessories as required to direct sensor to the north sky exposure from same source and manufacturer as switch.
 - g. Failure Mode: Luminaire stays ON.
- B. UL WJFX - Solid-State Outdoor Photoelectric Switch, Luminaire-Mounted:
 - 1. Lutron, Siemens, Leviton, Sensor Switch, WattStopper, Nexlight, Lithonia, Lightolier, ETC Architectural Control Systems, Hubbell, Crestron Electronics, or approved equal
 - 2. Source Limitations: Obtain products from single manufacturer.

3. 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. Plug-in, Locking-Type Photocontrols: UL CCN WJFX, including UL 773.

2.3 DAYLIGHT-HARVESTING CONTROLS

A. UL WJCT - Daylight-Harvesting Control Switch:

1. Lutron, Siemens, Leviton, Sensor Switch, WattStopper, Nexlight, Lithonia, Lightolier, ETC Architectural Control Systems, Hubbell, Crestron Electronics, or approved equal
2. Source Limitations: Obtain products from single manufacturer.
3. 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.
4. Standard Features:
 - a. System operates indoor lighting.
 - b. Ceiling-Mounted Switching Controls:
 - 1) Solid-state, light-level sensor unit, with integrated power pack, that detects changes in indoor lighting levels that are perceived by the eye.
 - c. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F (0 to 49 deg C).
 - d. Sensor Output:
 - 1) Contacts rated to operate the associated power pack, complying with UL 773A. Sensor must be powered by the power pack.
 - e. Sensor Type: Open loop.
 - f. Zone: Multi.
 - g. Power Pack:
 - 1) Dry contacts rated for 20 A LED load at 120 and 277 V(ac), for 13 A tungsten at 120 V(ac), and for 1 hp at 120 V(ac). Sensor has 24 V(dc), 150 mA, Class 2 power source.
 - a) LED status lights to indicate load status.
 - b) Plenum rated.
 - h. General Space Sensors Light-Level Monitoring Range: 10 to 200 fc (108 to 2152 lx), with an adjustment for turn-on and turn-off levels within that range.
 - i. Atrium Space Sensors Light-Level Monitoring Range: 100 to 1000 fc (1080 to 10 800 lx), with an adjustment for turn-on and turn-off levels within that range.
 - j. Skylight Sensors Light-Level Monitoring Range: 1000 to 10 000 fc (10 800 to 108 000 lx), with an adjustment for turn-on and turn-off levels within that range.
 - k. Time Delay: Adjustable from 5 to 300 seconds to prevent cycling.
 - l. Set-Point Adjustment: Equip with deadband adjustment of 25, 50, and 75 percent above the "on" set point, or provide with separate adjustable "on" and "off" set points.
 - m. Test Mode: User selectable, overriding programmed time delay to allow settings check.
 - n. Control Load Status: User selectable to confirm that load wiring is correct.

- o. Indicator: Two digital displays to indicate the beginning of on-off cycles.
- 5. Sequence of Operation: As daylight increases, the lights are turned off at a predetermined level. As daylight decreases, the lights are turned on at a predetermined level.
 - a. Lighting control set point is based on two lighting conditions:
 - 1) When no daylight is present.
 - 2) When significant daylight is present (target level).
 - b. System programming is done with two handheld, remote-control tools.

B. UL WJCT - Daylight-Harvesting Digital Control Dimmer:

- 1. Lutron, Siemens, Leviton, Sensor Switch, WattStopper, Nexlight, Lithonia, Lightolier, ETC Architectural Control Systems, Hubbell, Crestron Electronics, or approved equal
- 2. Source Limitations: Obtain products from single manufacturer.
- 3. 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.
- 4. 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 integrated power pack mounted on luminaire, 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 (120 to 640 lx).
 - f. Power Pack: Digital controller capable of accepting three 8PSJ inputs with one output rated for 20 A LED load at 120 and 277 V(ac), for 13 A LED at 120 and 277 V(ac), and for 1 hp at 120 V(ac). Sensor has 24 V(dc) Class 2 power source.
 - 1) With integral current monitoring.
 - 2) Compatible with digital addressable lighting interface.
 - 3) Plenum rated.
- 5. 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.

2.4 BUSINESS OCCUPANCY AND VACANCY (OCCUPANT) SENSORS

A. Passive-Infrared (PIR) Occupant:

- 1. Lutron, Siemens, Leviton, Sensor Switch, WattStopper, Nexlight, Lithonia, Lightolier, ETC Architectural Control Systems, Hubbell, Crestron Electronics, or approved equal
- 2. Source Limitations: Obtain products from single manufacturer.

3. 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. Photoelectric Controls: UL CCN WJCT, including UL 773A.
 - b. Energy Management Equipment: UL CCN PAZX, including UL 916 or UL 60730-1.
 - c. Intrusion Detection Units: UL CCN ANSR, including UL 639.
4. Standard Features:
 - a. Ceiling-mounted, solid-state indoor occupancy and vacancy sensors.
 - b. Integrated power pack.
 - c. Hardwired connection to switch and BAS.
 - d. Sensor Output: Sensor is powered from the power pack.
 - e. Power: Line voltage.
 - f. Power Pack: Dry contacts rated for 20 A LED load at 120 and 277 V(ac), for 13 A tungsten at 120 V(ac), and for 1 hp at 120 V(ac). Sensor has 24 V(dc), 150 mA, Class 2 power source.
 - g. Mounting:
 - 1) Sensor: Suitable for mounting in any position in a standard device box or outlet box.
 - 2) Relay: Externally mounted through a 1/2 inch (13 mm) knockout in a standard electrical enclosure.
 - 3) Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.
 - h. Indicator: Digital display, to show when motion is detected during testing and normal operation of sensor.
 - i. Bypass Switch: Override the "on" function in case of sensor failure.
 - j. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc (21.5 to 2152 lx); turn lights off when selected lighting level is present.
 - k. Detector Sensitivity: Detect occurrences of 6 inch (150 mm) minimum movement of any portion of a human body that presents a target of not less than 36 sq. inch (23 200 sq. mm).
 - 1) Detection Coverage (Room, Ceiling Mounted): Detect occupancy anywhere in a circular area of 1000 sq. ft (93 sq. m) when mounted on a 96 inch (2440 mm) high ceiling.
 - 2) Detection Coverage (Corridor, Ceiling Mounted): Detect occupancy within 90 ft (27.4 m) when mounted on a 10 ft (3 m) high ceiling.
5. Operation:
 - a. Occupancy Sensor: Unless otherwise indicated, turn lights on when coverage area is occupied, and turn them off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
 - b. Vacancy Sensor: Unless otherwise indicated, lights are manually turned on and sensor turns lights off when the room is unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
 - c. Combination Sensor: Unless otherwise indicated, sensor must be programmed to turn lights on when coverage area is occupied and turn them off when unoccupied, or to turn off lights that have been manually turned on; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.

B. Wall-Switch Occupancy Sensor:

1. Lutron, Siemens, Leviton, Sensor Switch, WattStopper, Nexlight, Lithonia, Lightolier, ETC Architectural Control Systems, Hubbell, Crestron Electronics, or approved equal
2. Source Limitations: Obtain products from single manufacturer.
3. 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. Photoelectric Controls: UL CCN WJCT, including UL 773A.
 - b. Energy Management Equipment: UL CCN PAZX, including UL 916 or UL 60730-1.
 - c. Intrusion Detection Units: UL CCN ANSR, including UL 639.
4. Standard Features:
 - a. Automatic-wall-switch occupant sensor with manual on-off switch, suitable for mounting in single gang switchbox using hardwired connection.
 - 1) Occupant 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.
 - 2) Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F (0 to 49 deg C).
 - 3) Switch Rating: Not less than 800 VA LED load at 120 V, 1200 VA LED load at 277 V, and 800 W incandescent.
 - b. Standard Range: 180-degree field of view, field adjustable from 180 to 40 degrees; with a minimum coverage area of 900 sq. ft (84 sq. m).
 - c. Sensing Technology: PIR.
 - d. Switch Type: Single pole, manual "on," automatic "off." Single pole, field-selectable automatic "on," or manual "on," automatic "off."
 - e. Capable of controlling load in three-way application.
 - f. Voltage: Match circuit voltage.
 - g. Ambient-Light Override: Concealed, field-adjustable, light-level sensor from 10 to 150 fc (108 to 1600 lx). Switch prevents lights from turning on when light level is higher than set point of sensor.
 - h. Time Delay:
 - 1) Concealed, field-adjustable, "off" time-delay selector at up to 30 minutes.
 - i. Adaptive Technology: Self-adjusting circuitry detects and memorizes usage patterns of the space and helps eliminate false "off" switching.
 - j. Color: White.
 - k. Faceplate: Color matched to switch.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine lighting control devices before installation. Reject lighting control devices that are wet, moisture damaged, or mold damaged.
- B. Examine walls and ceilings for suitable conditions where lighting control devices will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 SELECTION OF CONDUCTORS AND CABLES

- A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than 12 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than 18 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than 14 AWG. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.3 INSTALLATION OF LIGHTING CONTROL DEVICES

- A. Comply with manufacturer's published instructions.
- B. Reference Standards for Installation: Unless more stringent installation requirements are specified in the Contract Documents or manufacturer's published instructions, comply with the following:
 - 1. Electrical Construction: ICC IBC, ICC IFB, NFPA 1, NFPA 70, and NECA NEIS 1.
 - 2. Electrical Maintenance: NFPA 70B.
 - 3. Electrical Safety: NFPA 70E.
 - 4. Grounding and Bonding: NECA NEIS 331 and Article 250 of NFPA 70.
 - 5. Communications Work: BICSI N1.
 - 6. Life Safety and Means of Egress Work: NFPA 101.
 - 7. Work in Basements and Other Developed Subterranean Spaces: NFPA 520.
 - 8. Consult Architect for resolution of conflicting requirements.
- C. Special Installation Techniques:
 - 1. 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.
 - 2. 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. Installation of Wiring:
 - a. Wiring Method: Comply with Section 260519 "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size is 3/4 inch.
 - 1) Do not mix low voltage and high voltage conductors in the same conduit.
 - 2) Ensure low voltage conduits or control wires do not run parallel to current carrying conduits.
 - b. Wiring within Enclosures: Separate power-limited and nonpower-limited conductors in accordance with conductor manufacturer's published instructions.
 - c. Size conductors in accordance with lighting control device manufacturer's published 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.

- D. Interfaces with Other Work:
 - 1. Identification: Provide labels for lighting control devices and associated electrical equipment.
 - a. Identify field-installed conductors, interconnecting wiring, and components.
 - b. Label each enclosure with engraved metal or laminated-plastic nameplate.
 - c. Identify controlled circuits in lighting contactors.
 - d. Identify circuits or luminaires controlled by photoelectric and occupant sensors at each sensor.
 - e. Label time switches and contactors with a unique designation.

3.4 FIELD QUALITY CONTROL

- A. Administrant for Electrical Power Tests and Inspections:
 - 1. Engage qualified electrical testing and inspecting agency to administer and perform tests and inspections.
- B. Administrant for Lighting Tests and Inspections:
 - 1. Engage qualified lighting testing and inspecting agency to administer and perform tests and inspections.
- C. 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.
- D. 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.
- E. Field Quality-Control Reports: Collect, assemble, and submit test and inspection reports.

3.5 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting lighting control devices to suit actual occupied conditions. Provide up to two visits to the Project site during other-than-normal occupancy hours for this purpose. Some of the Work may be required during hours of darkness.
 - 1. For occupant and motion sensors, verify operation at outer limits of detector range. Set time delay to suit Owner's operations.
 - 2. For daylighting controls, adjust set points and deadband controls to suit Owner's operations.
 - 3. Align high-bay occupant sensors using manufacturer's laser aiming tool.

END OF SECTION 260923

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SECTION 262416 - PANELBOARDS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Power panelboards for distribution.
 - 2. Lighting and appliance branch-circuit panelboards.
 - 3. Disconnecting and overcurrent protective devices.
- B. Related Requirements:
 - 1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.

1.2 DEFINITIONS

- A. GFEP: Ground-fault equipment protection.
- B. MCCB: Molded-case circuit breaker.
- C. VPR: Voltage protection rating.
- D. SPD: Surge Protective Device

1.3 ACTION SUBMITTALS

- A. Product Data:
 - 1. Power panelboards.
 - 2. Lighting and appliance branch-circuit panelboards.
 - 3. Disconnecting and overcurrent protective devices.
 - 4. Include materials, switching and overcurrent protective devices, SPDs, accessories, and components indicated.
 - 5. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: For each panelboard and related equipment.
 - 1. Include dimensioned plans, elevations, sections, and details.
 - 2. Show tabulations of installed devices with nameplates, conductor termination sizes, equipment features, and ratings.
 - 3. Detail enclosure types including mounting and anchorage, environmental protection, knockouts, corner treatments, covers and doors, gaskets, hinges, and locks.
 - 4. Detail bus configuration, current, and voltage ratings.
 - 5. Short-circuit current rating of panelboards and overcurrent protective devices.
 - 6. Include evidence of listing, by qualified electrical testing laboratory recognized by authorities having jurisdiction, for SPD as installed in panelboard.

7. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
8. Include wiring diagrams for power, signal, and control wiring.
9. Key interlock scheme drawing and sequence of operations.

- C. Field Quality-Control Submittals:
1. Field quality-control reports.

1.4 INFORMATIONAL SUBMITTALS

- A. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.
- B. Manufacturers' Published Instructions: Record copy of official installation and testing instructions issued to Installer by manufacturer for the following:
1. Recommended procedures for installing panelboards.
 2. Recommended torque settings for bolted connections on panelboards.
 3. Recommended temperature range for energizing panelboards.
- C. Sample warranties.

1.5 CLOSEOUT SUBMITTALS

- A. Warranty documentation.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Spare Parts: Furnish to Owner spare parts, for repairing panelboards, that are packaged with protective covering for storage on-site and identified with labels describing contents. Include the following:
1. Keys: 1 key for each panel and two spares for each type of panelboard cabinet lock. All panels shall be keyed alike or to Owners keying system.
 2. Circuit Breakers Including GFCI and GFEP Types: Two spares for each panelboard.
 3. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
 4. Fuses for Fused Power-Circuit Devices: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.
- B. Handle and prepare panelboards for installation in accordance with NEMA PB 1.

1.8 WARRANTY

- A. Special Installer Extended Warranty: Installer warrants that fabricated and installed panelboards perform in accordance with specified requirements and agrees to repair or replace components or products that fail to perform as specified within extended-warranty period.
 - 1. Extended-Warranty Period: Two years from date of Substantial Completion; full coverage for labor, materials, and equipment.

PART 2 - PRODUCTS

2.1 PANELBOARDS AND LOAD CENTERS COMMON REQUIREMENTS

- A. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.
- B. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70, by qualified electrical testing agency recognized by authorities having jurisdiction, and marked for intended location and application.
- C. Comply with NEMA PB 1.
- D. Comply with NFPA 70.
- E. Enclosures: Flush-mounted, dead-front cabinets.
 - 1. Rated for environmental conditions at installed location.
 - a. Indoor Dry and Clean Locations: UL 50E, Type 1
 - 2. Height: 7 ft (2.13 m) maximum.
 - 3. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box. Trims must cover live parts and may have no exposed hardware.
 - 4. Provide full 180° door swings on panels where required to maintain egress path.
 - 5. Skirt for Surface-Mounted Panelboards: Same gage and finish as panelboard front with flanges for attachment to panelboard, wall, and ceiling or floor.
 - 6. Finishes:
 - a. Panels and Trim: galvanized steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
 - b. Back Boxes: Galvanized steel.
- F. Phase, Neutral, and Ground Buses:
 - 1. Material: Hard-drawn copper, 98 percent conductivity.
 - a. Plating must run entire length of bus.
 - b. Bus must be fully rated for entire length.
 - c. Sub-feed and feed-through lugs designed for use for both copper and aluminum conductors. Sub-feed shall signify that lugs are tapped ahead of buses and feed-through shall signify that lugs are tapped on load side of the main and buses.
 - 2. Interiors must be factory assembled into unit. Replacing switching and protective devices may not disturb adjacent units or require removing main bus connectors.

3. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.
 4. Full-Sized Neutral: Equipped with full-capacity bonding strap for service entrance applications. Mount electrically isolated from enclosure.
 5. Do not mount neutral bus in gutter.
- G. Conductor Connectors: Suitable for use with conductor material and sizes.
1. Material: Hard-drawn copper, 98 percent conductivity.
 2. Terminations must allow use of 75 deg C rated conductors without derating.
 3. Size: Lugs suitable for indicated conductor sizes, with additional gutter space, if required, for larger conductors.
 4. Main and Neutral Lugs: Mechanical type, with lug on neutral bar for each pole in panelboard.
 5. Ground Lugs and Bus-Configured Terminators: Mechanical type, with lug on bar for each pole in panelboard.
- H. Future Devices: Panelboards must have mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.
1. Minimum Percentage of Future Space Capacity: 20 percent.
- I. Panelboard Short-Circuit Current Rating:
1. Fully rated to interrupt symmetrical short-circuit current available at terminals. Assembly listed, by qualified electrical testing laboratory recognized by authorities having jurisdiction, for 100 percent interrupting capacity.
 - a. Panelboards and overcurrent protective devices rated 240 V or less must have short-circuit ratings as shown on Drawings, but not less than 10 000 A(rms) symmetrical.
 - b. Panelboards and overcurrent protective devices rated above 240 V and less than 600 V must have short-circuit ratings as shown on Drawings, but not less than 14 000 A(rms) symmetrical.
- J. Surge Suppression: Factory installed as integral part of indicated panelboards, complying with UL 1449 SPD Type 1.

2.2 POWER PANELBOARDS

- A. Eaton Cutler Hammer, I-T-E Siemens, General Electric, Square D, or approved equal.
- B. Listing Criteria: NEMA PB 1, distribution type.
- C. Mains: as indicated on drawings.
- D. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: Plug-in circuit breakers or Bolt-on circuit breakers.
- E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers or Plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.
- F. Branch Overcurrent Protective Devices: Fused switches.

- G. Contactors in Main Bus: NEMA ICS 2, Class A, electrically or mechanically held, general-purpose controller, with same short-circuit interrupting rating as panelboard.

2.3 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

- A. Eaton Cutler Hammer, I-T-E Siemens, General Electric, Square D, or approved equal.
- B. Listing Criteria: NEMA PB 1, lighting and appliance branch-circuit type.
- A. Mains: as indicated on drawings.
- B. Branch Overcurrent Protective Devices: Plug-in or Bolt-on circuit breakers, replaceable without disturbing adjacent units.
- C. Contactors in Main Bus: NEMA ICS 2, Class A, electrically or mechanically held, general-purpose controller, with same short-circuit interrupting rating as panelboard.
- D. Doors: Door-in-door construction with concealed hinges; secured with flush or multipoint latch with tumbler lock; keyed alike. Outer door must permit full access to panel interior. Inner door must permit access to breaker operating handles and labeling, but current carrying terminals and bus must remain concealed.

2.4 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. Eaton Cutler Hammer, I-T-E Siemens, General Electric, Square D, or approved equal.
- B. MCCB: Comply with UL 489, with interrupting capacity to meet available fault currents.
 - 1. Thermal-Magnetic Circuit Breakers:
 - a. Inverse time-current element for low-level overloads.
 - b. Instantaneous magnetic trip element for short circuits.
 - c. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
 - 2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
 - 3. Electronic Trip Circuit Breakers:
 - a. RMS sensing.
 - b. Field-replaceable rating plug or electronic trip.
 - c. Digital display of settings, trip targets, and indicated metering displays.
 - d. Multi-button keypad to access programmable functions and monitored data.
 - e. Ten-event, trip-history log. Each trip event must be recorded with type, phase, and magnitude of fault that caused trip.
 - f. Integral test jack for connection to portable test set or laptop computer.
 - 4. MCCB Features and Accessories:
 - a. Standard frame sizes, trip ratings, and number of poles.
 - b. Breaker handle indicates tripped status.
 - c. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
 - d. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.

- e. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in on or off position.
 - f. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.
 - g. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage with field-adjustable 0.1- to 0.6-second time delay.
 - h. Rating Plugs: Three-pole breakers with ampere ratings greater than 600A must have interchangeable rating plugs or electronic adjustable trip units.
 - i. Auxiliary Contacts: One, SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts and "b" contacts operate in reverse of circuit-breaker contacts.
 - j. Alarm Switch: Single-pole, normally open contact that actuates only when circuit breaker trips.
 - k. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key must be removable only when circuit breaker is in off position.
 - l. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground-fault protection function with other upstream or downstream devices.
 - m. Multipole units enclosed in single housing with single handle or factory assembled to operate as single unit.
- C. Fused Switch: NEMA KS 1, Type HD; clips to accommodate specified fuses; lockable handle.
- 1. Fuses and Spare-Fuse Cabinet: Comply with requirements specified in Section 262813 "Fuses."
 - 2. Fused Switch Features and Accessories:
 - a. Standard ampere ratings and number of poles.
 - b. Mechanical cover interlock with manual interlock override, to prevent opening of cover when switch is in on position. Interlock must prevent switch from being turned on with cover open. Operating handle must have lock-off means with provisions for three padlocks.
 - c. Auxiliary Contacts: Two normally open and normally closed contact(s) that operate with switch handle operation.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify actual conditions with field measurements prior to ordering panelboards to verify that equipment fits in allocated space in, and comply with, minimum required clearances specified in NFPA 70.
- B. Receive, inspect, handle, and store panelboards in accordance with NEMA PB 1.1.
- C. Examine panelboards before installation. Reject panelboards that are damaged, rusted, or have been subjected to water saturation.
- D. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Comply with manufacturer's published instructions.
- B. Reference Standards:
 - 1. Panelboards: Unless more stringent requirements are specified in Contract Documents or manufacturers' published instructions, comply with NEMA PB 1.1.
 - 2. Consult Architect for resolution of conflicting requirements.
- C. Special Techniques:
 - 1. Equipment Mounting:
 - a. Attach panelboard to vertical finished or structural surface behind panelboard.
 - 2. Mount top of trim 7.5 ft (2.3 m) above finished floor unless otherwise indicated on drawings.
 - 3. Mount panelboard cabinet plumb and rigid without distortion of box.
 - 4. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.
 - 5. Install overcurrent protective devices and controllers not already factory installed.
 - a. Set field-adjustable, circuit-breaker trip ranges.
 - b. Tighten bolted connections and circuit breaker connections using calibrated torque wrench or torque screwdriver in accordance with manufacturer's published instructions.
 - 6. Make grounding connections and bond neutral for services and separately derived systems to ground. Make connections to grounding electrodes, separate grounds for isolated ground bars, and connections to separate ground bars.
 - 7. Install filler plates in unused spaces.
 - 8. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.
 - 9. Mount spare fuse cabinet in accessible location.
- D. Interfaces with Other Work:
 - 1. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

3.3 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; install warning signs complying with requirements in Section 260553 "Identification for Electrical Systems."
- B. Panelboard Nameplates: Label each panelboard with nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- C. Install warning signs complying with requirements in Section 260553 "Identification for Electrical Systems" identifying source of remote circuit.
- D. Panelboard Label: Manufacturer's name and trademark, voltage, amperage, number of phases, and number of poles must be located on interior of panelboard door.

- E. Breaker Labels: Faceplate must list current rating, UL and IEC certification standards, and AIC rating.
- F. Circuit Directory:
 - 1. Provide typed or computer generated directory card inside panelboard door, mounted in transparent card holder or metal frame with transparent protective cover.
 - a. Circuit directory must identify specific purpose with detail sufficient to distinguish it from other circuits.
 - 2. Create directory to indicate installed circuit loads after balancing panelboard loads; incorporate Owner's final room designations. Obtain approval before installing. Handwritten directories are not acceptable. Install directory inside panelboard door.

3.4 WARNING

- A. Provide Label on exterior of all panels served by the generator: "Warning Panel is Served by Two Sources (Emergency & Normal). Both Sources Shall Be Locked OFF Before Servicing."

3.5 FIELD QUALITY CONTROL

- A. Acceptance Testing Preparation:
 - 1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
 - a. Measure steady state load currents at each panelboard feeder. Should the difference at any panelboard between phases exceed 20 percent, rearrange circuits in the panelboard to balance the phase loads within 20 percent.
 - b. Take care to maintain proper phasing for multi-wire branch circuits.
- B. Visual and Mechanical Inspection:
 - 1. Inspect for physical damage, proper alignment, anchorage, and grounding. Check proper installation and tightness of connections for circuit breakers, fusible switches, and fuses. Stub 4 empty one-inch conduits to accessible location above, ceiling and below floor, from each recessed panelboard that has accessible ceilings above and/or below the panel.
 - 2. Provide completed Hazard Warning Labels mounted on each panel.
 - 3. Finish painting of flush panelboards and individually mounted breakers shall be as specified in Division 09 Section "Painting".
 - 4. Properly support backboards, and panels. Coordinate with Division 06 Section "Rough Carpentry", to provide blocking as required.
 - 5. Provide filler plates for unused spaces in panelboards.
 - 6. Install panelboards plumb and properly secured. Recessed panels shall be flush with wall finishes.
- C. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection and electrical test for low-voltage air circuit breakers stated in NETA ATS, Paragraph 7.6 Circuit Breakers. Certify compliance with test parameters.
 - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 - 3. Perform the following infrared scan tests and inspections and prepare reports:

- a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.
 - b. Follow-up Infrared Scanning: Perform additional follow-up infrared scan of each panelboard 11 months after date of Substantial Completion.
 - c. Instruments and Equipment:
 - 1) Use infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
- D. Nonconforming Work:
 - 1. Panelboards will be considered defective if they do not pass tests and inspections.
 - 2. Remove and replace defective units and retest.
- E. Collect, assemble, and submit test and inspection reports, including certified report that identifies panelboards included and that describes scanning results, with comparisons of two scans. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.6 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly and lubricate as recommended by manufacturer.
- B. Set field-adjustable circuit-breaker trip ranges as indicated.
- C. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes. Prior to making circuit changes to achieve load balancing, inform Architect of effect on phase color coding.
 - 1. Measure loads during period of normal facility operations.
 - 2. Perform circuit changes to achieve load balancing outside normal facility operation schedule or at times directed by Architect. Avoid disrupting services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
 - 3. After changing circuits to achieve load balancing, recheck loads during normal facility operations. Record load readings before and after changing circuits to achieve load balancing.
 - 4. Tolerance: Maximum difference between phase loads, within panelboard, may not exceed 20 percent.

3.7 PROTECTION

- A. Temporary Heating: Prior to energizing panelboards, apply temporary heat to maintain temperature in accordance with manufacturer's published instructions.

END OF SECTION 262416

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SECTION 262726 - WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. General-use switches, dimmer switches, and fan-speed controller switches.
 - 2. General-grade duplex straight-blade receptacles.
 - 3. Ground-fault protective device receptacles.
 - 4. Connectors, cords, and plugs.
- B. Related Requirements:
 - 1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.
 - 2. Section 013100 "Project Management and Coordination" for preinstallation conference procedures.
 - 3. Section 260923 "Lighting Control Devices" for occupancy sensors, timers, control-voltage switches, and control-voltage dimmers.

1.2 ACTION SUBMITTALS

- A. Product Data to include manufacturer's catalog information showing dimensions, colors and configurations:
 - 1. Toggle switches.
 - 2. Dimmer switches.
 - 3. Duplex straight-blade receptacles.
 - 4. Receptacles with GFCI device.
 - 5. Cord connectors.
- B. Shop Drawings:
 - 1. Wiring diagrams for duplex straight-blade receptacles with integral switching means.
- C. Field Quality-Control Submittals:
 - 1. Field quality-control reports.

1.3 INFORMATIONAL SUBMITTALS

- A. Manufacturers' Instructions: Record copy of official installation and testing instructions issued to Installer by manufacturer for the following:
 - 1. Dimmers.
 - 2. Single straight-blade receptacles.
 - 3. Duplex straight-blade receptacles.
 - 4. Duplex straight-blade receptacles with integral switching means.
 - 5. Receptacles with GFCI device.

- B. Sample warranties.
- C. Special Tools:
 - 1. Proprietary equipment and software required to maintain, repair, adjust, or implement future changes to controlled receptacles.
 - 2. Proprietary equipment required to maintain, repair, adjust, or implement future changes to cord connectors.

1.4 WARRANTY FOR DEVICES

- 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.
Initial Warranty Period: Five years from date of Substantial Completion; full coverage for labor, materials, and equipment.

PART 2 - PRODUCTS

2.1 GENERAL-USE SWITCHES, DIMMER SWITCHES, FAN-SPEED CONTROLLER SWITCHES, AND MOTOR RATED SWITCHES

- A. Toggle Switch
 - 1. Cooper, Hubbell, Leviton, or approved equal.
 - 2. 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.
 - 3. General Characteristics:
 - a. Reference Standards: UL CCN WMUZ and UL 20.
 - b. All switches to be industrial grade.
 - 4. Options:
 - a. Device Color: White.
 - b. Configuration:
 - 1) General-duty, 120-277 V, 20 A, single pole, double pole, three way, and four way.
 - 5. Accessories:
 - a. Cover Plate: 0.060 inch (1.5 mm) 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.
- B. Dimmer Switch:
 - 1. Cooper, Hubbell, Leviton, or approved equal.
 - 2. Switch Type: Single Pole
 - 3. 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.

4. General Characteristics:
 - a. Reference Standards: UL CCN EOYX and UL 1472 lister dimmer.
5. Options:
 - a. Device Color: White.
 - b. Switch Style: Toggle.
 - c. Dimming Control Style: Slide
6. Accessories:
 - a. Cover Plate: 0.060 inch (1.5 mm) 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.

2.2 GENERAL-GRADE DUPLEX STRAIGHT-BLADE RECEPTACLES

- A. Duplex Straight-Blade Receptacle:
 1. Cooper, Hubbell, Leviton, or approved equal.
 2. 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.
 3. General Characteristics:
 - a. Reference Standards: UL CCN RTRT and UL 498.
 4. Options:
 - a. Device Color: White.
 - b. Configuration:
 - 1) General-duty, NEMA 5-20R.
 - 2) Industrial Grade, Motor Rated NEMA 5-15R and NEMA 5-20R
 5. Accessories:
 - a. Cover Plate: 0.060 inch (1.5 mm) 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.
- B. Wired Full-Controlled Duplex Straight-Blade Receptacle:
 1. Cooper, Hubbell, Leviton, or approved equal.
 2. 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.
 3. General Characteristics:
 - a. Reference Standards: UL CCN RTXI and UL Subject 498B.
 4. Options:
 - a. Device Color: White.
 - b. Configuration: NEMA 5-20R.
 5. Accessories:
 - a. Cover Plate: 0.060 inch (1.5 mm) 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.

- C. Wired Half-Controlled Duplex Straight-Blade Receptacle:
 - 1. Cooper, Hubbell, Leviton, or approved equal.
 - 2. 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.
 - 3. General Characteristics:
 - a. Reference Standards: UL CCN RTX1 and UL Subject 498B.
 - 4. Options:
 - a. Device Color: White.
 - b. Configuration: NEMA 5-20R.
 - 5. Accessories:
 - a. Cover Plate: 0.060 inch (1.5 mm) 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.

2.3 RECEPTACLES WITH GROUND-FAULT PROTECTIVE DEVICES

- A. General-Grade, Duplex Straight-Blade Receptacle with GFCI Device:
 - 1. Cooper, Hubbell, Leviton, or approved equal.
 - 2. 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.
 - 3. General Characteristics:
 - a. Reference Standards: UL CCN KCXS, UL 498, and UL 943.
 - 4. Options:
 - a. Device Color: White.
 - b. Configuration: NEMA 5-20R
 - 5. Accessories:
 - a. Cover Plate: 0.060 inch (1.5 mm) 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. Receptacles:
 - 1. Verify that receptacles to be procured and installed for Owner-furnished equipment are compatible with mating attachment plugs on equipment.

3.2 INSTALLATION OF SWITCHES

- A. Comply with manufacturer's instructions.

1. Install switches with OFF position down.
 - a. Locate close to door frame on latch side of door, or beyond swing of door where appropriate.
 - b. Switches indicated in the same area at the same mounting heights shall be ganged together under a common plate.
 2. Do not share neutral conductor on load side of dimmers.
 3. Provide matching blank face plate for all unused wall boxes.
 4. Install devices and plates vertical and plumb. Boxes shall be flush with finished surface.
- 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. Consult Architect for resolution of conflicting requirements.
- C. Identification:
1. Identify cover or cover plate for device with panelboard identification and circuit number in accordance with Section 260553 "Identification for Electrical Systems."

3.3 INSTALLATION OF STRAIGHT-BLADE RECEPTACLES

- A. Comply with manufacturer's instructions.
1. Provide matching blank face plate for all unused wall boxes.
 2. Install receptacles with grounding pole on top.
 3. When GFCI receptacles are called for on the Drawings, each outlet shall be provided with a GFCI device. Using a GFCI receptacle to protect "down-stream" receptacles will not be permitted.
 4. Where devices such as duplex receptacles, telephone/data outlets, and TV outlets are shown adjacent to each other, then group all under a common face plate.
 5. Install devices and plates vertical and plumb. Boxes shall be flush with finished surface.
- 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 in accordance with Section 260553 "Identification for Electrical Systems."

3.4 INSTALLATION OF CONNECTORS, CORDS, AND PLUGS

- A. Comply with manufacturer's instructions.

3.5 FIELD QUALITY CONTROL OF SWITCHES

- A. Tests and Inspections:
 - 1. Perform tests and inspections in accordance with manufacturers' instructions.
- B. Nonconforming Work:
 - 1. Unit 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.

3.6 FIELD QUALITY CONTROL OF STRAIGHT-BLADE RECEPTACLES

- 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.

3.7 FIELD QUALITY CONTROL OF LOCKING RECEPTACLES

- 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.
 - 6. Perform additional installation and maintenance inspections and diagnostic tests in accordance with NECA NEIS 130 and manufacturers' instructions.
- 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.

3.8 SYSTEM STARTUP FOR SWITCHES

- A. Perform startup service.
 - 1. Complete installation and startup checks for momentary switches, dimmer switches, and fan-speed controller switches in accordance with manufacturer's instructions.

3.9 ADJUSTING

- A. Occupancy Adjustments for Controlled Receptacles: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.10 PROTECTION

- A. Devices:
 - 1. 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.
 - 2. 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.
- B. Cord Reels and Fittings:
 - 1. After installation, protect cord reels and fittings 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.
- C. Connectors, Cords, and Plugs:
 - 1. After installation, protect connectors, cords, and plugs 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

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SECTION 262813 - FUSES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Condition apply to this Section.

1.2 SUMMARY

- A. Section Includes:
 - 1. Cartridge fuses rated 600 V ac and less for use in the following:
 - a. Control circuits.
 - b. Motor-control centers.
 - c. Panelboards.
 - d. Switchboards.
 - e. Enclosed controllers.
 - f. Enclosed switches.
 - 2. Spare-fuse cabinets.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for spare-fuse cabinets. Include the following for each fuse type indicated:
 - 1. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017700 "Closeout Procedures," include the following:
 - 1. Ambient temperature adjustment information.
 - 2. Current-limitation curves for fuses with current-limiting characteristics.
 - 3. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse used on the Project. Submit in PDF format.
 - 4. Coordination charts and tables and related data.

1.5 MAINTENANCE MATERIAL SUBMITTALS

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

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Ferraz Shawmut (Gould), Bussman, Eaton, Littelfuse, or approved equal.
- B. Source Limitations: Obtain fuses, for use within a specific product or circuit, from single source from single manufacturer.

2.2 CARTRIDGE FUSES

- A. ;l.Characteristics: NEMA FU 1, current-limiting, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.
 - 1. Type RK-1: 250-V, zero- to 600-A rating, 200 kAIC.
 - 2. Type RK-5: 250-V, zero- to 600-A rating, 200 kAIC.
 - 3. Type J: 600-V, zero- to 600-A rating, 200 kAIC.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with NEMA FU 1 for cartridge fuses.
- D. Comply with NFPA 70.
- E. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

2.3 SPARE-FUSE CABINET

- A. Characteristics: Wall-mounted steel unit with full-length, recessed piano-hinged door and key-coded cam lock and pull. Locate in Main Electrical Room.
 - 1. Size: Adequate for storage of spare fuses specified with 25 percent spare capacity minimum.
 - 2. Finish: Gray, baked enamel.
 - 3. Identification: "SPARE FUSES" in 1-1/2-inch- (38-mm-) high letters on exterior of door.
 - 4. Fuse Pullers: For each size of fuse, where applicable and available, from fuse manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.
- B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.

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

3.2 FUSE APPLICATIONS

- A. Cartridge Fuses:
 - 1. Feeders: Class J, time delay.
 - 2. Motor Branch Circuits: Class RK1 or Class RK5, time delay.
 - 3. Provide open-fuse indicator fuses or fuse covers with open fuse indication where available.

3.3 INSTALLATION

- A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.
- B. Install spare-fuse cabinet(s) in location as indicated in the field by Architect and Construction Manager

3.4 IDENTIFICATION

- A. Install labels complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems" and indicating fuse replacement information inside of door of each fused switch and adjacent to each fuse block, socket, and holder.

END OF SECTION 262813

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SECTION 262816 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Fusible switches.
 - 2. Nonfusible switches.
 - 3. Shunt trip switches.
 - 4. Molded-case circuit breakers (MCCBs).
 - 5. Molded-case switches.
 - 6. Enclosures.
- B. Related Requirements:
 - 1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.

1.2 DEFINITIONS

- A. GFEP: Ground-fault circuit-interrupter for equipment protection.
- B. GFLS: Ground-fault circuit-interrupter for life safety.
- C. SPDT: Single pole, double throw.

1.3 ACTION SUBMITTALS

- A. Product Data:
 - 1. For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include nameplate ratings, dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
 - 2. Enclosure types and details for types other than UL 50E, Type 1.
 - 3. Current and voltage ratings.
 - 4. Short-circuit current ratings (interrupting and withstand, as appropriate).
 - 5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
- B. Shop Drawings: For enclosed switches and circuit breakers.
 - 1. Include plans, elevations, sections, details, and attachments to other work.
 - 2. Include wiring diagrams for power, signal, and control wiring.
- C. Field Quality-Control Submittals:
 - 1. Field quality-control reports.

1.4 INFORMATIONAL SUBMITTALS

- A. Sample warranties.

1.5 CLOSEOUT SUBMITTALS

- A. Warranty documentation.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Spare Parts: Furnish to Owner spare parts, for repairing enclosed switches and circuit breakers, that are packaged with protective covering for storage on-site and identified with labels describing contents. Include the following:
 - 1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
 - 2. Fuse Pullers: Two for each size and type.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

- A. Source Limitations: Obtain products from single manufacturer.
- B. Electrical Components, Devices, and Accessories: 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.

2.2 FUSIBLE SWITCHES

- A. Eaton Cutler Hammer, Siemens, General Electric, Square D., or approved equal
- B. Type HD, Heavy Duty:
 - 1. Single throw.
 - 2. Poles as indicated on drawings.
 - 3. 240 or 600 V(ac) as required by the particular circuit
 - 4. Ampere rating as indicated on drawings.
 - 5. UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified fuses.
 - 6. Lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- C. Accessories:
 - 1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
 - 2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
 - 3. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.

4. Lugs: Mechanical or Compression type, suitable for number, size, and conductor material.

2.3 NONFUSIBLE SWITCHES

- A. Eaton Cutler Hammer, Siemens, General Electric, Square D., or approved equal
- B. Type GD, General Duty, Three Pole, Single Throw, 240 V(ac), 600 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept two padlocks, and interlocked with cover in closed position.
- C. Type HD, Heavy Duty, Three Pole, Single Throw, 240 or 600 V(ac) as indicated on drawings, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- D. Accessories:
 1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
 2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
 3. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
 4. Lugs: Mechanical or Compression type, suitable for number, size, and conductor material.

2.4 MOLDED-CASE CIRCUIT BREAKERS

- A. Eaton Cutler Hammer, Siemens, General Electric, Square D., or approved equal
- B. Circuit breakers must be constructed using glass-reinforced insulating material. Current carrying components must be completely isolated from handle and accessory mounting area.
- C. Circuit breakers must have toggle operating mechanism with common tripping of all poles, which provides quick-make, quick-break contact action. Circuit-breaker handle must be over center, be trip free, and reside in tripped position between on and off to provide local trip indication. Circuit-breaker escutcheon must be clearly marked on and off in addition to providing international I/O markings. Equip circuit breaker with push-to-trip button, located on face of circuit breaker to mechanically operate circuit-breaker tripping mechanism for maintenance and testing purposes.
- D. Maximum ampere rating and UL, IEC, or other certification standards with applicable voltage systems and corresponding interrupting ratings must be clearly marked on face of circuit breaker. Circuit breakers must be 100 percent rated.
- E. MCCBs must be equipped with device for locking in isolated position.
- F. Lugs must be suitable for 75 deg C rated wire.
- G. Standard: Comply with UL 489 with required interrupting capacity for available fault currents.

- H. Thermal-Magnetic Circuit Breakers: Inverse time-current thermal element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
- I. Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.
- J. Electronic Trip Circuit Breakers: Field-replaceable rating plug, RMS sensing, with the following field-adjustable settings:
 - 1. Instantaneous trip.
 - 2. Long- and short-time pickup levels.
 - 3. Long- and short-time time adjustments.
 - 4. Ground-fault pickup level, time delay, and I-squared t response.
- K. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller, and let-through ratings less than NEMA FU 1, RK-5.
- L. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker and trip activation on fuse opening or on opening of fuse compartment door.
- M. Features and Accessories:
 - 1. Standard frame sizes, trip ratings, and number of poles.
 - 2. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.
 - 3. Alarm Switch: One NO contact that operates only when circuit breaker has tripped.
 - 4. Auxiliary Contacts: One SPDT switch with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
 - 5. Lugs: Mechanical or Compression type, suitable for number, size, trip ratings, and conductor material.
 - 6. Ground-Fault Protection: Comply with UL 1053; integrally mounted, self-powered or remote-mounted and powered type as required for type of switch with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.
 - 7. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key must be removable only when circuit breaker is in off position.
 - 8. Zone-Selective Interlocking: Integral with electronic or ground-fault trip unit as required by breaker type; for interlocking ground-fault protection function.
 - 9. Electrical Operator: Provide remote control for on, off, and reset operations.

2.5 MOLDED-CASE SWITCHES

- A. Eaton Cutler Hammer, Siemens, General Electric, Square D., or approved equal
- B. Description: MCCB with fixed, high-set instantaneous trip only, and short-circuit withstand rating equal to equivalent breaker frame size interrupting rating.

- C. Standard: Comply with UL 489 with interrupting capacity to comply with available fault currents.
- D. Features and Accessories:
 - 1. Standard frame sizes and number of poles.
 - 2. Lugs:
 - a. Mechanical or Compression type, suitable for number, size, trip ratings, and conductor material.
 - b. Lugs must be suitable for 75 deg C rated wire.
 - 3. Ground-Fault Protection: Comply with UL 1053; remote-mounted and powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.
 - 4. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
 - 5. Auxiliary Contacts: One SPDT switch with "a" and "b" contacts; "a" contacts mimic switch contacts, "b" contacts operate in reverse of switch contacts.
 - 6. Alarm Switch: One NO contact that operates only when switch has tripped.
 - 7. Key Interlock Kit: Externally mounted to prohibit switch operation; key must be removable only when switch is in off position.
 - 8. Zone-Selective Interlocking: Integral with ground-fault shunt trip unit; for interlocking ground-fault protection function.
 - 9. Electrical Operator: Provide remote control for on, off, and reset operations.

2.6 ENCLOSURES

- A. Enclosed Switches and Circuit Breakers: UL 489, NEMA KS 1, UL 50E, and UL 50, to comply with environmental conditions at installed location.
- B. Enclosure Finish: Enclosure must be finished with gray baked enamel paint, electrodeposited on cleaned, phosphatized steel (UL 50E Type 1) unless otherwise noted on drawings.
- C. Conduit Entry: UL 50E Types 4, 4X, and 12 enclosures may not contain knockouts. UL 50E Types 7 and 9 enclosures must be provided with threaded conduit openings in both endwalls.
- D. Operating Mechanism: Circuit-breaker operating handle must be externally operable with operating mechanism being integral part of box, not cover. Cover interlock mechanism must have externally operated override. Override may not permanently disable interlock mechanism, which must return to locked position once override is released. Tool used to override cover interlock mechanism must not be required to enter enclosure in order to override interlock.
- E. Enclosures designated as UL 50E Type 4, 4X stainless steel, 12, or 12K must have dual cover interlock mechanism to prevent unintentional opening of enclosure cover when circuit breaker is ON and to prevent turning circuit breaker ON when enclosure cover is open.
- F. UL 50E Type 7/9 enclosures must be furnished with breather and drain kit to allow their use in outdoor and wet location applications.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.
 - 1. Commencement of work will indicate Installer's acceptance of areas and conditions as satisfactory.

3.2 SELECTION OF ENCLOSURES

- A. Indoor, Dry and Clean Locations: UL 50E, Type 1.
- B. Outdoor Locations: UL 50E, Type 3R

3.3 INSTALLATION

- A. Comply with manufacturer's published instructions.
- B. Special Techniques:
 - 1. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.
 - 2. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.
 - 3. Temporary Lifting Provisions: Remove temporary lifting of eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
 - 4. Install fuses in fusible devices.

3.4 IDENTIFICATION

- A. Comply with requirements in Section 260553 "Identification for Electrical Systems."
 - 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
 - 2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.5 FIELD QUALITY CONTROL

- A. Coordinate "Tests and Inspections" Paragraph below with "Qualifications" and articles in Section 260010 "Supplemental Requirements for Electrical."
- B. Tests and Inspections for Switches:
 - 1. Visual and Mechanical Inspection:
 - a. Inspect physical and mechanical condition.
 - b. Inspect anchorage, alignment, grounding, and clearances.

- c. Verify that unit is clean.
 - d. Verify blade alignment, blade penetration, travel stops, and mechanical operation.
 - e. Verify that fuse sizes and types match the Specifications and Drawings.
 - f. Verify that each fuse has adequate mechanical support and contact integrity.
 - g. Inspect bolted electrical connections for high resistance using one of the following methods:
 - 1) Use low-resistance ohmmeter.
 - a) Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from those of similar bolted connections by more than 50 percent of lowest value.
 - 2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method in accordance with manufacturer's published data or NETA ATS Table 100.12.
 - a) Bolt-torque levels must be in accordance with manufacturer's published data. In absence of manufacturer's published data, use NETA ATS Table 100.12.
 - h. Verify that operation and sequencing of interlocking systems is as described in the Specifications and shown on Drawings.
 - i. Verify correct phase barrier installation.
 - j. Verify lubrication of moving current-carrying parts and moving and sliding surfaces.
2. Electrical Tests:
- a. Perform resistance measurements through bolted connections with low-resistance ohmmeter. Compare bolted connection resistance values to values of similar connections. Investigate values that deviate from adjacent poles or similar switches by more than 50 percent of lowest value.
 - b. Measure contact resistance across each switchblade fuseholder. Drop values may not exceed high level of manufacturer's published data. If manufacturer's published data are not available, investigate values that deviate from adjacent poles or similar switches by more than 50 percent of lowest value.
 - c. Perform insulation-resistance tests for one minute on each pole, phase-to-phase and phase-to-ground with switch closed, and across each open pole. Apply voltage in accordance with manufacturer's published data. In absence of manufacturer's published data, use Table 100.1 from NETA ATS. Investigate values of insulation resistance less than those published in Table 100.1 or as recommended in manufacturer's published data.
 - d. Measure fuse resistance. Investigate fuse-resistance values that deviate from each other by more than 15 percent.
 - e. Perform ground fault test in accordance with NETA ATS Section 7.14 "Ground Fault Protection Systems, Low-Voltage."
- C. Nonconforming Work:
- 1. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.
 - 2. Remove and replace defective units and retest.
- D. Collect, assemble, and submit test and inspection reports.
- 1. Test procedures used.
 - 2. Include identification of each enclosed switch and circuit breaker tested and describe test results.
 - 3. List deficiencies detected, remedial action taken, and observations after remedial action.

- E. Manufacturer Services:
 - 1. Engage factory-authorized service representative to support field tests and inspections.

3.6 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

3.7 PROTECTION

- A. After installation, protect enclosed switches and circuit breakers 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.

3.8 MAINTENANCE

- A. Infrared Scanning of Enclosed Switches and Breakers: Two months after Substantial Completion, perform infrared scan of joints and connections. Remove covers so joints and connections are accessible to portable scanner. Take visible light photographs at same locations and orientations as infrared scans for documentation to ensure follow-on scans match same conditions for valid comparison.
 - 1. Instruments and Equipment: Use infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 - 2. Follow-up Infrared Scanning: Perform two follow-up infrared scans of enclosed switches and breakers, one at four months and another at 11 months after Substantial Completion.
 - 3. Instrument: Use infrared-scanning device designed to measure temperature or to detect significant deviations from normal values. Provide documentation of device calibration.
 - 4. Report: Prepare certified report that identifies units checked and that describes scanning results. Include notation of deficiencies detected, remedial actions taken, and scanning observations after remedial action.

END OF SECTION 262816

SECTION 265119 - LED INTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Downlight.
 - 2. Recessed, linear.
 - 3. Strip light.
 - 4. Materials.
 - 5. Luminaire support.
- B. Related Requirements:
 - 1. Section 260923 "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.

1.3 DEFINITIONS

- A. CCT: Correlated color temperature.
- B. CRI: Color Rendering Index.
- C. Fixture: See "Luminaire."
- D. IP: International Protection or Ingress Protection Rating.
- E. LED: Light-emitting diode.
- F. Lumen: Measured output of lamp and luminaire, or both.
- G. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Arrange in order of luminaire designation.
 - 2. Include data on features, accessories, and finishes.
 - 3. Include physical description and dimensions of luminaires.
 - 4. Include emergency lighting units, including batteries and chargers.

5. Include life, output (lumens, CCT, and CRI), and energy-efficiency data.
 6. Photometric data and adjustment factors based on laboratory tests, complying with IES "Lighting Measurements Testing and Calculation Guides" for each luminaire type. The adjustment factors shall be for lamps and accessories identical to those indicated for the luminaire as applied in this Project.
 - a. 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.
- B. Product Schedule: For luminaires and lamps. Use same designations indicated on Drawings.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing laboratory providing photometric data for luminaires.
- B. Product Certificates: For each type of luminaire.
- C. Product Test Reports: For each type of luminaire, for tests performed by manufacturer and witnessed by a qualified testing agency.
- D. Sample warranty.
- E. If submitting alternatives to the listed basis of design luminaires, provide point by point lighting calculations with selected fixtures to ensure required project light levels are met.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For luminaires and lighting systems to include in operation and maintenance manuals.
 1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Lamps: Ten for every 100 of each type and rating installed. Furnish at least one of each type.
 2. Diffusers and Lenses: One for every 100 of each type and rating installed. Furnish at least one of each type.
 3. Globes and Guards: One for every 20 of each type and rating installed. Furnish at least one of each type.

1.8 QUALITY ASSURANCE

- A. Luminaire Photometric Data Testing Laboratory Qualifications:
 1. Luminaire manufacturer's laboratory that is accredited under the NVLAP for Energy Efficient Lighting Products.

- B. Provide luminaires from a single manufacturer for each luminaire type.
- C. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

1.10 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 PERFORMANCE REQUIREMENTS

- A. Ambient Temperature: 41 to 104 deg F (5 to 40 deg C).
 - 1. Relative Humidity: Zero to 95 percent.
- B. Altitude: Sea level to 1000 feet (300 m).

2.2 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. "USE ONLY" and include specific lamp type.
 - b. Lamp diameter, shape, size, wattage, and coating.
 - c. CCT and CRI.
- C. Recessed luminaires shall comply with NEMA LE 4.

2.3 DOWNLIGHT

- A. See Luminaire Schedule on drawings for recommended manufacturers, voltage, lumens, and CRI/color temp.

- B. Lamp:
 - 1. Rated lamp life of 35,000 hours to L70.
 - 2. Dimmable from 100 percent to zero percent of maximum light output.
 - 3. Internal driver.
 - 4. User-Replaceable Lamps:
 - a. Bulb shape complying with ANSI C78.79.
 - b. Lamp base complying with ANSI C81.61 or IEC 60061-1.
 - 5. Lens Thickness: At least 0.125-inch (3.175-mm) minimum unless otherwise indicated.
- C. Housings:
 - 1. Extruded-aluminum housing and heat sink unless otherwise noted.
 - 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. Diffusers and Globes:
 - 1. 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.
 - 2. Glass: Annealed crystal glass unless otherwise indicated.
 - 3. Lens Thickness: At least 0.125-inch (3.175-mm) minimum unless otherwise indicated.
- F. Standards:
 - 1. ENERGY STAR certified.
 - 2. RoHS compliant.
 - 3. UL Listing: Listed for damp location, where noted on drawings.
 - 4. Recessed luminaires shall comply with NEMA LE 4.

2.4 RECESSED, LINEAR

- A. See Luminaire Schedule on drawings for recommended manufacturers, voltage, lumens, and CRI/color temp.
- B. Lamp:
 - 1. Rated lamp life of 35,000 hours to L70.
 - 2. Dimmable from 100 percent to zero percent of maximum light output.
 - 3. Internal driver.
 - 4. User-Replaceable Lamps:
 - a. Bulb shape complying with ANSI C78.79.
 - b. Lamp base complying with ANSI C81.61 or IEC 60061-1.
 - 5. Lens Thickness: At least 0.125-inch (3.175-mm) minimum unless otherwise indicated.
- C. Housings:
 - 1. Extruded-aluminum housing and heat sink unless otherwise noted.
 - 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. 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.
 - 2. Glass: Annealed crystal glass unless otherwise indicated.
 - 3. Lens Thickness: At least 0.125-inch (3.175-mm) minimum unless otherwise indicated.
- F. Standards:
 - 1. ENERGY STAR certified.
 - 2. RoHS compliant.
 - 3. UL Listed.
 - 4. NEMA LE 4.

2.5 STRIP LIGHT

- A. See Luminaire Schedule on drawings for recommended manufacturers, voltage, lumens, and CRI/color temp.
- B. Lamp:
 - 1. Rated lamp life of 35,000 hours to L70.
 - 2. Dimmable from 100 percent to zero percent of maximum light output.
 - 3. Internal driver.
 - 4. User-Replaceable Lamps:
 - a. Bulb shape complying with ANSI C78.79.
 - b. Lamp base complying with ANSI C81.61 or IEC 60061-1.
 - 5. Lens Thickness: At least 0.125-inch (3.175-mm) minimum unless otherwise indicated.
- C. Housings:
 - 1. Extruded-aluminum housing and heat sink unless otherwise noted.
 - 2. Painted finish.
 - 3. 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. 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.
 - 2. Glass: Annealed crystal glass unless otherwise indicated.
 - 3. Lens Thickness: At least 0.125-inch (3.175-mm) minimum unless otherwise indicated.
- F. Standards:
 - 1. ENERGY STAR certified.
 - 2. RoHS compliant.

3. UL Listed.

2.6 MATERIALS

- A. Metal Parts:
 1. Free of burrs and sharp corners and edges.
 2. Sheet metal components shall be steel unless otherwise indicated.
 3. Form and support to prevent warping and sagging.
- B. Steel:
 1. ASTM A36/A36M for carbon structural steel.
 2. ASTM A568/A568M for sheet steel.
- C. Stainless Steel:
 1. Manufacturer's standard grade.
 2. Manufacturer's standard type, ASTM A240/240M.
- D. Galvanized Steel: ASTM A653/A653M.
- E. Aluminum: ASTM B209.

2.7 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.

2.8 LUMINAIRE SUPPORT

- A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.
- B. Single-Stem Hangers: 1/2-inch (13-mm) steel tubing with swivel ball fittings and ceiling canopy. Finish same as luminaire.
- C. Wires: ASTM A641/A641M, Class 3, soft temper, zinc-coated steel, 12 gage (2.68 mm)
- D. Rod Hangers: 3/16-inch (5-mm) minimum diameter, cadmium-plated, threaded steel rod.
- E. Hook Hangers: Integrated assembly matched to luminaire, line voltage, and equipment with threaded attachment, cord, and locking-type plug.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before luminaire installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 TEMPORARY LIGHTING

- A. If approved by the Architect, use selected permanent luminaires for temporary lighting. When construction is sufficiently complete, clean luminaires used for temporary lighting and install new lamps.

3.3 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. Locate fixtures to avoid interference with mechanical and structural features.
- E. In finished spaces, consult the Architect prior to making adjustment to fixture locations.
- F. 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.
- G. Flush-Mounted Luminaires:
 - 1. Secured to outlet box.
 - 2. Attached to ceiling structural members at four points equally spaced around circumference of luminaire.
 - 3. Trim ring flush with finished surface.
- H. Suspended Luminaires:
 - 1. Ceiling Mount:
 - a. Two 5/32-inch- (4-mm-) diameter aircraft cable supports adjustable to 10 feet (3 m) in length
 - b. Four-point pendant mount with 5/32-inch- (4-mm-) diameter aircraft cable supports adjustable to 10 feet (3 m) in length.

- c. Hook mount.
 - 2. Pendants and Rods: Where longer than 48 inches (1200 mm), brace to limit swinging.
 - 3. Chain Hung: Where fixtures are specifically indicated to be chain mounted, provide wire hook chain set & jack chains cut to length as required to suspend luminaire at indicated height. Use MC cable supported by cable ties from fixture to junction box mounted in structure above each fixture.
 - 4. Stem-Mounted, Single-Unit Luminaires: Suspend with twin-stem hangers. Support with approved outlet box and accessories that hold stem and provide damping of luminaire oscillations. Support outlet box vertically to building structure using approved devices.
 - 5. Continuous Rows of Luminaires: Use tubing or stem for wiring at one point and tubing or rod or wire support for suspension for each unit length of luminaire chassis, including one at each end.
 - 6. Do not use ceiling grid as support for pendant luminaires. Connect support wires or rods to building structure.
- I. Ceiling-Grid-Mounted Luminaires:
 - 1. Secure to any required outlet box.
 - 2. Secure luminaire to the luminaire opening using approved fasteners in a minimum of four locations, spaced near corners of luminaire.
 - 3. Use minimum 12-gauge safety hanger wire supports to connect luminaire to ceiling grid and building structure. Hangers shall be independent of the ceiling framing suspension system and shall extend from fixture housing to structure above. Lighting fixtures weight less than 56lbs shall have two hangers, at diagonal corners of fixture (2 locations). Lighting fixtures weighing more than 56 pounds shall have four hangers, one at each corner of fixture (4 locations) or evenly distributed around fixture perimeter for non-rectangular fixtures. Wires shall have no tension (slack) to prevent ceiling distortion. In addition, attach to ceiling frame "T"'s as required by code.
 - J. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for wiring connections.
 - K. Fixtures in sloping ceilings shall have angle face plate for proper orientation of fixture.
 - L. Locate recessed ceiling luminaires as indicated on reflected ceiling plan. Fixtures shall have frame and trim details to match the ceiling suspension system furnished. Coordinate details with Acoustical Treatment Section and installation with the Ceiling Installer to assure fixtures are centered on tiles or on joints as required.
 - M. Install surface mounted luminaires plumb and adjust to align with building lines and with each other. Install spacers where required to allow proper installation of rabbeted (Tegular) ceiling tiles. Secure to prevent movement.
 - N. Install clips to secure recessed luminaires in place. Install recessed luminaires to permit removal from below.
 - O. Install recessed luminaires using accessories and firestopping materials to meet regulatory requirements for fire rating.
 - P. Install accessories furnished with each luminaire.
 - Q. Bond products and metal accessories to branch circuit equipment grounding conductor.

3.4 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.5 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.
 - 2. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.
- B. Luminaire will be considered defective if it does not pass operation tests and inspections.
- C. All fixtures and equipment shall be in factory fresh condition at time of delivery of building to Owners with all scratches, mars, etc., refinished to factory standards.
- D. Prepare test and inspection reports.

3.6 ADJUSTING

- A. Replace drivers and boards that have failed at Substantial Completion and six (6) months thereafter.
- B. Clean electrical parts to remove conductive and deleterious materials.
- C. Remove dirt and debris from enclosure.
- D. Clean photometric control surfaces using procedures as recommended by manufacturer.
- E. Clean finishes and touch up damage.

END OF SECTION 265119

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SECTION 265213 - EMERGENCY AND EXIT LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Emergency lighting.
 - 2. Exit signs.
 - 3. Materials.
 - 4. Luminaire support components.
- B. Related Requirements:
 - 1. Section 260010 "Supplemental Requirements for Electrical" for additional abbreviations, definitions, submittals, qualifications, testing agencies, and other Project requirements applicable to Work specified in this Section.

1.2 DEFINITIONS

- A. Correlated Color Temperature (CCT): The absolute temperature, measured in kelvins, of a blackbody whose chromaticity most nearly resembles that of the light source.
- B. Color Rendering Index (CRI): Measure of the degree of color shift that objects undergo when illuminated by the light source as compared with the color of those same objects when illuminated by a reference source.
- C. Emergency Lighting Unit: A lighting unit with internal or external emergency battery powered supply and the means for controlling and charging the battery and unit operation.
- D. Lumen (lm): The SI derived unit of luminous flux equal to the luminous flux emitted within a unit solid angle by a unit point source (1 lm = 1 cd-sr).

1.3 ACTION SUBMITTALS

- A. Product Data:
 - 1. For each type of emergency lighting unit, exit sign, and emergency lighting support.
 - a. Include data on features, accessories, and finishes.
 - b. Include physical description of unit and dimensions.
 - c. Battery and charger for light units.
 - d. Include life, output of luminaire (lumens, CCT, and CRI), and energy-efficiency data.
 - e. Include photometric data and adjustment factors based on laboratory tests by, or under supervision of, qualified luminaire photometric testing laboratory, for each luminaire type.
- B. Shop Drawings:
 - 1. For nonstandard or custom luminaires.

- a. Include plans, elevations, sections, and mounting and attachment details.
- b. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
- c. Include diagrams for power, signal, and control wiring.

C. Product Schedule:

- 1. For emergency lighting units. Use same designations indicated on Drawings.
- 2. For exit signs. Use same designations indicated on Drawings.

1.4 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of luminaire.
- B. Product Test Reports: For each luminaire for tests performed by, or under supervision of, qualified luminaire photometric testing laboratory.
- C. Sample Warranty: For manufacturer's warranty.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Lamps: 10 for every 100 of each type and rating installed. Furnish at least one of each type.
 - 2. Luminaire-mounted, emergency battery pack: One for every 20 emergency lighting units. Furnish at least one of each type.
 - 3. Diffusers and Lenses: One for every 100 of each type and rating installed. Furnish at least one of each type.
 - 4. Globes and Guards: One for every 20 of each type and rating installed. Furnish at least one of each type.

1.6 QUALITY ASSURANCE

- A. Provide luminaires from a single manufacturer for each luminaire type.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

1.8 WARRANTY

- A. Special Installer Extended Warranty for Emergency and Exit Lighting: Installer warrants that fabricated and installed emergency luminaires and exit signs, including batteries, perform in accordance with specified requirements and agrees to repair or replace components and assemblies that fail to perform as specified within extended warranty period.

1. Extended Warranty Period: Two year(s) from date of Substantial Completion; full coverage for labor, materials, and equipment.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR EMERGENCY LIGHTING

- A. Electrical Components, Devices, and Accessories: Listed and labeled in accordance with NFPA 70 and UL 924, by qualified electrical testing laboratory recognized by authorities having jurisdiction, and marked for intended location and application.
- B. Comply with NFPA 101.
- C. Comply with NEMA LE 4 for recessed luminaires.
- D. Comply with UL 1598 for fluorescent luminaires.
- E. Internal Type Emergency Power Unit: Self-contained, modular, battery-inverter unit, factory mounted within luminaire body.
 1. Emergency Connection: Operate one lamp(s) continuously at an output of 1100 lumens each upon loss of normal power. Connect unswitched circuit to battery-inverter unit and switched circuit to luminaire ballast.
 2. Operation: Relay automatically turns lamp on when power-supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
 3. Test Push-Button and Indicator Light: Visible and accessible without opening luminaire or entering ceiling space.
 - a. Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
 - b. Indicator Light: LED indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
 4. Battery: Sealed, maintenance-free, nickel-cadmium or lead-acid type unless otherwise noted.
 5. Charger: Fully automatic, solid-state, constant-current type with sealed power transfer relay.
 6. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.
- F. External Type Emergency Power Unit: Self-contained, modular, battery-inverter unit, suitable for powering one or more lamps, remote mounted from luminaire.
 1. Manufacturers: Bodine, Iota, Chloride, DualLite or approved equal.
 2. Emergency Connection: Operate one LED lamp continuously. Connect unswitched circuit to battery-inverter unit and switched circuit to luminaire.
 3. Operation: Relay automatically turns lamp on when power-supply circuit voltage drops to 80 percent of nominal voltage or below. Lamp automatically disconnects from battery when voltage approaches deep-discharge level. When normal voltage is restored, relay

disconnects lamps from battery, and battery is automatically recharged and floated on charger.

4. Battery: Sealed, maintenance-free, nickel-cadmium type.
5. Charger: Fully automatic, solid-state, constant-current type.
6. Housing: Type 1 enclosure listed for installation inside, on top of, or remote from luminaire. Remote assembly must be located no less than half of distance recommended by emergency power unit manufacturer, whichever is less.
7. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
8. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.
9. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

2.2 EMERGENCY LIGHTING

A. Emergency Lighting Unit:

1. See Luminaire Schedule on drawings for basis of design manufacturer, shape, voltage, lumens, and CRI/color temp.
2. Manufacturers: Lithonia, Lightalarms, Sure-Lite, Chloride, Dual-Lite, Prescolite, or approved equal.
3. Options:
 - a. Wall with universal junction box adaptor.
 - b. UV stable thermoplastic housing.
 - c. Two LED lamp heads.
 - d. Internal emergency power unit.

B. Remote Emergency Lighting Unit

1. See Luminaire Schedule on drawings for basis of design manufacturer, shape, voltage, lumens, and CRI/color temp.
2. Manufacturers: Lithonia, Lightalarms, Sure-Lite, Chloride, Dual-Lite, Prescolite, or approved equal.
3. Options:
 - a. Wall with universal junction box adaptor.
 - b. UV stable thermoplastic housing.
 - c. Two LED lamp heads.
 - d. External emergency power unit.

2.3 EXIT SIGNS

A. General Characteristics: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.

B. Internally Lighted Sign

1. See Luminaire Schedule on drawings for basis of design manufacturer, shape, voltage, lumens, and CRI/color temp.
2. Manufacturers: Lithonia, Lightalarms, Sure-Lite, Chloride, Dual-Lite, Prescolite, or approved equal.

3. Options:
 - a. Lamps for AC Operation:
 - 1) LEDs; 50,000 hours minimum rated lamp life.
 - b. Self-Powered Exit Signs (Battery Type): Internal emergency power unit.

2.4 MATERIALS

- A. Metal Parts:
 1. Free of burrs and sharp corners and edges.
 2. Sheet metal components must be steel unless otherwise indicated.
 3. Form and support to prevent warping and sagging.
- B. Doors, Frames, and Other Internal Access:
 1. Smooth operating, free of light leakage under operating conditions.
 2. Designed to permit relamping without use of tools.
 3. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.
- C. Diffusers and Globes:
 1. Glass: Annealed crystal glass unless otherwise indicated.
 2. Acrylic: 100 percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
 3. Lens Thickness: At least 0.125 inch (3.175 mm) minimum unless otherwise indicated.
- D. Housings:
 1. Extruded aluminum housing.
- E. Conduit: ERMC, minimum metric designator 21 (trade size 3/4).

2.5 METAL FINISHES

- A. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within range of approved Samples and are assembled or installed to minimize contrast.

2.6 LUMINAIRE SUPPORT COMPONENTS

- A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.
- B. Support Wires: ASTM A641/A641M, Class 3, soft temper, zinc-coated steel, 0.106 inch (2.69 mm).

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for conditions affecting performance of luminaires.
- B. Examine roughing-in for luminaire to verify actual locations of luminaire and electrical connections before luminaire installation.
- C. Examine walls, floors, roofs, and ceilings for suitable conditions where emergency lighting luminaires will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.
- B. Aim directional lampheads to maximize light in egress paths and as directed.
- C. D.C. Wiring: No.10 AWG. minimum, or as noted, in rigid conduit or electrical metallic tubing or concealed MC cable.
 - 1. Except as noted, use home run from each device to associated battery unit.
 - 2. Devices may share same home run to battery unit provided that each home run meets the following criteria or wire sizes are increased to assure maximum of 2-1/2% voltage drop.

Total Watts	Total Conductor Distance
70	25 ft.
50	35 ft.
36	45 ft.
19	95 ft.

- D. AC Wiring to Exit Lights: In separate conduit, or MC cable with ground.
- E. Exit Sign Mounting: Generally mount directly above and centered over the doorway opening, on the wall where possible, or mounted from the ceiling when wall mounting is not possible. End wall mounted where required, up 7'-6" AFF. The intent is to locate signs to allow for maximum visibility. Consult Architect before installation, if in question.
- F. Ceiling Grid Mounted Luminaires:
 - 1. Secure to outlet box, if provided.
 - 2. Secure emergency power unit using approved fasteners in a minimum of four locations, spaced near corners of emergency power unit.

3.3 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

Tests and Inspections:

1. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery power and retransfer to normal.
- B. Nonconforming Work:
 1. Luminaire will be considered defective if it does not pass operation tests and inspections.
 2. Remove and replace defective units and retest.
- C. Prepare test and inspection reports.

3.5 SYSTEM STARTUP

- A. Perform startup service:
 1. Charge emergency power units minimum of one hour and depress switch to conduct short-duration test.
 2. Charge emergency power units minimum of 24 hours and conduct one-hour discharge test.

3.6 ADJUSTING

- A. Adjustments: Within 12 months of date of Substantial Completion, provide on-site visit to do the following:
 1. Inspect luminaires. Replace lamps, emergency power units (including batteries) and exit signs, and luminaires that are defective.
 - a. Parts and supplies must be manufacturer's authorized replacement parts and supplies.
 2. Conduct short-duration tests on all emergency lighting.

3.7 PROTECTION

- A. Remove and replace luminaires and exit signs that are damaged or caused to be unfit for use by construction activities.

END OF SECTION 265213

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SECTION 265619 - LED EXTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Luminaire-mounted photoelectric relays.
 - 2. Luminaire types.
 - 3. Materials.
 - 4. Finishes.
 - 5. Luminaire support components.
- B. Related Requirements:
 - 1. Section 260923 "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.

1.3 DEFINITIONS

- A. CCT: Correlated color temperature.
- B. CRI: Color rendering index.
- C. Fixture: See "Luminaire."
- D. IP: International Protection or Ingress Protection Rating.
- E. Lumen: Measured output of lamp and luminaire, or both.
- F. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of luminaire.
 - 1. Arrange in order of luminaire designation.
 - 2. Include data on features, accessories, and finishes.
 - 3. Include physical description and dimensions of luminaire.
 - 4. Lamps, include life, output (lumens, CCT, and CRI), and energy-efficiency data.
 - 5. Photometric data and adjustment factors based on laboratory tests, complying with IES Lighting Measurements Testing and Calculation Guides, of each luminaire type. The

adjustment factors shall be for lamps and accessories identical to those indicated for the luminaire as applied in this Project.

- a. Manufacturer's Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the NVLAP for Energy Efficient Lighting Products.
 6. Wiring diagrams for power, control, and signal wiring.
 7. Photoelectric relays.
 8. Means of attaching luminaires to supports and indication that the attachment is suitable for components involved.
- B. Product Schedule: For luminaires and lamps. Use same designations indicated on Drawings.
1. Include design calculations for luminaire supports.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing laboratory providing photometric data for luminaires.
- B. Product Certificates: For each type of the following:
 1. Luminaire.
 2. Photoelectric relay.
- C. Product Test Reports: For each luminaire, for tests performed by manufacturer and witnessed by a qualified testing agency.
- D. Source quality-control reports.
- E. Sample warranty.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For luminaires and photoelectric relays to include in operation and maintenance manuals.
 1. Provide a list of all lamp types used on Project. Use ANSI and manufacturers' codes.
 2. Provide a list of all photoelectric relay types used on Project; use manufacturers' codes.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 1. Lamps: Ten for every 100 of each type and rating installed. Furnish at least one of each type.
 2. Glass, Acrylic, and Plastic Lenses, Covers, and Other Optical Parts: One for every 100 of each type and rating installed. Furnish at least one of each type.
 3. Diffusers and Lenses: One for every 100 of each type and rating installed. Furnish at least one of each type.
 4. Globes and Guards: One for every 20 of each type and rating installed. Furnish at least one of each type.

1.8 QUALITY ASSURANCE

- A. Luminaire Photometric Data Testing Laboratory Qualifications:
 - 1. Luminaire manufacturers' laboratory that is accredited under the NVLAP for Energy Efficient Lighting Products.
- B. Provide luminaires from a single manufacturer for each luminaire type.
- C. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.
- D. Installer Qualifications: An authorized representative who is trained and approved by manufacturer.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering prior to shipping.

1.10 FIELD CONDITIONS

- A. Verify existing and proposed utility structures prior to the start of work associated with luminaire installation.
- B. Mark locations of exterior luminaires for approval by Architect prior to the start of luminaire installation.

1.11 WARRANTY

- A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures, including luminaire support components.
 - b. Faulty operation of luminaires and accessories.
 - c. Deterioration of metals, metal finishes, and other materials beyond normal weathering.
 - 2. Warranty Period: 2 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. NRTL Compliance: Luminaires shall be listed and labeled for indicated class and division of hazard by an NRTL.

- C. UL Compliance: Comply with UL 1598 and listed for wet location.
- D. Lamp base complying with ANSI C81.61 or IEC 60061-1.
- E. Bulb shape complying with ANSI C79.1.
- A. See Luminaire Schedule on drawings for recommended manufacturers, voltage, lumens, and CRI/color temp.
- B. L70 lamp life of 35,000 hours.
- C. Lamps dimmable from 100 percent to 0 percent of maximum light output.
- D. Internal driver.
- E. Lamp Rating: Lamp marked for outdoor use.
- F. Source Limitations:
 - 1. For luminaires, obtain each color, grade, finish, type, and variety of luminaire from single source with resources to provide products of consistent quality in appearance and physical properties.

2.2 LUMINAIRE TYPES

- A. Egress:
 - 1. See Luminaire Schedule on drawings for recommended manufacturers, voltage, lumens, and CRI/color temp.
 - 2. Mounting: Building with extruded-aluminum or stainless-steel.
 - 3. Luminaire-Mounting Height: As noted on drawings. Coordinate with exterior finishes.
 - 4. Distribution: As noted on drawings.
 - 5. Diffusers and Globes: As noted on drawings.
 - 6. Housings:
 - a. Extruded-aluminum housing and heat sink.

2.3 MATERIALS

- A. Metal Parts: Free of burrs and sharp corners and edges.
- B. Sheet Metal Components: Corrosion-resistant aluminum unless otherwise noted on drawings. Form and support to prevent warping and sagging.
- C. 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. Doors shall be removable for cleaning or replacing lenses.
- D. Diffusers and Globes:
 - 1. Acrylic Diffusers: 100 percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

2. Glass: Annealed crystal glass unless otherwise indicated.
 3. Lens Thickness: At least 0.125 inch (3.175 mm) minimum unless otherwise indicated.
- E. Lens and Refractor Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.
- F. Reflecting surfaces shall have minimum reflectance as follows unless otherwise indicated:
1. White Surfaces: 85 percent.
 2. Specular Surfaces: 83 percent.
 3. Diffusing Specular Surfaces: 75 percent.
- G. Housings:
1. Rigidly formed, weather- and light-tight enclosure that will not warp, sag, or deform in use.
 2. Provide filter/breather for enclosed luminaires.
- H. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
1. Label shall include the following lamp characteristics:
 - a. "USE ONLY" and include specific lamp type.
 - b. Lamp diameter, shape, size, wattage and coating.
 - c. CCT and CRI for all luminaires.

2.4 FINISHES

- A. Variations in Finishes: Noticeable variations in same piece are unacceptable. 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.
- B. Luminaire Finish: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.
- C. Factory-Applied Finish for Aluminum Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
- D. Factory-Applied Finish for Steel Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1 or SSPC-SP 8.
 2. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.
 - a. Color:

- 1) As selected from manufacturer's standard catalog of colors.

2.5 LUMINAIRE SUPPORT COMPONENTS

- A. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for channel and angle iron supports and nonmetallic channel and angle supports.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for luminaire electrical conduit to verify actual locations of conduit connections before luminaire installation.
- C. Examine exterior walls for suitable conditions where luminaires will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 TEMPORARY LIGHTING

- A. If approved by the Architect, use selected permanent luminaires for temporary lighting. When construction is substantially complete, clean luminaires used for temporary lighting and install new lamps.

3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Comply with NECA 1.
- B. Install lamps in each luminaire.
- C. Fasten luminaire to structural support.
- D. Supports:
 1. Sized and rated for luminaire weight.
 2. Able to maintain luminaire position after cleaning and relamping.
 3. Support luminaires without causing deflection of finished surface.
 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. Wall-Mounted Luminaire Support:
 1. Attached to a minimum 1/8 inch (3 mm) backing plate attached to wall structural members.
- F. Wiring Method: Install cables in raceways. Conceal raceways and cables.

- G. Install luminaires level, plumb, and square with finished grade unless otherwise indicated. Provide shims or double nuts to adjust plumb. Grout around each base for neat smooth tight finish.
- H. Coordinate layout and installation of luminaires with other construction.
- I. Adjust luminaires that require field adjustment or aiming. Include adjustment of photoelectric device to prevent false operation of relay by artificial light sources, favoring a north orientation.
- J. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" and Section 260533 "Raceways and Boxes for Electrical Systems" for wiring connections and wiring methods.

3.4 CORROSION PREVENTION

- A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.
- B. Steel Conduits: Comply with Section 260533 "Raceways and Boxes for Electrical Systems." In concrete foundations, wrap conduit with 0.010-inch- (0.254-mm-) thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

3.5 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.6 FIELD QUALITY CONTROL

- A. Inspect each installed luminaire for damage. Replace damaged luminaires and components.
- B. Perform the following tests and inspections:
 - 1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
 - 2. Verify operation of photoelectric controls.
- C. Illumination Tests:
 - 1. Measure light intensities at night. Use photometers with calibration referenced to NIST standards. Comply with applicable IES testing guide(s).
 - 2. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
- D. Luminaire will be considered defective if it does not pass tests and inspections.
- E. All fixtures and equipment shall be in factory fresh condition at time of delivery of building to Owners with all scratches, mars, etc., refinished to factory standards.

- F. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

3.7 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain luminaires and photocell relays.

3.8 ADJUSTING

- A. Aim and adjust luminaires after dark as directed.
- B. Replace drivers and boards that have failed at Substantial Completion and six (6) months thereafter.
- C. Clean electrical parts to remove conductive and deleterious materials.
- D. Remove dirt and debris from enclosure.
- E. Clean photometric control surfaces using procedures as recommended by manufacturer.
- F. Clean finishes and touch up damage.

END OF SECTION 265619

SECTION 270010 - SUPPLEMENTAL REQUIREMENTS FOR COMMUNICATIONS

PART 1 - GENERAL

1.1 SUMMARY

- A. Scope of Work:
 - 1. All telecommunications wiring, conduit, and additional related equipment covered in Division 27 specifications shall be the responsibility of the contractor to procure and install.
- B. Section Includes:
 - 1. Supplemental requirements generally applicable to the Work specified in Division 27.
- C. Related Requirements:
 - 1. Section 260010 "Supplemental Requirements for Electrical" for abbreviations and acronyms for electrical terms and units of measure, abbreviations and acronyms for electrical raceway types, abbreviations and acronyms for electrical cable types, and additional coordination drawing submittal requirements.

1.2 REFERENCES

- A. Abbreviations and Acronyms for Communications:
 - 1. LAN: Local area network.
 - 2. PoE: Power over Ethernet.
 - 3. POTS: Plain old telephone service. See "public switched telephone network."
 - 4. TCP/IP: Transmission control protocol/Internet protocol.
 - 5. WAN: Wide area network.
- B. Definitions for Communications:
 - 1. Calling Party Control (CPC): A momentary break in phone line loop current, which is used to signal voicemail and other automated telephone company services that distant party has hung up.
 - 2. Private Branch Exchange (PBX): Analog telephone switch that routes calls internal to a business or organization so a direct external line for each phone is unnecessary.
 - 3. Public Switched Telephone Network (PSTN): Analog telephone technology that uses twisted-pair cables from a telephone-provider central office for the transmission medium. PSTN refers to the telephone network; POTS refers to the individual subscriber line.
 - 4. Remote Office Phone System (ROPS): VoIP system that allows phones for a business or organization located anywhere in the world with internet connectivity to behave similar to phones connected to a PBX.
 - 5. Ringer Equivalence Number (REN): The loading effect of a single traditional telephone ringing circuit. TIA-968 defines REN 1 as an impedance of 7000 Ω at 20 Hz (Type A ringer) or 8000 Ω from 15 Hz to 68 Hz (Type B ringer). The sum of the RENs for all devices on a subscriber line circuit may not exceed the maximum permitted REN for the subscriber line.

6. Voice over Internet Protocol (VoIP): Digital telephone packet technology that uses the internet for its transmission medium.

1.3 COORDINATION

- A. Interruption of Existing Telephone Service: Do not interrupt telephone service to facilities occupied by Owner or others unless permitted under the following conditions:
 1. Notify Construction Manager and Owner no fewer than seven days in advance of proposed interruption of telephone service.
 2. Do not proceed with interruption of telephone service without Owner's written permission.
- B. Interruption of Existing Internet Service: Do not interrupt internet service to facilities occupied by Owner or others unless permitted under the following conditions:
 1. Notify Construction Manager and Owner no fewer than seven days in advance of proposed interruption of internet service.
 2. Do not proceed with interruption of internet service without Owner's written permission.
- C. A lump sum allowance of \$2000 shall be included in the project for fees to be paid to Consolidated related to the relocation of telephone and internet services on site servicing the Police Garage.

1.4 INFORMATIONAL SUBMITTALS

- A. Installation Schedule for Communications Systems: At preconstruction meeting, and periodically thereafter as dates change, provide schedule for installation of communications Work to Owner and Architect including, but not limited to, milestone dates for the following activities:
 1. Submission of specified coordination drawings.
 2. Submission of action submittals specified in Division 27.
 3. Orders placed for major equipment.
 4. Arrival of major equipment on-site.
 5. Telephone and internet service outages.
 6. Telephone and internet service inspection and activation.
 7. Closing of walls and ceilings containing communications Work.
 8. System startup, testing, and commissioning activities for communications equipment.
 9. System startup, testing, and commissioning activities for Work specified in other divisions that depends on Work specified in Division 27.
 10. System startup, testing, and commissioning activities for automation systems (SCADA, BMS, lighting, HVAC, fire alarm, fire pump, etc.).
 11. Requests for special inspections.
 12. Requests for inspections by authorities having jurisdiction.
- B. Certificates:
 1. Welding certificates.
- C. Qualification Statements:
 1. For qualified regional manufacturer.
 2. For communications design professional.

3. For welder.
4. For communications cable Installer.
5. For communications testing agency and on-site communications testing supervisor.
6. For structural testing and inspecting agency.

1.5 QUALIFICATIONS

- A. Qualified Regional Manufacturer: Manufacturer, possessing qualifications specified in Section 014000 "Quality Requirements," that maintains a service center capable of providing training, parts, and emergency on-site repairs to Project site with response time less than eight hours.
- B. Communications Design Professional: Design professional possessing active qualifications specified in Section 014000 "Quality Requirements" and the following:
 1. Expertise in design of communications infrastructure and distribution equipment.
 2. BICSI Registered Communications Distribution Designer (RCDD) certification.
- C. Welder: Installer possessing active qualifications specified in Section 014000 "Quality Requirements," with training and certification in accordance with AWS D1.1/D1.1M.
- D. Communications Cable Installer: Entity possessing active qualifications specified in Section 014000 "Quality Requirements" and the following:
 1. Training and manufacturer certification to install, splice, and terminate communications cabling.
 2. Installation Supervisor: BICSI Technician (TECH) certification.
 3. Copper Installers: 30 percent of employees possess BICSI Copper Installer 2 (INSTC) certification. Remaining employees possess BICSI Installer 1 (INST1) certification.
 4. Fiber Installers: 30 percent of employees possess BICSI Optical Fiber Installer 2 (INSTF) certification. Remaining employees possess BICSI Installer 1 (INST1) certification.
- E. Communications Testing Agency: Entity possessing active credentials from a qualified electrical testing laboratory recognized by authorities having jurisdiction.
 1. On-site communications testing supervisor must have BICSI Technician (TECH) certification and documented training, and be experienced with testing communications equipment in accordance with BICSI testing standards.

1.6 FIELD CONDITIONS

- A. Modeling, analysis, product selection, installation, and quality control for Work specified in Division 27 must comply with requirements specified in Section 260011 "Facility Performance Requirements for Electrical."

PART 2 - PRODUCTS

2.1 SUBSTITUTION LIMITATIONS FOR COMMUNICATIONS EQUIPMENT

- A. Substitution requests for communications equipment will be entertained under the following conditions:
 - 1. Substitution requests may be submitted for consideration prior to the Communications Preconstruction Conference if accompanied by value analysis data indicating that substitution will comply with Project performance requirements while significantly increasing value for Owner throughout life of facility.
 - 2. Contractor is responsible for sequencing and scheduling equipment procurement. After the Communications Preconstruction Conference, insufficient lead time for equipment delivery will not be considered a valid reason for substitution.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protection of In-Place Conditions:
 - 1. Provide temporary covers for all open device location boxes and conduit stub ups to protect from dirt and debris during construction.

3.2 INSTALLATION OF COMMUNICATIONS WORK

- A. Unless more stringent requirements are specified in the Contract Documents or manufacturers' instructions, comply with NFPA 70, NECA NEIS 1, and BICSI N1 for installation of Work specified in Division 27. Consult Architect for resolution of conflicting requirements.

3.3 SYSTEM STARTUP

- A. Commissioning Activities:
 - 1. Provide testing of all installed telecommunications wire and connections. Coordinate with owner's IT representative to document final test results.

3.4 FIELD QUALITY CONTROL

- A. Adminstrant for Communications Tests and Inspections:
 - 1. Administer and perform tests and inspections.

3.5 CLEANING

- A. Waste Management:
 - 1. Dispose of all electronic and other waste as required by local jurisdiction.

END OF SECTION 270010

SECTION 270528 - PATHWAYS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Metal conduits and fittings.
 - 2. Metal wireways and auxiliary gutters.
 - 3. Hooks.
 - 4. Boxes, enclosures, and cabinets.

1.3 DEFINITIONS

- A. ARC: Aluminum rigid conduit.
- B. GRC: Galvanized rigid conduit.
- C. IMC: Intermediate metal conduit.
- D. RTRC: Reinforced thermosetting resin conduit.

1.4 ACTION SUBMITTALS

- A. Product data for the following:
 - 1. Surface pathways
 - 2. Wireways and fittings.
 - 3. Tele-power poles.
 - 4. Boxes, enclosures, and cabinets.
 - 5. Underground handholes and boxes.

PART 2 - PRODUCTS

2.1 METAL CONDUITS AND FITTINGS

- A. Description: Metal raceway of circular cross section with manufacturer-fabricated fittings.
- B. Cooper B-Line, Square D, Husky, Legrand, or approved equal

- C. 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.
- D. GRC: Comply with ANSI C80.1 and UL 6.
- E. IMC: Comply with ANSI C80.6 and UL 1242.
- F. PVC-Coated Steel Conduit: PVC-coated GRC.
 - 1. Comply with NEMA RN 1.
 - 2. Coating Thickness: 0.040 inch (1 mm), minimum.
- G. EMT: Comply with ANSI C80.3 and UL 797.
- H. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.
 - 1. Fittings for EMT:
 - a. Material: Steel or die cast.
 - b. Type: compression.
 - 2. 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.
 - 3. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch (1 mm), with overlapping sleeves protecting threaded joints.

2.2 METAL WIREWAYS AND AUXILIARY GUTTERS

- A. Description: Sheet metal trough of rectangular cross section fabricated to required size and shape, without holes or knockouts, and with hinged or removable covers.
- B. Grainger, Cooper, Square D, Husky, Hoffman, or approved equal
- C. General Requirements for Metal Wireways and Auxiliary Gutters:
 - 1. Comply with UL 870 and NEMA 250, Type 1 unless otherwise indicated, and sized according to NFPA 70.
 - 2. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
 - 3. Comply with TIA-569-D.
- D. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
- E. Wireway Covers: Hinged type unless otherwise indicated.
- F. Finish: Manufacturer's standard enamel finish.

2.3 SURFACE METAL PATHWAYS

- A. Description: Galvanized steel with snap-on covers, complying with UL 5.

- B. Grainger, Husky, Hoffman, or approved equal.
- C. Finish: Manufacturer's standard enamel finish in color selected by Architect.
- D. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- E. Comply with TIA-569-D.

2.4 HOOKS

- A. Description: Prefabricated sheet metal cable supports for telecommunications cable.
- B. Arlington, Eaton, AI Fittings, Anixter, or approved equal.
- C. Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.
- D. Comply with TIA-569-D.
- E. Galvanized steel.
- F. J shape.

2.5 BOXES, ENCLOSURES, AND CABINETS

- A. Description: Enclosures for communications.
- B. Fiber Optic Link, Telco, Platt, Armor Logix, or approved equal.
- C. 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 (100 mm square by 60 mm deep).
 - 5. Gangable boxes are allowed.
- D. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.
- E. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, aluminum, Type FD, with gasketed cover.
- F. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- G. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, cast aluminum with gasketed cover.

- H. Nonmetallic Outlet and Device Boxes: Comply with NEMA OS 2 and UL 514C.
- I. 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. Nonmetallic Enclosures:
 - a. Material: Plastic.
 - 3. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.
- J. 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. Outdoors: Apply pathway products as specified below unless otherwise indicated:
 - 1. Exposed Conduit: GRC.
 - 2. Concealed Conduit, Aboveground: GRC.
 - 3. Underground Conduit: RNC, Type EPC-80-PVC, direct buried.
 - 4. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.
- B. Indoors: Apply pathway products as specified below unless otherwise indicated:
 - 1. Exposed, Not Subject to Physical Damage: EMT.
 - 2. Exposed, Not Subject to Severe Physical Damage: EMT.
 - 3. Concealed in Ceilings and Interior Walls and Partitions: EMT.
 - 4. Damp or Wet Locations: GRC.
 - 5. Pathways for Optical-Fiber or Communications Cable in Spaces Used for Environmental Air: Plenum-type, optical-fiber-cable pathway.
 - 6. Pathways for Optical-Fiber or Communications-Cable Risers in Vertical Shafts: Riser-type, optical-fiber-cable pathway.
 - 7. Pathways for Concealed General-Purpose Distribution of Optical-Fiber or Communications Cable: General-use, optical-fiber-cable pathway or Plenum-type, optical-fiber-cable pathway.
 - 8. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 stainless steel units in institutional and commercial kitchens and damp or wet locations.
- C. Minimum Pathway Size: 3/4-inch (21-mm) trade size for copper and aluminum cables, and 1 inch (25 mm) for optical-fiber cables.
- D. Pathway Fittings: Compatible with pathways and suitable for use and location.

1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
 2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with this type of conduit. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer and apply in thickness and number of coats recommended by manufacturer.
 3. EMT: Use set-screw or compression steel fittings. Comply with NEMA FB 2.10.
- E. Do not install aluminum conduits, boxes, or fittings in contact with concrete or earth.
- F. Install surface pathways only where indicated on Drawings.
- G. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F (49 deg C).

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.
- 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. Comply with requirements in Section 270529 "Hangers and Supports for Communications Systems" for hangers and supports.
- E. Comply with requirements in Section 270544 "Sleeves and Sleeve Seals for Communications Pathways and Cabling" for sleeves and sleeve seals for communications.
- F. Keep pathways at least 6 inches (150 mm) away from parallel runs of flues and steam or hot-water pipes. Install horizontal pathway runs above water and steam piping.
- G. Complete pathway installation before starting conductor installation.
- H. Arrange stub-ups so curved portions of bends are not visible above finished slab.
- I. Install no more than the equivalent of two 90-degree bends in any pathway run. Support within 12 inches (300 mm) of changes in direction. Utilize long radius ells for all optical-fiber cables.
- J. Conceal rigid conduit within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
- K. Support conduit within 12 inches (300 mm) of enclosures to which attached.
- L. Pathways Embedded in Slabs:

1. Run conduit larger than 1-inch (27-mm) trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure pathways to reinforcement at maximum 10-foot (3-m) intervals.
 2. Arrange pathways to cross building expansion joints at right angles with expansion fittings. Comply with requirements for expansion joints specified in this article.
 3. Arrange pathways to keep a minimum of 1 inch (25 mm) of concrete cover in all directions.
 4. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.
- M. Stub-ups to Above Recessed Ceilings:
1. Use EMT, IMC, or RMC for pathways.
 2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
- N. Coat field-cut threads on PVC-coated pathway with a corrosion-preventing conductive compound prior to assembly.
- O. Install pathways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus one additional quarter-turn.
- P. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure, to assure a continuous ground path.
- Q. Cut conduit perpendicular to the length. For conduits of 2-inch (50-mm) trade size and larger, use roll cutter or a guide to ensure cut is straight and perpendicular to the length.
- R. Install pull wires in empty pathways. Use polypropylene or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 12 inches (300 mm) of slack at each end of pull wire. Secure pull wire, so it cannot fall into conduit. Cap pathways designated as spare alongside pathways in use.
- S. Install pathway-sealing fittings at accessible locations according to NFPA 70 and fill them with listed sealing compound. For concealed pathways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install pathway-sealing fittings according to NFPA 70.
- T. Install devices to seal pathway interiors at accessible locations. Locate seals, so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all pathways at the following points:
1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
 2. Where an underground service pathway enters a building or structure.
 3. Where otherwise required by NFPA 70.
- U. Comply with manufacturer's written instructions for solvent welding PVC conduit and fittings.
- V. Expansion-Joint Fittings:
1. Install in each run of aboveground RNC that is located where environmental temperature change may exceed 30 deg F (17 deg C), and that has straight-run length that exceeds 25 feet (7.6 m). Install in each run of aboveground RMC and EMT that is located where

environmental temperature change may exceed 100 deg F (55 deg C), and that has straight-run length that exceeds 100 feet (30 m).

2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
3. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F (0.06 mm per meter of length of straight run per deg C) of temperature change for PVC conduits. Install fitting(s) that provide expansion and contraction for at least 0.000078 inch per foot of length of straight run per deg F (0.0115 mm per meter of length of straight run per deg C) of temperature change for metal conduits.
4. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
5. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

W. Hooks:

1. Size to allow a minimum of 25 percent future capacity without exceeding design capacity limits.
2. Shall be supported by dedicated support wires. Do not use ceiling grid support wire or support rods.
3. Hook spacing shall allow no more than 6 inches (150 mm) of slack. The lowest point of the cables shall be no less than 6 inches (150 mm) adjacent to ceilings, mechanical ductwork and fittings, luminaires, power conduits, power and telecommunications outlets, and other electrical and communications equipment.
4. Space hooks no more than 5 feet (1.5 m) o.c.
5. Provide a hook at each change in direction.

X. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.

Y. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surface to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.

Z. Horizontally separate boxes mounted on opposite sides of walls, so they are not in the same vertical channel.

AA. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.

BB. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

CC. Set metal floor boxes level and flush with finished floor surface.

DD. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

3.3 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR COMMUNICATIONS PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 270544 "Sleeves and Sleeve Seals for Communications Pathways and Cabling."

3.4 FIRESTOPPING

- A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.5 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 271513 - COMMUNICATIONS COPPER HORIZONTAL CABLING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Category 6a twisted pair cable.
 - 2. Twisted pair cable hardware.
 - 3. Multiuser telecommunications outlet assembly (MUTOA).
 - 4. Cable management system.
 - 5. Identification products.

1.2 DEFINITIONS

- A. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.
- B. EMI: Electromagnetic interference.
- C. FTP: Shielded twisted pair.
- D. F/FTP: Overall foil screened cable with foil screened twisted pair.
- E. F/UTP: Overall foil screened cable with unscreened twisted pair.
- F. IDC: Insulation displacement connector.
- G. Jack: Also commonly called an "outlet," it is the fixed, female connector.
- H. LAN: Local area network.
- I. Plug: Also commonly called a "connector," it is the removable, male telecommunications connector.
- J. Screen: A metallic layer, either a foil or braid, placed around a pair or group of conductors.
- K. Shield: A metallic layer, either a foil or braid, placed around a pair or group of conductors.
- L. S/FTP: Overall braid screened cable with foil screened twisted pair.
- M. S/UTP: Overall braid screened cable with unscreened twisted pairs.
- N. UTP: Unscreened (unshielded) twisted pair.

1.3 COPPER HORIZONTAL CABLING DESCRIPTION

- A. Horizontal cable cabling system shall provide interconnections between Distributor A, Distributor B, or Distributor C, and the equipment outlet, otherwise known as "Cabling Subsystem 1," in the telecommunications cabling system structure. Cabling system consists of horizontal cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for horizontal-to-horizontal cross-connection.
 - 1. TIA-568-C.1 requires that a minimum of two equipment outlets be installed for each work area.
 - 2. Horizontal cabling shall contain no more than one transition point or consolidation point between the horizontal cross-connect and the telecommunications equipment outlet.
 - 3. Bridged taps and splices shall not be installed in the horizontal cabling.
- B. A work area is approximately 100 sq. ft. (9.3 sq. m), and includes the components that extend from the equipment outlets to the station equipment.
- C. The maximum allowable horizontal cable length is 295 feet (90 m). This maximum allowable length does not include an allowance for the length of 16 feet (4.9 m) to the workstation equipment or in the horizontal cross-connect.

1.4 ACTION SUBMITTALS

- A. Product Data:
 - 1. Category 6a twisted pair cable.
 - 2. Twisted pair cable hardware.
 - 3. Multiuser telecommunications outlet assembly (MUTOA).
 - 4. Cable management system.
 - 5. Identification products.
- B. Twisted pair cable testing plan.
- C. Field quality-control reports.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer, installation supervisor, and field inspector.
- B. Product Certificates: For each type of product.
- C. Source quality-control reports.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For splices and connectors to include in maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Connecting Blocks: One of each type.
 - 2. Cover Plates: One of each type.
 - 3. Jacks: Ten of each type.
 - 4. Multiuser Telecommunications Outlet Assemblies: One of each type.
 - 5. Patch-Panel Units: One of each type.
 - 6. Plugs: Ten of each type.

1.8 QUALITY ASSURANCE

- A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
 - 1. Layout Responsibility: Preparation of Shop Drawings.
 - 2. Installation Supervision: Installation shall be under the direct supervision of Technician who shall be present at all times when Work of this Section is performed at Project site.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Test cables upon receipt at Project site.
 - 1. Test each pair of twisted pair cable for open and short circuits.

1.10 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.11 COORDINATION

- A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers, fire alarm manufacturer, and Owner's additional campus monitoring systems.

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, Non-Plenum Rated:
 - a. Type CMR complying with UL 1666.
- 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 6a TWISTED PAIR CABLE

- A. Category 6a Twisted Pair Cable: Four-pair, balanced twisted pair cable, certified to meet transmission characteristics of Category 6a cable at frequencies up to 500 MHz.
- B. Standard: Comply with TIA-568-C.2 for Category 6a cables.
- C. Conductors: 100-ohm, 23 AWG solid copper.
- D. Shielding/Screening: Unshielded twisted pairs (UTP).
- E. Cable Rating: Riser.
- F. Jacket: thermoplastic.

2.4 TWISTED PAIR CABLE HARDWARE

- A. Twisted Pair Cable Hardware: 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 6a.
 - 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. Obtain twisted pair cable hardware from same manufacturer as twisted pair cable, from single source.
- D. Connecting Blocks:
 - 1. 110-style IDC for Category 6a.
 - 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 (483 mm) equipment racks.
 - 3. Number of Jacks per Field: One for each four-pair cable indicated.
- G. Patch Cords: Factory-made, four-pair cables in 36-inch (900-mm) lengths; 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.
- 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.
- 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.
- J. Cover Plate:
 - 1. Two port, vertical single gang cover plates designed to mount to single gang wall boxes.
 - 2. Eight port, vertical double gang cover plates designed to mount to double gang wall boxes.
 - 3. Plastic Cover Plate: High-impact plastic. Coordinate color with Section 260533.16 "Boxes and Covers for Electrical Systems."
 - 4. For use with snap-in jacks accommodating any combination of twisted pair, optical fiber, and coaxial work area cords.
 - a. Flush mounting jacks, positioning the cord at a 45-degree angle.
- K. Legend:
 - 1. Machine printed, in the field, using adhesive-tape label.
 - 2. Snap-in, clear-label covers and machine-printed paper inserts.

2.5 CABLE MANAGEMENT SYSTEM

- A. Cable Management System: Computer-based cable management system, with integrated database capabilities.

- B. Document physical characteristics by recording the network, TIA details, and connections between equipment and cable.
- C. Information shall be presented in database view.

2.6 IDENTIFICATION PRODUCTS

- A. Comply with TIA-606-B and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

2.7 SOURCE QUALITY CONTROL

- A. Factory test cables on reels according to TIA-568-C.1.
- B. Factory test twisted pair cables according to TIA-568-C.2.
- C. Cable will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 WIRING METHODS

- A. Routing:
 - 1. Install cables in raceways, except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces, attics, and gypsum board partitions where unenclosed wiring method may be used. Conceal raceway and cables, except in unfinished spaces.
 - a. Comply with requirements for raceways and boxes specified in Section 270528 "Pathways for Communications Systems."
 - 2. Conceal conductors and cables in accessible ceilings, walls, and floors where possible.
- B. 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.

3.2 INSTALLATION OF PATHWAYS

- A. Comply with requirements for demarcation point, cabinets, and racks specified in Section 271100 "Communications Equipment Room Fittings."
- B. Comply with Section 270528 "Pathways for Communications Systems."
- C. Comply with Section 260529 "Hangers and Supports for Electrical Systems."
- D. Comply with Section 260536 "Cable Trays for Electrical Systems."

- E. Drawings indicate general arrangement of pathways and fittings.

3.3 INSTALLATION OF TWISTED PAIR HORIZONTAL CABLES

- A. Comply with NECA 1 and NECA/BICSI 568.

- B. General Requirements for Cabling:

1. Comply with TIA-568-C.0, TIA-568-C.1, and TIA-568-C.2.
2. Comply with BICSI's "Information Transport Systems Installation Methods Manual (ITSIMM), 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 (12 mm) 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. MUTOA shall not be used as a cross-connect point.
7. Consolidation points may be used only for making a direct connection to equipment outlets:
 - a. Do not use consolidation point as a cross-connect point, as a patch connection, or for direct connection to workstation equipment.
 - b. Locate consolidation points for twisted pair cables at least 49 feet (15 m) from communications equipment room.
8. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches (760 mm) and not more than 6 inches (150 mm) from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
9. Install lacing bars to restrain cables, prevent straining connections, and prevent bending cables to smaller radii than minimums recommended by manufacturer.
10. 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.
11. 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.
12. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
13. In the communications equipment room, install a 10-foot- (3-m-) long service loop on each end of cable.
14. 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.

- C. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend twisted pair cabling, not in a wireway or pathway, a minimum of 8 inches (200 mm) above ceilings by cable supports not more than 60 inches (1524 mm) apart.
3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

- D. Group connecting hardware for cables into separate logical fields.
- E. 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.
 - 2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches (127 mm).
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches (300 mm).
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches (600 mm).
 - 3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches (64 mm).
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches (150 mm).
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches (300 mm).
 - 4. Separation between communications cables in grounded metallic raceways, power lines, and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches (76 mm).
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches (150 mm).
 - 5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches (1200 mm).
 - 6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches (127 mm).

3.4 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."

3.5 GROUNDING

- A. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical 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 (50-mm) 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.

3.6 IDENTIFICATION

- A. Identify system components, wiring, and cabling complying with TIA-606-B. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
 - 1. Administration Class: Class 1.
 - 2. Color-code cross-connect fields and apply colors to voice and data service backboards, connections, covers, and labels.
- B. Paint and label colors for equipment identification shall comply with TIA-606-B for Class 2 level of administration.
- C. Cable Schedule: Install in a prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.
- D. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors.
- E. Cable and Wire Identification:
 - 1. Label each cable within 4 inches (100 mm) 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 (4.5 m).
 - 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.

- F. 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.

3.7 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.
- B. 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.
- C. Collect, assemble, and submit test and inspection reports.

3.8 MAINTENANCE

- A. Software Service Agreement:
 - 1. Technical Support: Beginning at Substantial Completion, verify that software service agreement includes software support for two years.
 - 2. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within two years from date of Substantial Completion.
 - 3. Upgrade Reports: Prepare report after each update, documenting upgrades installed.

END OF SECTION 271513

SECTION 284621.11 - ADDRESSABLE FIRE-ALARM SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Addressable fire-alarm system.
 - 2. Fire-alarm control panel (FACP).
 - 3. Manual fire-alarm boxes.
 - 4. System smoke detectors.
 - 5. Duct smoke detectors.
 - 6. Heat detectors.
 - 7. Fire-alarm notification appliances.
 - 8. Exit-marking audible notification appliances.
 - 9. Firefighters' smoke-control system.
 - 10. Fire-alarm remote annunciators.
 - 11. Fire-alarm addressable interface devices.
- B. Related Requirements:
 - 1. Section 260519 "Low-Voltage Electrical Power Conductors and Cables" or

1.3 DEFINITIONS

- A. DACT: Digital alarm communicator transmitter.
- B. EMT: Electrical metallic tubing.
- C. FACP: Fire-alarm control Panel.
- D. High-Performance Building: A building that integrates and optimizes on a life-cycle basis all major high-performance attributes, including energy conservation, environment, safety, security, durability, accessibility, cost-benefit, productivity, sustainability, functionality, and operational considerations.
- E. Mode: The terms "Active Mode," "Off Mode," and "Standby Mode" are used as defined in the 2007 Energy Independence and Security Act (EISA).
- F. NICET: National Institute for Certification in Engineering Technologies.
- G. PC: Personal computer.

- H. Voltage Class: For specified circuits and equipment, voltage classes are defined as follows:
 - 1. Control Voltage: Listed and labeled for use in remote-control, signaling, and power-limited circuits supplied by a Class 2 or Class 3 power supply having rated output not greater than 150 V and 5 A, allowing use of alternate wiring methods complying with NFPA 70, Article 725.
 - 2. Low Voltage: Listed and labeled for use in circuits supplied by a Class 1 or other power supply having rated output not greater than 1000 V, requiring use of wiring methods complying with NFPA 70, Article 300, Part I.

1.4 SEQUENCING AND SCHEDULING

- A. Existing Fire-Alarm Equipment: Maintain existing equipment fully operational until new equipment has been tested and accepted. When new equipment is installed, label it "NOT IN SERVICE" until it is accepted. Remove labels from new equipment when put into service, and label existing fire-alarm equipment "NOT IN SERVICE" until removed from building.
- B. Equipment Removal: After acceptance of new fire-alarm system, remove existing disconnected fire-alarm equipment and wiring.

1.5 ACTION SUBMITTALS

- A. Approved Permit Submittal: Submittals must be approved by authorities having jurisdiction prior to submitting them to Architect.
- B. Product Data: For each type of product, including furnished options and accessories.
 - 1. Include construction details, material descriptions, dimensions, profiles, and finishes.
 - 2. Include rated capacities, operating characteristics, and electrical characteristics.
- C. Shop Drawings: For fire-alarm system.
 - 1. Coordinate with and obtain approval from the local Fire Chief (AHJ), prior to the Shop Drawing submittal.
 - 2. Comply with recommendations and requirements in "Documentation" section of "Fundamentals" chapter in NFPA 72.
 - 3. Include plans, elevations, sections, and details, including details of attachments to other Work.
 - 4. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and locations. Indicate conductor sizes, indicate termination locations and requirements, and distinguish between factory and field wiring.
 - 5. Annunciator panel details as required by authorities having jurisdiction.
 - 6. Detail assembly and support requirements.
 - 7. Include voltage drop calculations for notification-appliance circuits.
 - 8. Include battery-size calculations.
 - 9. Include input/output matrix.
 - 10. Include written statement from manufacturer that equipment and components have been tested as a system and comply with requirements in this Section and in NFPA 72.
 - 11. Include performance parameters and installation details for each detector.
 - 12. Verify that each duct detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.

13. Provide program report showing that air-sampling detector pipe layout balances pneumatically within airflow range of air-sampling detector.
 14. Provide control wiring diagrams for fire-alarm interface to HVAC; coordinate location of duct smoke detectors and access to them.
 - a. Show critical dimensions that relate to placement and support of sampling tubes, detector housing, and remote status and alarm indicators.
 - b. Show field wiring and equipment required for HVAC unit shutdown on alarm.
 - c. Locate detectors in accordance with manufacturer's written instructions.
 - d. Show air-sampling detector pipe routing.
 15. Include voice/alarm signaling-service equipment rack or console layout, grounding schematic, amplifier power calculation, and single-line connection diagram.
- D. Delegated Design Submittal: For notification appliances and smoke and heat detectors, in addition to submittals listed above, indicate compliance with performance requirements and design criteria, including analysis data signed and sealed by qualified professional engineer responsible for their preparation.
1. Drawings showing location of each notification appliance and smoke and heat detector, ratings of each, and installation details as needed to comply with listing conditions of device.
 2. Design Calculations: Calculate requirements for selecting spacing and sensitivity of detection, complying with NFPA 72. Calculate spacing and intensities for strobe signals and sound-pressure levels for audible appliances.
 3. Indicate audible appliances required to produce square wave signal per NFPA 72.

1.6 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.
- B. Qualification Statements: For Installer.
- C. Sample Warranty: Submittal must include line item pricing for replacement parts and labor.

1.7 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For fire-alarm systems and components to include in emergency, operation, and maintenance manuals.
 1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following.
 - a. Comply with "Records" section of "Inspection, Testing and Maintenance" chapter in NFPA 72.
 - b. Provide "Fire-Alarm and Emergency Communications System Record of Completion Documents" in accordance with "Completion Documents" Article in "Documentation" section of "Fundamentals" chapter in NFPA 72.
 - c. Complete wiring diagrams showing connections between devices and equipment. Each conductor must be numbered at every junction point with indication of origination and termination points.
 - d. Riser diagram.
 - e. Device addresses.
 - f. Record copy of site-specific software.

- g. Provide "Inspection and Testing Form" in accordance with "Inspection, Testing and Maintenance" chapter in NFPA 72, and include the following:
 - 1) Equipment tested.
 - 2) Frequency of testing of installed components.
 - 3) Frequency of inspection of installed components.
 - 4) Requirements and recommendations related to results of maintenance.
 - 5) Manufacturer's user training manuals.
- h. Manufacturer's required maintenance related to system warranty requirements.
- i. Abbreviated operating instructions for mounting at FACP and each annunciator unit.

1.8 MAINTENANCE MATERIAL SUBMITTALS

- A. Extra Stock Material: Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Lamps for Remote Indicating Lamp Units: Quantity equal to 10 percent of amount installed, but no fewer than one unit.
 - 2. Lamps for Strobe Units: Quantity equal to 10 percent of amount installed, but no fewer than one unit.
 - 3. Smoke Detectors, Fire Detectors: Quantity equal to 10 percent of amount of each type installed, but no fewer than one unit of each type.
 - 4. Detector Bases: Quantity equal to two percent of amount of each type installed, but no fewer than one unit of each type.
 - 5. Keys and Tools: One extra set for access to locked or tamperproofed components.
 - 6. Audible and Visual Notification Appliances: One of each type installed.
 - 7. Fuses: Two of each type installed in system. Provide in box or cabinet with compartments marked with fuse types and sizes.
 - 8. Filters for Air-Sampling Detectors: Quantity equal to two percent of amount of each type installed, but no fewer than one unit of each type.
 - 9. Air-Sampling Fan: Quantity equal to one for every five detectors, but no fewer than one unit of each type.

1.9 QUALITY ASSURANCE

- A. Installer Qualifications:
 - 1. Personnel must be trained and certified by manufacturer for installation of units required for this Project.
 - 2. Installation must be by personnel certified by NICET as fire-alarm Level III technician.
 - 3. Obtain certification by NRTL in accordance with NFPA 72.
 - 4. Licensed or certified by authorities having jurisdiction.

1.10 WARRANTY

- A. Provide Manufacturer's standard warranty.

PART 2 - PRODUCTS

2.1 ADDRESSABLE FIRE-ALARM SYSTEM

- A. Description:
 - 1. Noncoded, UL-certified addressable system, with multiplexed signal transmission and horn-and-strobe notification for evacuation.
- B. Performance Criteria:
 - 1. Regulatory Requirements:
 - a. Fire-Alarm Components, Devices, and Accessories: Listed and labeled by a NRTL in accordance with NFPA 70 for use with selected fire-alarm system and marked for intended location and application.
 - 2. General Characteristics:
 - a. Automatic sensitivity control of certain smoke detectors.
 - b. Fire-alarm signal initiation must be by one or more of the following devices:
 - 1) Manual stations.
 - 2) Heat detectors.
 - 3) Smoke detectors.
 - 4) Duct smoke detectors.
 - 5) Carbon monoxide detectors.
 - 6) Combustible gas detectors.
 - 7) Automatic sprinkler system water flow.
 - c. Fire-alarm signal must initiate the following actions:
 - 1) Continuously operate alarm notification appliances.
 - 2) Identify alarm and specific initiating device at FACP and remote annunciators.
 - 3) Transmit alarm signal to remote alarm receiving station.
 - 4) Switch HVAC equipment controls to fire-alarm mode.
 - 5) Close smoke dampers in air ducts of designated air-conditioning duct systems.
 - 6) Activate emergency lighting control.
 - 7) Activate emergency shutoffs for gas and fuel supplies.
 - 8) Record events in system memory.
 - d. Supervisory signal initiation must be by one or more of the following devices and actions:
 - 1) Valve supervisory switch.
 - 2) Zones or individual devices have been disabled.
 - 3) FACP has lost communication with network.
 - e. System trouble signal initiation must be by one or more of the following devices and actions:
 - 1) Open circuits, shorts, and grounds in designated circuits.
 - 2) Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
 - 3) Loss of communication with addressable sensor, input module, relay, control module, remote annunciator, printer interface, or Ethernet module.
 - 4) Loss of primary power at FACP.
 - 5) Ground or single break in internal circuits of FACP.
 - 6) Abnormal ac voltage at FACP.
 - 7) Break in standby battery circuitry.

- 8) Failure of battery charging.
- 9) Abnormal position of switch at FACP or annunciator.
- 10) Voice signal amplifier failure.
- 11) Hose cabinet door open.
- f. System Supervisory Signal Actions:
 - 1) Initiate notification appliances.
 - 2) Identify specific device initiating event at FACP and remote annunciators
 - 3) Record event on system printer.
 - 4) After time delay of 200 seconds, transmit trouble or supervisory signal to remote alarm receiving station.
 - 5) Transmit system status to building management system.
 - 6) Display system status on graphic annunciator.
- g. Network Communications:
 - 1) Provide network communications for fire-alarm system in accordance with fire-alarm manufacturer's written instructions.
 - 2) Provide network communications pathway per manufacturer's written instructions and requirements in NFPA 72 and NFPA 70.
 - 3) Provide integration gateway using BACnet or Modbus for connection to building automation system. Coordinate with Division 23.
- h. Document Storage Box:
 - 1) Description: Enclosure to accommodate standard 8-1/2-by-11 inch (216-by-279 mm) manuals and loose document records. Legend sheet will be permanently attached to door for system required documentation, key contacts, and system information. Provide two key ring holders with location to mount standard business cards for key contact personnel.
 - 2) Material and Finish: 18-gauge cold-rolled steel; four mounting holes.
 - 3) Color: Red powder-coat epoxy finish.
 - 4) Labeling: Permanently screened with 1 inch (25 mm) high lettering "SYSTEM RECORD DOCUMENTS" with white indelible ink.
 - 5) Security: Locked with 3/4 inch (19 mm) barrel lock. Provide solid 12 inch (304 mm) stainless steel piano hinge.

2.2 FIRE-ALARM CONTROL PANEL (FACP)

- A. Siemens, Notifier, Gamewell, Simplex/JCI, Edwards EST, or approved equal.
- B. Description: Field-programmable, microprocessor-based, modular, power-limited design with electronic modules.
- C. Performance Criteria:
 - 1. Regulatory Requirements: Comply with NFPA 72 and UL 864.
 - 2. General Characteristics:
 - a. System software and programs must be held in nonvolatile flash, electrically erasable, programmable, read-only memory, retaining information through failure of primary and secondary power supplies.
 - b. Include real-time clock for time annotation of events on event recorder and printer.
 - c. Provide communication between FACP and remote circuit interface panels, annunciators, and displays.
 - d. FACP must be listed for connection to central-station signaling system service.

- e. Provide nonvolatile memory for system database, logic, and operating system and event history. System must require no manual input to initialize in the event of complete power down condition. FACP must provide minimum 500-event history log.
- f. Addressable Initiation Device Circuits: FACP must indicate which communication zones have been silenced and must provide selective silencing of alarm notification appliance by building communication zone.
 - 1) Addressable Control Circuits for Operation of Notification Appliances and Mechanical Equipment: FACP must be listed for releasing service.
- g. Fire-Alarm Annunciator: Arranged for interface between human operator at FACP and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and programming and control menu.
 - 1) Annunciator and Display: LCD, 80 characters, minimum.
 - 2) Keypad: Arranged to permit entry and execution of programming, display, and control commands.
- h. Initiating-Device, Notification-Appliance, and Signaling-Line Circuits:
 - 1) Pathway Class Designations: NFPA 72, Class B.
 - 2) Pathway Survivability: Level 0.
 - 3) Install no more than 50 addressable devices on each signaling-line circuit.
 - 4) Install fault circuit isolators to comply with circuit performance requirements of NFPA 72 or with manufacturer's written instructions, whichever is more conservative.
- i. Serial Interfaces:
 - 1) One dedicated RS 485 port for central station operation using point ID DACT.
 - 2) One RS 485 port for remote annunciators, Ethernet module, or multi-interface module (printer port).
 - 3) One USB port for PC configuration.
- j. Stairwell Pressurization: Provide output signal using addressable relay to start stairwell pressurization system. Signal must remain on until alarm conditions are cleared and fire-alarm system is reset. Signal must not stop in response to alarm acknowledge or signal silence commands.
 - 1) Pressurization starts when alarm is received at FACP.
 - 2) Alarm signals from smoke detectors at pressurization air supplies have higher priority than other alarm signals that start system.
- k. Notification-Appliance Circuit:
 - 1) Audible appliances must sound in three-pulse temporal pattern, as defined in NFPA 72.
 - 2) Where notification appliances provide signals to sleeping areas, alarm signal must be 520 Hz square wave with intensity 15 dB above average ambient sound level or 5 dB above maximum sound level, or at least 75 dB(A-weighted), whichever is greater, measured at pillow.
 - 3) Visual alarm appliances must flash in synchronization where multiple appliances are in same field of view, as defined in NFPA 72.
- l. Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, supervisory, and trouble signals to remote alarm station.
- m. Indicate number of alarm channels for automatic, simultaneous transmission of different announcements to different zones or for manual transmission of announcements by use of central-control microphone. Amplifiers must comply with UL 1711.

- 1) Allow application of, and evacuation signal to, indicated number of zones and simultaneously allow voice paging to other zones selectively or in combination.
 - 2) Programmable tone and message sequence selection.
 - 3) Standard digitally recorded messages for "Evacuation" and "All Clear."
 - 4) Generate tones to be sequenced with audio messages of type recommended by NFPA 72 and that are compatible with tone patterns of notification-appliance circuits of FACP.
- n. Status Annunciator: Indicate status of various voice/alarm speaker zones and status of firefighters' two-way telephone communication zones.
 - o. Preamplifiers, amplifiers, and tone generators must automatically transfer to backup units, on primary equipment failure.
 - p. Primary Power: 24 V(dc) obtained from 120 V(ac) service and power-supply module. Initiating devices, notification appliances, signaling lines, trouble signals, and supervisory signals must be powered by 24 V(dc) source.
 - q. Alarm current draw of entire fire-alarm system must not exceed 80 percent of power-supply module rating.
 - r. Secondary Power: 24 V(dc) supply system with batteries, automatic battery charger, and automatic transfer switch.
 - s. Batteries: Sealed lead calcium or Sealed, valve-regulated, recombinant lead acid or Vented, wet-cell pocket, plate nickel cadmium.

D. Accessories:

1. Instructions: Computer printout or typewritten instruction card mounted behind plastic or glass cover in stainless steel or aluminum frame. Include interpretation and describe appropriate response for displays and signals. Briefly describe functional operation of system under normal, alarm, and trouble conditions.

2.3 MANUAL FIRE-ALARM BOXES

- A. Siemens, Notifier, Gamewell, Simplex/JCI, Edwards EST, or approved equal.
- B. General Requirements for Manual Fire-Alarm Boxes: Comply with UL 38. Boxes must be finished in red with molded, raised-letter operating instructions in contrasting color; must show visible indication of operation; and must be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer's surface back box.
 1. Single-action mechanism, pull-lever type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to FACP.
 2. Double-action mechanism requiring two actions to initiate alarm, pull-lever type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to FACP.
 3. Station Reset: Key- or wrench-operated switch.
 4. Able to be used in indoor areas.

2.4 SYSTEM SMOKE DETECTORS

- A. Photoelectric Smoke Detectors:
 1. Siemens, Notifier, Gamewell, Simplex/JCI, Edwards EST, or approved equal.
 2. Performance Criteria:

- a. Regulatory Requirements:
 - 1) NFPA 72.
 - 2) UL 268.
- b. General Characteristics:
 - 1) Detectors must be two-wire type.
 - 2) Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to FACP.
 - 3) Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
 - 4) Integral Visual-Indicating Light: LED type, indicating detector has operated and power-on status.
 - 5) Detector address must be accessible from FACP and must be able to identify detector's location within system and its sensitivity setting.
 - 6) Operator at FACP, having designated access level, must be able to manually access the following for each detector:
 - a) Primary status.
 - b) Device type.
 - c) Present average value.
 - d) Present sensitivity selected.
 - e) Sensor range (normal, dirty, etc.).
 - 7) Detector must have functional humidity range within 10 to 90 percent relative humidity.
 - 8) Color: White.
 - 9) Multiple levels of detection sensitivity for each sensor.
 - 10) Sensitivity levels based on time of day.

2.5 DUCT SMOKE DETECTORS

- A. Siemens, Notifier, Gamewell, Simplex/JCI, Edwards EST, or approved equal.
- B. Description: Photoelectric-type, duct-mounted smoke detector.
- C. Performance Criteria:
 - 1. Regulatory Requirements:
 - a. NFPA 72.
 - b. UL 268A.
 - 2. General Characteristics:
 - a. Detectors must be two-wire type.
 - b. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to FACP.
 - c. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
 - d. Integral Visual-Indicating Light: LED type, indicating detector has operated and power-on status.
 - e. Detector address must be accessible from FACP and must be able to identify detector's location within system and its sensitivity setting.
 - f. Operator at FACP, having designated access level, must be able to manually access the following for each detector:
 - 1) Primary status.
 - 2) Device type.

- 3) Present average value.
- 4) Present sensitivity selected.
- 5) Sensor range (normal, dirty, etc.).
- g. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with supplied detector for smoke detection in HVAC system ducts.
- h. Each sensor must have multiple levels of detection sensitivity.
- i. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.

2.6 CARBON MONOXIDE DETECTORS

- A. Siemens, Notifier, Gamewell, Simplex/JCI, Edwards EST, or approved equal.
- B. Description: Carbon monoxide detector listed for connection to fire-alarm system.
- C. Performance Criteria:
 - 1. Regulatory Requirements:
 - a. NFPA 72
 - b. NFPA 720.
 - c. UL 2075.
 - 2. General Characteristics:
 - a. Mounting: Adapter plate for outlet box mounting.
 - b. Testable by introducing test carbon monoxide into sensing cell.
 - c. Detector must provide alarm contacts and trouble contacts.
 - d. Detector must send trouble alarm when nearing end-of-life, power supply problems, or internal faults.
 - e. Locate, mount, and wire in accordance with manufacturer's written instructions.
 - f. Provide means for addressable connection to fire-alarm system.
 - g. Test button simulates alarm condition.

2.7 HEAT DETECTORS

- A. Combination-Type Heat Detectors:
 - 1. Siemens, Notifier, Gamewell, Simplex/JCI, Edwards EST, or approved equal.
 - 2. Performance Criteria:
 - a. Regulatory Requirements:
 - 1) NFPA 72.
 - 2) UL 521.
 - b. General Characteristics:
 - 1) Temperature sensors must test for and communicate sensitivity range of device.
 - c. Actuated by fixed temperature of 135 deg F (57 deg C) or rate of rise that exceeds 15 deg F (8 deg C) per minute unless otherwise indicated.
 - d. Mounting: Adapter plate for outlet box mounting or Twist-lock base interchangeable with smoke-detector bases.
 - e. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to FACP.
 - f. Detector must have functional humidity range of 10 to 90 percent relative humidity.

- g. Color: White.
- B. Fixed-Temperature-Type Heat Detectors:
- 1. Siemens, Notifier, Gamewell, Simplex/JCI, Edwards EST, or approved equal.
 - 2. Performance Criteria:
 - a. Regulatory Requirements:
 - 1) NFPA 72.
 - 2) UL 521.
 - b. General Characteristics:
 - 1) Actuated by temperature that exceeds fixed temperature of 190 deg F (88 deg C).
 - 2) Mounting: Adapter plate for outlet box mounting or Twist-lock base interchangeable with smoke-detector bases.
 - 3) Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to FACP.
 - 4) Detector must have functional humidity range of 10 to 90 percent.
 - 5) Color: White.

2.8 FIRE-ALARM NOTIFICATION APPLIANCES

- A. Fire-Alarm Audible Notification Appliances:
- 1. Siemens, Notifier, Gamewell, Simplex/JCI, Edwards EST, or approved equal.
 - 2. Description: Horns, bells, or other notification devices that cannot output voice messages.
 - 3. Performance Criteria:
 - a. Regulatory Requirements:
 - 1) NFPA 72.
 - b. General Characteristics:
 - 1) Connected to notification-appliance signal circuits, zoned as indicated, equipped for mounting as indicated, and with screw terminals for system connections.
 - 2) Chimes, Low-Level Output: Vibrating type, 75 dB(A-weighted) minimum rated output.
 - 3) Chimes, High-Level Output: Vibrating type, 81 dB(A-weighted) minimum rated output.
 - 4) Sounders, High Volume 24 V(dc): Less than 6 mA of alarm current.
 - 5) Sounders, Low Volume 24 V(dc): Less than 4 mA of alarm current.
 - 6) Audible notification appliances must have functional humidity range of 10 to 95 percent relative humidity.
 - 7) ISO Temporal 3 Evacuation Tone: 90 plus or minus 4 dB(A-weighted) at 24 V.
 - 8) ISO Temporal 3 Alert Tone: 95 plus or minus 5 dB(A-weighted) at 24 V.
 - 9) AS2220 Evacuation Tone: 93 plus or minus 4 dB(A-weighted) at 24 V.
 - 10) AS2220 Alert Tone: 93 plus or minus 5 dB(A-weighted) at 24 V.
 - 11) Horns: Electric-vibrating-polarized type, 24 V(dc); with provision for housing operating mechanism behind grille. Comply with UL 464. Horns must produce sound-pressure level of 90 dB(A-weighted), measured 10 ft. (3 m) from horn, using coded signal prescribed in UL 464 test protocol.
- B. Fire-Alarm Visible Notification Appliances:
- 1. Siemens, Notifier, Gamewell, Simplex/JCI, Edwards EST, or approved equal.

2. Performance Criteria:
 - a. Regulatory Requirements:
 - 1) NFPA 72.
 - 2) UL 1971.
 - b. General Characteristics:
 - 1) Clear or nominal white polycarbonate lens mounted on aluminum faceplate.
 - 2) Mounting: Wall mounted unless otherwise indicated.
 - 3) For units with guards to prevent physical damage, light output ratings must be determined with guards in place.
 - 4) Flashing must be in temporal pattern, synchronized with other units.
 - 5) Strobe Leads: Factory connected to screw terminals.
 - 6) Mounting Faceplate: Factory finished, red.

2.9 FIRE-ALARM REMOTE ANNUNCIATORS

- A. Siemens, Notifier, Gamewell, Simplex/JCI, Edwards EST, or approved equal.
- B. Performance Criteria:
 1. Regulatory Requirements:
 - a. NFPA 72.
 2. General Characteristics:
 - a. Annunciator functions must match those of FACP for alarm, supervisory, and trouble indications. Manual switching functions must match those of FACP, including acknowledging, silencing, resetting, and testing.
 - 1) Mounting: Flush cabinet, NEMA 250, Type 1.
 - b. Display Type and Functional Performance: Alphanumeric display and LED indicating lights must match those of FACP. Provide controls to acknowledge, silence, reset, and test functions for alarm, supervisory, and trouble signals.

2.10 FIRE-ALARM ADDRESSABLE INTERFACE DEVICES

- A. Siemens, Notifier, Gamewell, Simplex/JCI, Edwards EST, or approved equal.
- B. Performance Criteria:
 1. Regulatory Requirements:
 - a. NFPA 72.
 2. General Characteristics:
 - a. Include address-setting means on module.
 - b. Store internal identifying code for control panel use to identify module type.
 - c. Listed for controlling HVAC fan motor controllers.
 - d. Monitor Module: Microelectronic module providing system address for alarm-initiating devices for wired applications with normally open contacts.
 - e. Integral Relay: Capable of providing direct signal to circuit-breaker shunt trip for power shutdown.
 - 1) Allow control panel to switch relay contacts on command.
 - 2) Have minimum of two normally open and two normally closed contacts available for field wiring.
 - f. Control Module:
 - 1) Operate notification devices.

- 2) Operate solenoids for use in sprinkler service.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions for compliance with requirements for ventilation, temperature, humidity, and other conditions affecting performance of the Work.
 1. Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment and wiring are installed, before installation begins.
- B. Examine roughing-in for electrical connections to verify actual locations of connections before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Preinstallation Testing: Perform verification of functionality of installed components of existing system prior to starting work. Document equipment or components not functioning as designed.
- B. Interruption of Existing Fire-Alarm Service: Do not interrupt fire-alarm service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary guard service in accordance with requirements indicated:
 1. Notify Construction Manager and Owner no fewer than seven days in advance of proposed interruption of fire-alarm service.
 2. Do not proceed with interruption of fire-alarm service without Owner's written permission.
- C. Protection of In-Place Conditions: Protect devices during construction unless devices are placed in service to protect facility during construction.

3.3 INSTALLATION OF EQUIPMENT

- A. Comply with NECA 305, NFPA 72, NFPA 101, and requirements of authorities having jurisdiction for installation and testing of fire-alarm equipment. Install electrical wiring to comply with requirements in NFPA 70 including, but not limited to, Article 760, "Fire Alarm Systems."
 1. Devices placed in service before other trades have completed cleanup must be replaced.
 2. Devices installed, but not yet placed, in service must be protected from construction dust, debris, dirt, moisture, and damage in accordance with manufacturer's written storage instructions.
- B. Conform to all requirements of the Authority Having Jurisdiction (AHJ).
- C. All components of the same manufacturer, FM approved and listed by Underwriters' Laboratories, Inc., and so labeled.

- D. Smoke detectors shall not be installed prior to system programming and testing period. If construction is on going during this period, then protect the smoke detectors from contamination and physical damage.
- E. Make conduit and wiring connections to door release devices, sprinkler flow switches, sprinkler valve tamper switches, duct smoke detectors.
- F. Provide nameplates identifying all equipment, junction boxes and controls. Paint all junction boxes red.
- G. Include all necessary software, programming and the selection of the proper type and quantities of the system components to assure a complete, operational, and Code Compliant System.
- H. Where the effect of more than one strobe is visible in one location (including reflected light), then configure the system to synchronize the strobes.
- I. All devices and panels shall be flush mounted in finished areas and may be surface mounted in unfinished areas such as storage rooms. Where devices are surface mounted, the back box shall be a cast red box designed to mate with the device for a smooth appearance.
- J. System shall be completely field programmable.
- K. The drawings do not show all details of the Fire Alarm System. It shall be the responsibility of the authorized supplier/installer to provide a fully operational code compliant system.
 - 1. HVAC units: Interface shall be field programmable to allow activation on general alarm and/or on selective zoning of local detectors. Set initially to shut down on general alarm, plus send status signal to the Energy Management/Temperature Control system (ATC) provided under Division 23 Section "Instrumentation and Control for Mechanical Systems". For all HVAC equipment that is required to be shut down upon a fire alarm condition, ensure that fire alarm shutdown of equipment is wired through input contacts within the starter enclosure. Upon receipt of a signal from the building's fire alarm system, power to the load side of the starter shall be turned off. Circuitry shall be provided to ensure that power is off whether the starter is in the "AUTO", "HAND" or "BYPASS" mode. If this feature is not available from the starter manufacturer, Division 23 shall be responsible for providing a contactor on the line side of the starter to accomplish the same function. The contactor shall meet the requirements specified under this division.
 - 2. HVAC Duct Smoke Dampers: Interface shall be field programmable to allow activation on general alarm and/or on selective zoning of local detectors. Set initially to close dampers on general alarm, plus send status signal to the Energy Management/Temperature Control system (ATC) provided under Division 23 Section "Instrumentation and Control for Mechanical Systems".
- L. Install wall-mounted equipment, with tops of cabinets not more than 78 inch (1980 mm) above finished floor.
- M. Manual Fire-Alarm Boxes:
 - 1. Install manual fire-alarm box in normal path of egress within 60 inch (1520 mm) of exit doorway.
 - 2. Mount manual fire-alarm box on background of contrasting color.

3. Operable part of manual fire-alarm box must be between 42 and 48 inch (1060 and 1220 mm) above floor level. Devices must be mounted at same height unless otherwise indicated.
- N. Smoke- and Heat-Detector Spacing:
1. Comply with "Smoke-Sensing Fire Detectors" section in "Initiating Devices" chapter in NFPA 72, for smoke-detector spacing.
 2. Comply with "Heat-Sensing Fire Detectors" section in "Initiating Devices" chapter in NFPA 72, for heat-detector spacing.
 3. Smooth ceiling spacing must not exceed 30 ft. (9 m).
 4. Spacing of detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas must be determined in accordance with Annex A in NFPA 72.
 5. HVAC: Locate detectors not closer than 36 inch (910 mm) from air-supply diffuser or return-air opening.
 6. Lighting Fixtures: Locate detectors not closer than 12 inch (300 mm) from lighting fixture and not directly above pendant mounted or indirect lighting.
- O. Install cover on each smoke detector that is not placed in service during construction. Cover must remain in place except during system testing. Remove cover prior to system turnover.
- P. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend full width of duct. Tubes more than 36 inch (9100 mm) long must be supported at both ends.
1. Do not install smoke detector in duct smoke-detector housing during construction. Install detector only during system testing and prior to system turnover.
- Q. Single-Station Smoke Detectors: Where more than one smoke alarm is installed within dwelling or suite, they must be connected so that operation of smoke alarm causes alarm in smoke alarms to sound.
- R. Remote Status and Alarm Indicators: Install in visible location near each smoke detector, sprinkler water-flow switch, and valve-tamper switch that is not readily visible from normal viewing position.
- S. Audible Alarm-Indicating Devices: Install not less than 6 inch (150 mm) below ceiling. Install bells and horns on flush-mounted back boxes with device-operating mechanism concealed behind grille. Install devices at same height unless otherwise indicated.
- T. Visible Alarm-Indicating Devices: Install adjacent to each alarm bell or alarm horn and at least 6 inch (150 mm) below ceiling. Install devices at same height unless otherwise indicated.
- U. Device Location-Indicating Lights: Locate in public space near device they monitor.

3.4 ELECTRICAL CONNECTIONS

- A. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- B. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."

- C. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.
- D. Mount outlet box for electric door holder to withstand 80 pounds pulling force.
- E. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.
 - 1. Nameplate must be laminated acrylic or melamine plastic signs, as specified in Section 260553 "Identification for Electrical Systems."

3.5 CONTROL CONNECTIONS

- A. Install control and electrical power wiring to field-mounted control devices.
- B. Connect control wiring in accordance with Section 260523 "Control-Voltage Electrical Power Cables."
- C. Install nameplate for each control connection, indicating field control panel designation and I/O control designation feeding connection.

3.6 PATHWAYS

- A. Pathways must be installed in EMT.
- B. Exposed EMT must be painted red enamel.

3.7 CONNECTIONS

- A. Make addressable connections with supervised interface device to the following devices and systems. Install interface device less than 36 inch (910 mm) from device controlled. Make addressable confirmation connection when such feedback is available at device or system being controlled.
 - 1. Smoke dampers in air ducts of designated HVAC duct systems.
 - 2. Alarm-initiating connection to activate emergency lighting control.
 - 3. Alarm-initiating connection to activate emergency shutoffs for gas and fuel supplies.
 - 4. Supervisory connections at valve supervisory switches.
 - 5. Data communication circuits for connection to building management system.
 - 6. Supervisory connections at fire-extinguisher locations.

3.8 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 270553 "Identification for Communications Systems."
- B. At FACP provide minimum of two ground rods with a "box connecting rod" or a #12 AWG solid copper wire, enclosed in conduit, connect to ground terminal of the FACP. Resistance of ground connection shall not exceed 25 ohms.

- C. Install framed instructions in location visible from FACP.

3.9 GROUNDING

- A. Ground FACP and associated circuits in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."
- B. Ground shielded cables at control panel location only. Insulate shield at device location.

3.10 FIELD QUALITY CONTROL

- A. Field tests must be witnessed by Owner, Contractor, and authorities having jurisdiction (Local Fire Chief). Invite Architect/Engineer's representative.
- B. Administrant for Tests and Inspections:
 - 1. Engage factory-authorized service representative to administer and perform tests and inspections on components, assemblies, and equipment installations, including connections.
- C. Tests and Inspections:
 - 1. Include testing at substantial completion, at 6 months after occupancy and again two weeks prior to end of first year warranty. (Total of 3 complete documented tests). Invite the Owner, Architect and Local Fire Department to witness each test.
 - 2. Visual Inspection: Conduct visual inspection prior to testing.
 - a. Inspection must be based on completed record Drawings and system documentation that is required by "Completion Documents, Preparation" table in "Documentation" section of "Fundamentals" chapter in NFPA 72.
 - b. Comply with "Visual Inspection Frequencies" table in "Inspection" section of "Inspection, Testing and Maintenance" chapter in NFPA 72; retain "Initial/Reacceptance" column and list only installed components.
 - 3. System Testing: Comply with "Test Methods" table in "Testing" section of "Inspection, Testing and Maintenance" chapter in NFPA 72.
- D. Test shall include but not be limited to:
 - 1. Before energizing the cables and wires, check for correct connections and test for short circuits, ground faults, continuity, and insulation.
 - 2. Close each sprinkler system flow valve and verify proper supervisory alarm at the FACP.
 - 3. Verify activation of all flow switches.
 - 4. Open initiating device circuits and verify that the trouble signal actuates.
 - 5. Open signaling line circuits and verify that the trouble signal actuates.
 - 6. Open and short notification appliance circuits and verify that trouble signal actuates.
 - 7. Open and short (wire only) network communications and verify that trouble signals are received at network annunciators or reporting terminals.
 - 8. Ground initiating device circuits and verify response of trouble signals.
 - 9. Ground signaling line circuits and verify response of trouble signals.
 - 10. Ground notification appliance circuits and verify response of trouble signals.
 - 11. Check alert tone and prerecorded voice message to all alarm notification devices.
 - 12. Check installation, supervision, and operation of all intelligent smoke detectors using walk test.

13. Each of the alarm conditions that the system is required to detect shall be introduced on the system. Verify the proper receipt and the proper processing of the signal at the FACP and the correct activation of the control panel points.
 14. When the Vendor determines that the system must be equipped with optional features to satisfy this specification, the manufacturer's manual shall be consulted to determine the proper testing procedures. This is intended to address such items as verifying controls performed by individually addressed or grouped devices, sensitivity monitoring, verification functionality and similar.
 15. Factory-authorized service representative must prepare "Fire Alarm System Record of Completion" in "Documentation" section of "Fundamentals" chapter in NFPA 72 and "Inspection and Testing Form" in "Records" section of "Inspection, Testing and Maintenance" chapter in NFPA 72.
- E. Reacceptance Testing: Perform reacceptance testing to verify proper operation of added or replaced devices and appliances.
 - F. Fire-alarm system will be considered defective if it does not pass tests and inspections.
 - G. Prepare test and inspection reports.

3.11 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain fire-alarm system.
- B. In addition to the site training on programming features previously specified, provide minimum of two four hour periods to instruct the owner in the proper operation and maintenance requirements of the system. Provide one four hour period at substantial completion (after all testing and the system is fully operational and accepted by the fire department) and the other four hour period six months after substantial completion.
- C. Provide a typewritten, bound, laminated "Sequence of Operation" to the Owner.

3.12 SOFTWARE SERVICE AGREEMENT

- A. Comply with UL 864.
- B. Technical Support: Beginning at Substantial Completion, service agreement must include software support for two years.
- C. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software must include operating system and new or revised licenses for using software.
 1. Upgrade Notice: At least 30 days to allow Owner to schedule access to system and to upgrade computer equipment if necessary.

END OF SECTION 284621.11

MAINE TURNPIKE AUTHORITY

SPECIFICATIONS

PART IV – APPENDIX 1

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Donohue, Sean W.

From: Lessard, Jeremy S CIV USARMY CENAE (USA) <Jeremy.S.Lessard@usace.army.mil>
Sent: Thursday, October 9, 2025 8:34 AM
To: Donohue, Sean W.
Cc: Taddeo, Brian A.; Van Ooyen, Kristi
Subject: RE: Crosby Maintenance Yard SVN Filing
Attachments: MAINE GENERAL PERMITS.pdf; MTA Crosby Staff Building SVN.pdf

This Message Is From an External Sender

This message came from outside your organization.

Hello Sean,

This is in reference to the Crosby Yard Site improvements located along the southbound lane of I-95 in Portland, Maine. I am contacting you regarding the Corps of Engineers permitting process.

Based on our review of your application your project appears to qualify for Self-Verification (SV) of the 2020 Maine General Permits (GPs). Projects that meet the terms & conditions of SV may proceed without further authorization with this office, provided the applicant complies with all requirements of applicable GPs. The General conditions can be found on the attached document on pages 6-19.

USACE has concluded our review on this project. You are required to notify this office should activities under our authority change. Please use this email as your documentation for this project. Reminder work must be under contract or commence by Oct. 14 of this year. Commencement of work can be a shovel scoop in the wetland.

Please call/ email with any questions.

Best Regards,

-Jeremy

Jeremy Lessard, PWS
Project Manager, Maine Project Office
New England District
U.S. Army Corps of Engineers
Cell: 978-941-3914
Desk: 978-318-8789

From: Donohue, Sean W. <sdonohue@maineturnpike.com>
Sent: Wednesday, October 8, 2025 3:39 PM
To: Lessard, Jeremy S CIV USARMY CENAE (USA) <Jeremy.S.Lessard@usace.army.mil>

Cc: Taddeo, Brian A. <BTaddeo@maineturnpike.com>; Van Ooyen, Kristi <KVanOoyen@maineturnpike.com>

Subject: [Non-DoD Source] Crosby Maintenance Yard SVN Filing

Hi Jeremy,

Attached is the Self Verification Notice for the proposed staff building at Crosby Maintenance Yard that I mentioned on the phone today.

I did start the USFWS IPAC to get the Official Species List and included that in the attached SVN filing, but did not run through any keys or project consultation. I was able to add you as a member to continue that review.

If you have any questions about the project or need anything else, please let me know.

Thanks for the help.

Sean



Sean Donohue, LSS, NHCWS, LSE
Permitting Coordinator/ Environmental Liaison

Maine Turnpike Authority
2360 Congress Street
Portland, ME 04102
Tel: 207-482-8275
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**DEPARTMENT OF THE ARMY
GENERAL PERMITS FOR
THE STATE OF MAINE**

The New England District of the U.S. Army Corps of Engineers (Corps) hereby issues 23 General Permits (GPs), listed below, for activities subject to Corps jurisdiction in waters of the United States within the boundaries of the State of Maine including tribal lands, and in adjacent ocean waters to the seaward limit of the outer continental shelf. These GPs are issued in accordance with Corps regulations at 33 CFR 320 – 332 and specifically 33 CFR 325.2(e)(2). These GPs will protect the aquatic environment and the public interest while effectively authorizing activities that have no more than minimal individual and cumulative adverse environmental effects.

This document contains the following sections:	Pages
I. CORPS JURISDICTION	1
II. GENERAL CRITERIA	2
III. PROCEDURES	3 – 4
IV. GENERAL CONDITIONS	5 – 19
V. MAINE GENERAL PERMITS	20 – 35
VI. SELF-VERIFICATION NOTIFICATION FORM	36
VII. CONTENT OF A PRE-CONSTRUCTION NOTIFICATION	37 – 42
VIII. AGENCY CONTACTS	43 – 45
IX. DEFINITIONS	46 – 51

I. CORPS JURISDICTION

1. Permits are required from the Corps for the following work:

- a. The construction of any structure in, over, or under any navigable water of the U.S. (see 33 CFR 328), the excavating or dredging from or depositing of material in such waters, or the accomplishment of any other work affecting the course, location, condition, or capacity of such waters. The Corps regulates these activities under Section 10 of the Rivers and Harbors Act of 1899 (see 33 CFR 322);
- b. The discharge of dredged or fill material and certain discharges associated with excavation into waters of the U.S. including wetlands. The Corps regulates these activities under Section 404 of the Clean Water Act (see 33 CFR 323); and
- c. The transportation of dredged material for the purpose of disposal in the ocean. The Corps regulates these activities under Section 103 of the Marine Protection, Research and Sanctuaries Act of 1972 (see 33 CFR 324).

2. Related laws: Section 408 of the Rivers and Harbors Act of 1899, Section 401 of the Clean Water Act, Section 402 of the Clean Water Act, Section 307(c) of the Coastal Zone Management Act of 1972, Section 106 of the National Historic Preservation Act of 1966, Section 7 of the Endangered Species Act, the Fish and Wildlife Coordination Act of 1956, the Magnuson-Stevens Fishery Conservation and Management Act, Section 302 of the Marine Protection, Research and Sanctuaries Act of 1972, and Section 7(a) of the Wild and Scenic Rivers Act.

II. GENERAL CRITERIA

1. In order for activities to qualify for these General Permits (GPs), they shall meet the GPs terms and eligibility criteria on pages 1-4, all applicable general conditions (GCs) in Section IV, and terms of the Maine General Permits in Section V. Any activity not specifically listed may still be eligible for authorization under these GPs; prospective permittees are advised to contact the Corps for specific eligibility determination.

2. Under these GPs, activities may qualify for the following:

- **SELF-VERIFICATION (SV):** Notification to the Corps is required at least two weeks before work commences; the Corps will acknowledge receipt and GP eligibility of the SV activity in writing.
- **PRE-CONSTRUCTION NOTIFICATION (PCN):** Notification to and written verification from the Corps is required. *No work under PCN may proceed until written verification from the Corps is received.*

The thresholds for activities eligible for SV and PCN are defined in the general conditions in Section IV and Maine General Permits in Section V.

3. Prospective permittees shall review:

- a. Section I to determine if the activity requires Corps authorization.
- b. Sections III , IV, and V to determine if the activity is eligible for authorization under these GPs, and specifically whether it is eligible for SV, or whether a PCN is required.

4. Prospective permittees are encouraged to contact the Corps with questions at any time (U.S. Army Corps of Engineers, Maine Project Office, 442 Civic Center Drive, Suite 350, Augusta, Maine 04330, ph. 207-623-8367). Pre-application meetings, whether arranged by the Corps or requested by a prospective permittee, are encouraged to facilitate the review of projects. Pre-application meetings and/or site visits help streamline the authorization process by alerting the prospective permittee to potentially time-consuming factors that are likely to arise during the evaluation of their project (e.g. avoidance, minimization and compensatory mitigation requirements, historic properties, endangered species, essential fish habitat, vernal pools, and dredging of contaminated sediments).

5. Permittees shall ensure compliance with all applicable GCs in Section IV and GPs in Section V. Non-compliance with these GPs and GCs may subject the permittee to criminal, civil, or administrative criminal penalties, and/or an ordered restoration, and/or the permit may be modified, suspended or revoked by the Corps.

III. PROCEDURES

1. **State Approvals.** Applicants are responsible for applying for and obtaining any required state or local approvals. Federal and state jurisdiction and review criteria may differ in some instances. State permits may be required for specific projects regardless of the GP category.

In order for authorizations under these GPs to be valid, when any of the following state approvals or statutorily-required reviews is also required, the approvals shall be obtained prior to the commencement of work in Corps jurisdiction:

- Maine Department of Environmental Protection (DEP): Natural Resources Protection Act (NRPA) permit, including permit-by-rule (PBR) and general permit authorizations; Site Location of Development Act permit; Maine Waterway Development and Conservation Act permit; and Maine Hazardous Waste, Septage, and Solid Waste Management Act license.
- Maine Department of Agriculture, Conservation and Forestry: Land Use Planning Commission (LUPC) permit.
- Maine Department of Marine Resources: Aquaculture Leases and Licenses.
- Maine Department of Agriculture, Conservation and Forestry, Bureau of Parks and Lands, Submerged Lands: Submerged Lands Lease.

2. **How to Obtain/Apply for Corps Authorization.**

a. **Self-Verification (SV):** Prospective permittees shall confirm that the activity meets all the applicable terms and conditions of SV. Consultation with the Corps and/or other relevant federal and state agencies may be necessary to ensure compliance with the applicable general conditions (GCs) and related federal laws such as the National Historic Preservation Act (GC 15), the Endangered Species Act (GC 16), the Magnuson-Stevens Fishery Conservation and Management Act (GC 17), and the Wild and Scenic Rivers Act (GC 13). Activities that are eligible for SV are authorized under these GPs provided the prospective permittee has:

- i. Confirmed that the activity meets all applicable terms and conditions of SV.
- ii. Provided notifications to the State Historic Preservation Officer (SHPO) (the SHPO in the State of Maine is the Maine Historic Preservation Commission, or MHPC) and all five federally-recognized tribes in the State of Maine (Tribal Historic Preservation Officers, or THPOs) listed in Section VIII before submitting the SV to the Corps in order to be reviewed for the presence of historic, archeological, architectural, or tribal resources in the action area that the activity may affect (see GC 15). Prospective permittees are not required to wait for a response to their notifications before submitting the SV to the Corps.
- iii. At least two weeks before work is to commence, submitted to the Corps a Self-Verification Notification Form (SVNF, page 36) with all of the following attachments: location map, project plans, and an Official Species List of federally threatened and endangered species that may occur in the activity's action area and the email address of the person who generated the list (see GC 16).

NOTE: A copy of a state permit application form may be an acceptable surrogate for the SVNF itself; however, the applicant shall not rely on the state permitting agency to provide the Corps a copy of their state permit application.

b. **Pre-Construction Notification (PCN):** Notification to, and written verification from the Corps is required. For activities that do not qualify for SV or where otherwise required by the terms and conditions of the GPs, the prospective permittee shall submit a PCN and obtain written verification from the Corps before starting work in Corps jurisdiction. The Corps will coordinate review of all PCN activities with other federal and state agencies, as appropriate. The Corps will attempt to issue written verification of the PCN within 60 days of receiving a complete application.

All prospective permittees for PCN activities shall follow the instructions on found on pages 37 – 42, and in particular:

- i. Submit directly to the Corps application form *ENG Form 4345* (pages 40 – 42), or the surrogate state permit application form as noted above.

- ii. Provide project information outlined on pages 37 – 42 (Content of a Pre-Construction Notification).
- iii. Submit an Official Species List of federally threatened and endangered species that may occur in the activity's action area and the email address of the person who generated the list (GC 16).
- iv. Provide notifications to the SHPO (MHPC) and all five THPOs in the State of Maine listed in Section VIII before submitting the PCN to the Corps in order to be reviewed for the presence of historic, archeological, architectural, or tribal resources in the action area that the activity may affect (see GC 15). The PCN shall include documentation that MHPC and all of the THPOs were notified (a copy of the prospective permittee's cover letter or emails to MHPC and the THPOs is acceptable). Prospective permittees are not required to wait for a response to their notifications before submitting a PCN to the Corps.

c. Individual Permit (IP): Projects that are not eligible for these GPs require an IP (33 CFR 325.5(b)) and prospective permittees shall submit an application directly to the Corps. These GPs do not affect the Corps IP review process or activities exempt from Corps regulation. For general information regarding IPs prospective permittees are encouraged to contact the Corps. ***In addition, the Corps retains discretionary authority on a case-by-case basis to elevate GP-eligible activities to an IP based on concerns for the aquatic environment or for any other factor of the public interest (33 CFR 320.4(a)). Whenever the Corps notifies a prospective permittee that an IP is required, no work in Corps jurisdiction may be conducted until the Corps issues the required authorization in writing indicating that the work may proceed.***

d. Emergency Situations: Contact the Corps immediately in the event of an emergency situation for information on the verification process. Emergency situations are limited to sudden, unexpected occurrences that could potentially result in an unacceptable hazard to life, a significant loss of property, or an immediate, unforeseen, and significant economic hardship if corrective action requiring a permit is not undertaken within a time period less than the normal time needed to process an application under standard procedures. Emergency work is subject to the same terms and conditions of these GPs as non-emergency work, and similarly, must qualify for authorization under these GPs; otherwise an IP is required. The Corps will work with all applicable agencies to expedite verification according to established procedures in emergency situations.

IV. GENERAL CONDITIONS

An activity is authorized under the General Permits (GPs) only if that activity and the permittee satisfy all of the applicable GPs terms and following general conditions (GCs):

1. Federal Jurisdiction.
2. Minimal Direct, Secondary and Cumulative Effects.
3. Other Permits.
4. Water Quality and Coastal Zone Management.
5. Fills Within 100-Year Floodplains.
6. Discretionary Authority.
7. Single and Complete Project.
8. Use of Multiple General Permits.
9. Mitigation (Avoidance, Minimization, and Compensatory Mitigation).
10. Corps Projects and Property.
11. Navigation.
12. National Lands.
13. Wild and Scenic Rivers.
14. St. John/St. Croix Rivers.
15. Historic Properties.
16. Federal Threatened and Endangered Species.
17. Essential Fish Habitat.
18. Aquatic Life Movements and Management of Water Flows.
19. Spawning, Breeding, and Migratory Areas.
20. Vernal Pools.
21. Restoration of Special Aquatic Sites (Including Wetland Areas).
22. Invasive and Other Unacceptable Species.
23. Soil Erosion, Sediment, and Turbidity Controls.
24. Time-of-Year Work Windows/Restrictions.
25. Pile Driving and Pile Removal in Navigable Waters.
26. Temporary Fill.
27. Heavy Equipment in Wetlands or Mudflats.
28. Bank and Shoreline Stabilization Including Living Shorelines.
29. Stream Work and Crossings, and Wetland Crossings.
30. Utility Line Installation and Removal.
31. Storage of Seasonal Structures.
32. Aquaculture.
33. Permit(s)/Authorization Letter On-Site.
34. Inspections.
35. Maintenance.
36. Federal Liability.
37. Property Rights.
38. Previously Authorized Activities.
39. Transfer of GP Verifications.
40. Modification, Suspension, and Revocation.
41. Special Conditions.
42. False or Incomplete Information.
43. Abandonment.
44. Enforcement Cases.
45. Duration of Authorization.

1. Federal Jurisdiction.

a. Applicability of these GPs shall be evaluated with reference to federal jurisdictional boundaries (e.g. mean high water mark, high tide line, ordinary high water mark, and wetland boundary). Activities shall be evaluated with reference to “waters of the U.S.” under the Clean Water Act (33 CFR 328) and “navigable waters of the U.S.” under Section 10 of the Rivers and Harbors Act of 1899 (33 CFR 329). Prospective permittees are responsible for ensuring that the boundaries used satisfy the federal criteria defined at 33 CFR 328 – 229. These sections prescribe the policy, practice and procedures to be used in determining the extent of the Corps jurisdiction. Note: Waters of the U.S. includes all waters pursuant to 33 CFR 328.3(a), and in adjacent wetlands as that term is defined in 33 CFR 328.3(c).

b. Permittees shall identify on project plans wetlands, other special aquatic sites (SAS) including vegetated shallows (or submerged aquatic vegetation, SAV) and mudflats, and other waters, such as lakes and ponds, and perennial and intermittent streams on the project site. Wetlands shall be delineated in accordance with the Corps of Engineers Wetlands Delineation Manual and the most recent regional supplement pertaining to the State of Maine. GP-eligible activities may utilize wetland determinations conducted by State of Maine staff in-lieu of a wetland delineation. For activities located in Essential Fish Habitat (GC 17), permittees shall also identify on project plans natural rocky habitats and shellfish areas in order to satisfy the Magnuson-Stevens Fishery Conservation and Management Act.

2. Minimal Direct, Secondary and Cumulative Effects. To be eligible and subsequently authorized by these GPs, an activity shall result in no more than minimal individual and cumulative effects on the aquatic environment as determined by the Corps in accordance with the criteria listed within these GPs and GCs. This may require project modifications involving avoidance, minimization, or compensatory mitigation for unavoidable impacts to ensure that the net adverse effects of an activity are no more than minimal.

3. Other Permits. Permittees shall obtain other Federal, State, or local authorizations as required by law. Permittees are responsible for applying for and obtaining all required State of Maine or local approvals including a Flood Hazard Development Permit issued by the town/city. Work that is not regulated by the State of Maine, but is subject to Corps jurisdiction, may still be eligible for authorization under these GPs.

4. Water Quality and Coastal Zone Management.

a. Permittees shall satisfy any conditions imposed by the State of Maine and EPA, where applicable, in their Clean Water Act Section 401 Water Quality Certification (WQC) for these GPs, or in any Individual Section 401 WQC. See Section VIII for state-specific contact info and to determine if any action is required to obtain a 401 WQC. The Corps may require additional water quality management measures to ensure that the authorized activity does not cause or contribute to a violation of water quality standards. All projects authorized by these GPs shall be designed, constructed and operated to minimize or eliminate the discharge of pollutants.

b. Permittees shall satisfy any additional conditions imposed by the State of Maine in their Coastal Zone Management (CZM) Act of 1972 consistency concurrences for these GPs, or in any Individual CZM consistency concurrences. The Corps may require additional measures to ensure that the authorized activity is consistent with state coastal zone management requirements.

5. Fills Within 100-Year Floodplains. The activity shall comply with applicable Federal Emergency Management Agency (FEMA) approved State of Maine or municipal floodplain management requirements. Permittees should contact FEMA and/or the State of Maine Floodplain Management Program regarding floodplain management requirements (see Section VIII for Federal and state-specific contact info).

6. Discretionary Authority. Notwithstanding compliance with the terms and conditions of these GPs, the Corps retains discretionary authority to require a PCN or IP review based on concerns for the aquatic environment or for any other factor of the public interest (see 33 CFR 320.4(a)). This authority is invoked on a case-by-case basis whenever the Corps determines that the potential consequences of the proposal warrant a higher level of review based on the concerns stated above. This authority may be invoked for projects that may contribute to cumulative environmental impacts that are more than minimal or if there is a special resource or concern associated with a particular project.

7. Single and Complete Project. The term “single and complete project” is defined at 33 CFR 330.2(i) as the total project proposed or accomplished by one owner/developer or partnership or other association of owners/developers. These GPs shall not be used for piecemeal work and shall be applied to single and complete projects and as such, the same GP shall not be used more than once for the same single and complete project.

a. For non-linear projects, a single and complete project shall have independent utility. Portions of a multi-phase project that depend upon other phases of the project do not have independent utility. Phases of a project that would be constructed even if the other phases were not built can be considered as separate single and complete projects with independent utility.

b. Unless the Corps determines the activity has independent utility, all components of a single project and/or all planned phases of a multi-phased project (e.g., subdivisions should include all work such as roads, utilities, and lot development) shall be treated together as constituting one single and complete project. If any component of a single and complete project requires a PCN, the entire single and complete project shall be reviewed under PCN.

c. For linear projects such as power lines or pipelines with multiple crossings, a “single and complete project” is all crossings of a single water of the U.S. (i.e. single waterbody) at a specific location. For linear projects crossing a single waterbody several times at separate and distant locations, each crossing is considered a single and complete project. However, individual channels in a braided stream or river, or individual arms of a large, irregularly-shaped wetland or lake, etc., are not separate waterbodies, and crossings of such features cannot be considered separately.

8. Use of Multiple General Permits. The use of more than one GP for a single and complete project is prohibited, except when the acreage loss of waters of the U.S. authorized by the GPs does not exceed the acreage limit of the GPs with the highest specified acreage limit. For example, if a road crossing over waters is constructed under GP 10, with an associated utility line crossing authorized by GP 9, if the maximum acreage loss of waters of the U.S. for the total project is ≥ 3 acres it shall be evaluated as an IP.

9. Mitigation (Avoidance, Minimization, and Compensatory Mitigation).

a. Activities shall be designed and constructed to avoid and minimize adverse effects, both temporary and permanent, to waters of the U.S. to the maximum extent practicable to ensure that adverse effects to the aquatic environment are no more than minimal.

b. Compensatory mitigation for unavoidable impacts to waters of the U.S., including direct, secondary and temporal loss, will generally be required for permanent impacts that exceed the SV limits (SV limits are detailed in Section V), and may be required for temporary impacts that exceed the SV limits, to offset unavoidable impacts which remain after all appropriate and practicable avoidance and minimization has been achieved and to ensure that the adverse effects to the aquatic environment are no more than minimal. Proactive restoration projects or temporary impact work with no secondary effects may generally be excluded from this requirement.

c. Mitigation proposals shall follow the guidelines found in the Compensatory Mitigation for Losses of Aquatic Resources; Final Rule April 10, 2008; 33 CFR 332 (which can be found at: www.nae.usace.army.mil/Missions/Regulatory/Mitigation under “Compensatory Mitigation for Losses of Aquatic Resources, 33 CFR 332 (Compensatory Mitigation Rule)”) and any other regulation. Permittees considering the use of a monetary payment *in-lieu* of permittee-responsible mitigation as compensation for unavoidable impacts to waters of the U.S. in the State of Maine may utilize the Maine Natural Resources Conservation Program (MNRCP). Information regarding this compensatory program can be found at: www.mnrcp.org For unavoidable jurisdictional impacts affecting federally-endangered Atlantic salmon and/or its critical habitat, permittees may be required to compensate for the impacts by utilizing the Maine Atlantic Salmon Restoration and Conservation Program. Information regarding this *in-lieu-fee* compensatory program can be found at: www.maine.gov/dmr/science-research/searun/programs/ilffacts.html

10. Corps Projects and Property.

a. Corps projects and property can be found at: www.nae.usace.army.mil/Missions/Civil-Works

b. In addition to any authorization under these GPs, prospective permittees shall contact the Corps Real Estate Division at (978) 318-8585 for work occurring on or potentially affecting Corps properties and/or Corps-controlled easements to initiate reviews and determine what real estate instruments are necessary to perform work. Permittees may not commence work on Corps properties and/or Corps-controlled easements until they

have received any required Corps real estate documents evidencing site-specific permission to work.

c. Any proposed temporary or permanent modification or use of a Federal project (including but not limited to a levee, dike, floodwall, channel, anchorage, breakwater, seawall, bulkhead, jetty, wharf, pier, or other work built or maintained but not necessarily owned by the United States), which may obstruct or impair the usefulness of the Federal project in any manner, is not eligible for SV and requires review and approval by the Corps pursuant to 33 USC 408 (Section 408).

d. A PCN is required for all work in, over, under, or within a distance of three times the authorized depth of a Corps Federal Navigation Project (FNP) and may require permission under Section 408.

e. Any structure or work that extends closer to the horizontal limits of any FNP than a distance of three times the project's authorized depth shall be subject to removal at the owner's expense prior to any future Corps dredging or the performance of periodic hydrographic surveys.

f. Where a Section 408 permission is applicable, written verification for the PCN will not be issued prior to the decision on the Section 408 permission request.

11. Navigation

a. There shall be no unreasonable interference with general navigation by the existence or use of the activity authorized herein, and no attempt shall be made by the permittee to prevent the full and free use by the public of all navigable waters at or adjacent to the activity authorized herein.

b. Work in, over, under, or within a distance of three times the authorized depth of an FNP shall specifically comply with GC 10.

c. Any safety lights and/or signals prescribed by the U.S. Coast Guard, State of Maine or municipality, through regulations or otherwise, shall be installed and maintained at the permittee's expense on authorized facilities in navigable waters of the U.S.

d. The permittee understands and agrees that, if future operations by the U.S. require the removal, relocation, or other alteration, of the structure or work herein authorized, or if, in the opinion of the Secretary of the Army or his authorized representative, said structure or work shall cause unreasonable obstruction to the free navigation of the navigable waters, the permittee will be required, upon due notice from the Corps, to remove, relocate, or alter the structural work or obstructions caused thereby, without expense to the U.S. No claim shall be made against the U.S. on account of any such removal or alteration.

12. National Lands. Activities that impinge upon the value of any National Lands or Federal Properties including but not limited to a National Wildlife Refuge, National Forest, or any area administered by the National Park Service, U.S. Fish and Wildlife Service or U.S. Forest Service are not eligible for SV and require PCN.

13. Wild and Scenic Rivers.

a. The following activities in designated rivers of the National Wild and Scenic River (NWSR) System, or in a river designated by Congress as a "study river" for possible inclusion in the system, require a PCN unless the National Park Service has determined in writing to the prospective permittee that the proposed work will not adversely affect the NWSR designation or study status:

- i. Activities that occur in NWSR segments, in and 0.25 miles up or downstream of NWSR segments, or in tributaries within 0.25 miles of NWSR segments.
- ii. Activities that occur in wetlands within 0.25 miles of NWSR segments.
- iii. Activities that have the potential to alter free-flowing characteristics in NWSR segments.

b. As of October 14, 2020, National Wild and Scenic Rivers and congressional study rivers in Maine include: the Allagash River beginning at Telos Dam continuing to Allagash checkpoint at Eliza Hole Rapids, approximately 3 miles upstream of the confluence with the St. John River (length = 92.5 miles); and 11.25 miles of the York River, in the State of Maine, from its headwaters at York Pond to the mouth of the river at York Harbor, plus tributaries (the York River is currently under study).

14. St. John/St. Croix Rivers. A PCN is required for any work within the Saint John and Saint Croix River basins that requires approval of the International Joint Commission. In addition, a PCN is required if any temporary or permanent use, obstruction or diversion of international boundary waters could affect the natural flow or levels of waters on the Canadian side of the line; or if any construction or maintenance of remedial works,

protective works, dams, or other obstructions in waters downstream from boundary waters could raise the natural level of water on the Canadian side of the boundary.

15. Historic Properties.

a. No undertaking shall cause effects (as defined at 33 CFR 325 Appendix C and 36 CFR 800) on properties listed on, determined to be eligible for listing on, or potentially eligible for listing on the National Register of Historic Places, including previously unknown historic properties within the permit area, unless the Corps or another federal action agency has satisfied the consultation requirements of Section 106 of the National Historic Preservation Act (NHPA). The majority of historic properties are not listed on the National Register of Historic Places and may require identification and evaluation by qualified historic preservation and/or archeological consultants in coordination with the Corps and the State Historic Preservation Officer (SHPO) (the SHPO in the State of Maine is the Maine Historic Preservation Commission, MHPC) and/or the five federally-recognized tribes in the State of Maine (Tribal Historic Preservation Officers, or THPOs). The MHPC, the THPOs, and the National Register of Historic Places can assist with locating information on:

- i. Previously identified historic properties; and
- ii. Areas with potential for the presence of historic resources, which may require identification and evaluation by qualified historic preservation and/or archeological consultants in consultation with the Corps and MHPC and/or the THPO(s).

b. For activities eligible for these GPs, permittees shall ensure that the activity will not cause effects as stated above in 15(a). In order to comply with this condition, both SV and PCN prospective permittees shall notify MHPC and all five THPOs for their identification of historic properties. MHPC and the THPOs will generally respond within 30 days of receiving the notification if they believe that the activity may have an adverse effect to historic properties. A PCN is required if an activity may have an adverse effect to historic properties. The PCN shall be submitted as soon as possible if a proposed activity may cause effects as stated above in 15(a) a to ensure that the Corps is aware of any potential effects of the proposed activity on any historic property to ensure all Section 106 requirements are met.

c. All PCNs shall:

- i. Show notification to MHPC and all five THPOs for their identification of historic properties;
- ii. State which historic properties may be affected by the proposed work or include a vicinity map indicating the location of the historic properties or the potential for the presence of historic properties; and
- iii. Include any available documentation from MHPC or the THPO(s) indicating that there are or are not historic properties affected.

d. The requirements to comply with Section 106 of the NHPA may be satisfied by a Programmatic Agreement (PA) or Programmatic Consultation (PC) with the Corps, New England District or another federal agency. New England District PAs and PCs are found at www.nae.usace.army.mil/Missions/Regulatory

e. If the permittee discovers any previously unknown historic, cultural or archeological remains and artifacts while accomplishing the activity authorized by these permits, the permittee shall immediately notify the district engineer of what was found, and avoid construction activities that may affect the remains and artifacts until the required coordination has been completed. The district engineer will initiate the Federal, Tribal and state coordination required to determine if the items or remains warrant a recovery effort or if the site is eligible for listing in the National Register of Historic Places.

f. Federal agencies should follow their own procedures for complying with the requirements of Section 106 of the NHPA. Federal permittees shall provide the Corps with the appropriate documentation to demonstrate compliance with those requirements.

g. Federal and non-federal applicants should coordinate with the Corps before conducting any onsite archeological work (reconnaissance, surveys, recovery, etc.) requested by MHPC or the THPOs, as the Corps will determine the Permit Area for the consideration of historic properties based on 33 CFR 325 Appendix C. This is to ensure that work done is in accordance with Corps requirements.

16. Federal Threatened and Endangered Species.

- a. No activity is authorized by these GPs which:
 - i. Is likely to directly or indirectly jeopardize the continued existence of a threatened or endangered species or a species proposed for such designation, as identified under the Federal Endangered Species Act (ESA), or which will directly or indirectly destroy or adversely modify the critical habitat or proposed critical habitat of such species;
 - ii. “May affect” a listed species or critical habitat, unless Section 7 consultation addressing the effects of the proposed activity has been completed;
 - iii. Is “likely to adversely affect” a listed species or critical habitat unless Section 7 consultation has been completed by the Corps or another lead action agency in coordination with the Corps under the provisions of a Programmatic Agreement (PA) or Programmatic Consultation (PC); or
 - iv. Violates the ESA.
- b. All prospective permittees shall attach to their SVNF or PCN an Official Species List obtained from the U.S. Fish and Wildlife Service’s Information for Planning and Consultation (IPaC) found at: <https://ecos.fws.gov/ipac> and provide the email address of the person who generated the list.
- c. For proposed activities in tidal waters, prospective permittees should also refer to the National Oceanic and Atmospheric Administration (NOAA) Fisheries’ Section 7 Mapper for federally-listed species found at: <https://noaa.maps.arcgis.com/apps/webappviewer/index.html>
- d. A PCN is required if a threatened or endangered species, a species proposed for listing as threatened or endangered, or designated or proposed critical habitat (all hereinafter referred to as “listed species or habitat”), as identified under the ESA, may be affected by the proposed work. An activity may remain eligible for SV if the only listed species affected is the northern long-eared bat (*Myotis septentrionalis*), and only after Section 7 consultation has been completed by the Corps under the 4(d) Rule Streamlined Consultation.
- e. Federal agencies shall follow their own procedures for complying with the requirements of the ESA while ensuring that the Corps and any other federal action agencies are included in the consultation process.
- f. Non-federal representatives designated by the Corps to conduct informal consultation or prepare a biological assessment shall follow the requirements in the designation document(s) and the ESA. Non-federal representatives shall also provide the Corps with the appropriate documentation to demonstrate compliance with those requirements. The Corps will review the documentation and determine whether it is sufficient to address ESA compliance for the GP activity, or whether additional ESA consultation is necessary.
- g. The requirements to comply with Section 7 of the ESA may be satisfied by a Programmatic Agreement (PA) or Programmatic Consultation (PC) with the Corps, New England District or another federal agency. New England District PAs and PCs are found at: www.nae.usace.army.mil/Missions/Regulatory

17. Essential Fish Habitat (EFH).

- a. PCN activities in tidal waters and the following rivers and streams, including all tributaries to the extent that they are currently or were historically accessible for salmon migration, shall be reviewed for the potential to adversely affect EFH (activities meeting SV criteria have been determined to result in no more than minimal adverse effects to EFH and therefore need no additional review):

Androscoggin River	Aroostook River	Boyden River	Dennys River
Ducktrap River	East Machias River	Hobart Stream	Kennebec River
Machias River	Narraguagus River	Orland River	Passagassawaukeag River
Patten Stream	Penobscot River	Pleasant River	Presumpscot River
Saco River	Sheepscot River	St. Croix River	Tunk Stream
Union River			

- b. Prospective permittees may be required to describe and identify potential adverse effects to EFH and should refer to the NOAA Fisheries’ EFH Mapper found at: www.fisheries.noaa.gov/resource/map/essential-fish-habitat-mapper

- c. The requirements to comply with the Magnuson-Stevens Fishery Conservation and Management Act may be satisfied by a Programmatic Agreement (PA) or Programmatic Consultation (PC) with the Corps, New England District or another federal agency. New England District PAs and PCs are found at: www.nae.usace.army.mil/Missions/Regulatory

18. Aquatic Life Movements and Management of Water Flows.

a. No activity may substantially disrupt the necessary life cycle movements of those species of aquatic life indigenous to the waterbody, including those species that normally migrate through the area, unless the activity's primary purpose is to impound water. Unless otherwise stated, activities permanently impounding water in a stream require a PCN to ensure impacts to aquatic life species are avoided and minimized. All permanent and temporary crossings of waterbodies and wetlands shall be:

- i. Suitably spanned, bridged, culverted, or otherwise designed and constructed to maintain low flows to sustain the movement of those aquatic species; and
- ii. Properly aligned and constructed to prevent bank erosion or streambed scour both adjacent to and inside the crossing.

b. To avoid adverse impacts on aquatic organisms, the low flow channel/thalweg shall remain unobstructed during periods of low flow, except when it is necessary to perform the authorized work.

c. For work in tidal waters, in-stream controls (e.g. cofferdams) should be installed in such a way as to not obstruct fish passage.

d. To the maximum extent practicable, the preconstruction course, condition, capacity, and location of open waters must be maintained for each activity, including stream channelization, storm water management activities, and temporary and permanent road crossings, except as provided below. The activity must be constructed to withstand expected high flows. The activity shall not restrict or impede the passage of normal or high flows, unless the primary purpose of the activity is to impound water or manage high flows. The activity may alter the pre-construction course, condition, capacity, and location of open waters if it benefits the aquatic environment (e.g. stream restoration or relocation activities).

e. Activities that temporarily or permanently adversely impact upstream or downstream flood conditions require a PCN.

19. Spawning, Breeding, and Migratory Areas.

a. Jurisdictional activities in waters of the U.S. such as certain excavations, discharges of dredged or fill material, and/or suspended sediment producing activities that provide value as fish migratory areas, fish and shellfish spawning or nursery areas, or amphibian and migratory bird breeding areas, during spawning or breeding seasons shall be avoided and minimized to the maximum extent practicable.

b. Jurisdictional activities in waters of the U.S. that provide value as breeding areas for migratory birds must be avoided to the maximum extent practicable. The permittee is responsible for ensuring their action complies with the Migratory Bird Treaty Act and the Bald and Golden Eagle Protection Act. The permittee is responsible for contacting the U.S. Fish and Wildlife's Maine Field Office (see Section VIII for contact info) to determine applicable measures to reduce impacts to migratory birds or eagles, including whether "incidental take" permits are necessary and available under the Migratory Bird Treaty Act or Bald and Golden Eagle Protection Act for a particular activity.

20. Vernal Pools.

a. A PCN is required if a discharge of dredged or fill material is proposed within a vernal pool depression located within waters of the U.S.

b. GC 20(a) above does not apply to projects that are within a municipality that meets the provisions of a Corps-approved vernal pool Special Area Management Plan (SAMP) and are otherwise eligible for SV, and the applicant meets the requirements to utilize the vernal pool SAMP.

21. Restoration of Special Aquatic Sites (Including Wetland Areas).

a. In areas of authorized temporary disturbance, if trees are cut they shall be cut at or above ground level and not uprooted in order to prevent disruption to the wetland soil structure and to allow stump sprouts to revegetate the work area, unless otherwise authorized.

b. The introduction or spread of invasive plant species in disturbed areas shall be controlled. If construction mats are to be used in areas of invasive plant species, they shall be thoroughly cleaned before re-use.

c. Wetland areas where permanent disturbance is not authorized shall be restored to their original condition and elevation. Original condition means protection and/or removal of existing soil and vegetation, and replacement back to the original location such that the original soil layering and vegetation schemes are

approximately the same, unless otherwise authorized. Restoration shall typically commence no later than the completion of construction.

d. Upon completion of construction, all areas of authorized disturbed wetland area shall be stabilized with a wetland seed mix containing only plant species native to New England and shall not contain any species listed in the “Invasive and Other Unacceptable Plant Species” Appendix K in the “New England District Compensatory Mitigation Guidance” found at: www.nae.usace.army.mil/Missions/Regulatory/Mitigation

22. Invasive and Other Unacceptable Species.

a. The introduction or spread of invasive or other unacceptable plant or animal species on the project site or areas adjacent to the project site caused by the site work shall be avoided to the maximum extent practicable. For example, construction mats and equipment shall be thoroughly cleaned and free of vegetation and soil before and after use. The introduction or spread of invasive plant or animal species on the project site caused by the site work shall be controlled.

b. No cultivars, invasive or other unacceptable plant species may be used for any mitigation, bioengineering, vegetative bank stabilization or any other work authorized by these GPs. However, non-native species and cultivars may be used when it is appropriate and specified in a written verification, such as using *Secale cereale* (Annual Rye) to quickly stabilize a site. All PCNs shall justify the use of non-native species or cultivars.

c. For the purposes of these GPs, plant species that are considered invasive and unacceptable are provided in Appendix K “Invasive and Other Unacceptable Plant Species” of the most recent “New England District Compensatory Mitigation Guidance” and is found at: www.nae.usace.army.mil/Missions/Regulatory/Mitigation The June 2009 “U.S. Army Corps of Engineers Invasive Species Policy” provides policy, goals and objectives and is located at www.nae.usace.army.mil/Missions/Regulatory/Invasive-Species If an Invasive Species Control/Management Plan has been prepared it should be included with any SV or PCN.

23. Soil Erosion, Sediment, and Turbidity Controls.

a. Adequate sedimentation and erosion control management measures, practices and devices, such as phased construction, installation of sediment control barriers (i.e. silt fence, vegetated filter strips, geotextilesilt fences, erosion control mixes, hay bales or other devices) downhill of all exposed areas, retention of existing vegetated buffers, application of temporary mulching during construction, and permanent seeding and stabilization shall be installed and properly maintained to reduce erosion and retain sediment on-site during and after construction. They shall be capable of preventing erosion; of collecting sediment, suspended and floating materials; and of filtering fine sediment.

b. Temporary sediment control barriers shall be removed upon completion of work, but not until all disturbed areas are permanently stabilized. The sediment collected by these sediment barriers shall be removed and placed at an upland location and stabilized to prevent its later erosion into a waterway or wetland.

c. All exposed soil and other fills shall be permanently stabilized at the earliest practicable date.

24. Time-of-Year Work (TOY) Windows/Restrictions. In-water work shall be conducted during the following TOY work windows (work allowed) under SV and any in-water work proposed during the following TOY restrictions (no work) shall be reviewed under PCN (and shall contain written justification for deviation from the work allowed windows). The term “in-water work” does not include conditions where the work site is “in-the-dry” (e.g. intertidal areas exposed at low tide). The term also does not include work contained in a cofferdam so long as the cofferdam was installed and subsequently removed within the work allowed window.

	<u>TOY Restriction (no work)</u>	<u>TOY Work Window (work allowed)</u>
Non-tidal waters	Oct. 1 st to Jul. 14 th	Jul. 15 th to Sep. 30 th
Tidal waters	Apr. 10 th to Nov. 7 th	Nov. 8 th to Apr. 9 th

Alternate work windows proposed under PCN will generally be coordinated with the U.S. Fish and Wildlife Service, National Marine Fisheries Service, Maine Department of Inland Fisheries and Wildlife, and/or Maine Department of Marine Resources and resulting written verifications may include species-specific work allowed windows.

25. Pile Driving and Pile Removal in Navigable Waters.

- a. Derelict, degraded, or abandoned piles and sheet piles in the project area shall be removed in their entirety as practicable and properly disposed of in an upland location and not in wetlands. In areas of fine-grained substrates, piles/sheets shall be removed by direct, vibratory, or clamshell pull method in order to minimize potential turbidity and sedimentation impacts. If removal is not practicable, said piles/sheets shall be cut off or driven to a depth of at least one foot below substrate.
- b. Work involving pile installation and/or removal should adhere to one of the five methods below:
 - i. “In-the-dry”, or
 - ii. In-water between Nov. 8th to Apr. 9th, or
 - iii. Drilled and pinned to ledge, or
 - iv. Vibratory hammers used to install any size and quantity of wood, concrete, or steel, or impact hammers limited to one hammer and <50 piles installed/day with the following: wood piles of any diameter, concrete piles ≤18-inches diameter, steel piles ≤12-inches diameter if: (1) the hammer is ≤3,000 pounds and a wood cushion or equivalent is used between the hammer and steel pile, or (2) a soft start is used. Soft starts require an initial set of three strikes from the impact hammer at 40% energy, followed by a 1-minute waiting period between subsequent three-strike sets. The soft-start procedure shall be conducted any time hammering ceases for more than 30 minutes.

26. Temporary Fill.

- a. Temporary fills, including but not limited to construction mats and corduroy roads shall be entirely removed as soon as they are no longer needed to construct the authorized work. Temporary fill shall be placed in its original location or disposed of at an upland site and suitably contained to prevent its subsequent erosion into waters of the U.S.
- b. All temporary fill and disturbed soils shall be stabilized to prevent its eroding into waters of the U.S. where it is not authorized. Work shall include phased or staged development to ensure only areas under active development are exposed and to allow for stabilization practices as soon as practicable. Temporary fill shall be placed in a manner that will prevent it from being eroded by expected high flows.
- c. Unconfined temporary fill authorized for discharge into waters of the U.S. shall consist of material that minimizes impacts to water quality (e.g. washed stone, stone, etc.).
- d. Appropriate measures shall be taken to maintain normal downstream flows and minimize flooding to the maximum extent practicable when temporary structures, work, and discharges of dredged or fill material, including cofferdams, are necessary for construction activities, access fills, or dewatering of construction sites. Materials shall be placed in a location and manner that does not adversely impact surface or subsurface water flow into or out of the wetland. Temporary fill authorized for discharge into wetlands shall be placed on geotextile fabric or other appropriate material laid on the pre-construction wetland grade where practicable to minimize impacts and to facilitate restoration to the original grade. Construction mats are excluded from this requirement.
- e. Construction debris and/or deteriorated materials shall not be placed or otherwise located in waters of the U.S.

27. Heavy Equipment in Wetlands or Mudflats. Operating heavy equipment (drill rigs, fixed cranes, etc.) within wetlands shall be minimized, and to the maximum extent practicable such equipment shall not be stored, maintained or repaired in wetlands. Where construction requires heavy equipment operation in wetlands, the equipment shall: a) have low ground pressure (typically <3 psi); b) be placed on swamp/construction/timber mats (herein referred to as “mats”) that are adequate to support the equipment in such a way as to minimize disturbance of wetland soil and vegetation; or c) be operated on adequately dry or frozen wetlands such that shear pressure does not cause subsidence of the wetlands immediately beneath equipment and upheaval of adjacent wetlands. Mats are to be placed in the wetland from the upland or from equipment positioned on mats if already working within a wetland. Other support structures that are capable of safely supporting equipment may be used with written Corps authorization. Similarly, the permittee may request written authorization from the Corps to waive use of mats during frozen or dry conditions. Construction mats should be managed in accordance with construction mat best management practices (BMPs) found at: www.nae.usace.army.mil/Missions/Regulatory/State-General-Permits/Maine-General-Permit

28. Bank and Shoreline Stabilization Including Living Shorelines.

a. Projects involving construction of or repair, replacement, and maintenance of bank or shoreline stabilization structures including living shorelines within Corps jurisdiction shall be designed to minimize environmental effects, effects to neighboring properties, scour, etc. to the maximum extent practicable.

b. Prospective permittees shall design and construct these stabilization projects using this sequential avoidance and minimization process: avoidance of aquatic resource impacts, diversion of overland flow, vegetative stabilization, living shorelines, stone-sloped surfaces, and walls/bulkheads. New vertical walls/bulkheads shall only be used in situations where reflected wave energy can be tolerated. Prospective permittees proposing new vertical walls/bulkheads shall provide written justification demonstrating why other methods of stabilization are not practicable and how the surrounding area would be affected by the resulting reflected wave energy.

Additional conditions to meet SV eligibility criteria for non-tidal bank and shoreline stabilization activities:

- a. Fill shall be ≤ 500 linear feet in total length as measured below the plane of the ordinary high watermark (OHWM), includes total if more than one stream bank.
- b. Fill placed below the plane of the OHWM shall be ≤ 1 cubic yard per linear foot.
- c. Fill shall not be angled steeper than 1H:1V.
- d. No discharge of fill in special aquatic sites other than wetlands.
- e. Stone revetment shall be comprised of angular material.
- f. No material shall be of the type, or placed in any location, or in any manner, to impair surface water flow into or out of any water of the U.S.
- g. No material shall be placed in a manner that will be eroded by normal or expected high flows (properly anchored trees and treetops may be used in low energy areas).
- h. The activity shall not be a stream channelization activity.

Additional conditions to meet SV eligibility criteria for tidal bank and shoreline stabilization activities:

- a. All in-water work shall be conducted “in-the-dry”.
- b. Fill shall be ≤ 500 linear feet in total length as measured below the plane of the high tide line (HTL) and shall be ≤ 200 linear feet in total length as measured below the plane of the mean high water mark (MHW), includes total for more than one bank. Vertical structures shall be ≤ 200 linear feet in total length as measured below the plane of the MHW and shall be ≤ 18 inches waterward of the existing vertical face.
- c. Fill placed below the plane of the HTL shall be ≤ 1 cubic yard per linear foot.
- d. Stone revetment shall be comprised of angular material.
- e. Shall not impact special aquatic sites (SAS, incl. submerged aquatic vegetation, SAV), impacts to natural rocky habitats are ≤ 100 square feet, and impacts to intertidal and shellfish areas are $\leq 1,000$ square feet).
- f. No structures/fill shall be steeper than 1H:1V.
- g. No new groins, breakwaters, or jetties.

29. Stream Work and Crossings, and Wetland Crossings.

a. A PCN is required for all new and replacement crossings in navigable waters.

b. In order to effectively size and configure crossings in navigable waters, new and replacement crossings shall consider factors including but not limited to: local tidal elevations over the range of tidal heights, basin topography and bathymetry, existing and proposed road elevations. Flood risk tolerance, conditions of habitat and natural community types present, and sea level rise during the useful life of the crossing.

c. A PCN is required for activities that result in unavoidable impacts to wetlands in excess of SV thresholds.

d. In-stream work and crossings and wetland crossings shall adhere to all applicable GCs including but not limited to:

- i. GC 16 (Federally Threatened and Endangered Species)
- ii. GC 17 (Essential Fish Habitat)
- iii. GC 18 (Aquatic Life Movements and Management of Water Flows)

- iv. GC 23 (Soil Erosion, Sediment and Turbidity Controls)
- v. GC 24 (Time-of-Year Work Windows/Restrictions)
- vi. GC 26 (Temporary Fill)
- vii. GC 28 (Bank Stabilization)
- e. Slip Lining. Work resulting in a decreased width, height, or diameter of an existing crossing (e.g. slip lining and invert lining) is discouraged and requires PCN. Written justification shall be provided for this activity.
- f. Culvert Extensions. A PCN is required for any extension to an existing culvert.
- g. Scour protection or armoring of the inlet and/or outlet of a crossing shall not disrupt normal flow patterns or substantially disrupt the necessary life cycle movements of those species of aquatic life indigenous to the waterbody, including those species that normally migrate through the area (see GC 18).
- h. The permittee shall maintain the work authorized herein in good condition and in conformance with the terms and general conditions of this permit to facilitate aquatic life passage as stated in GC 18. Culverts that develop “hanging” inlets or outlets, result in bed washout, or a stream that doesn’t match the characteristics of the substrate in the natural stream channel such as mobility, slope, stability confinement will require maintenance or repair to comply with this GC (this does not apply to temporary stream crossings).

Additional conditions to meet SV eligibility criteria for Stream Work and Crossings:

- a. Crossings shall be designed and constructed using the techniques and principles outlined in Stream Simulation, Stream Smart, Habitat Connectivity Design.
- b. Crossings shall be designed to be at least 1.2 times bankfull width. Any footings, abutments, and/or abutment armoring shall also be at least 1.2 times bankfull width.
- c. Crossings shall have a natural bottom substrate under or within the structure matching the characteristics of the substrate in the natural stream channel. Crossings shall be designed and constructed with appropriate streambed forms and streambed characteristics so that water depths and velocities are comparable to those found in the adjacent natural channel at a variety of flows.
- d. Crossings shall include a bank on both sides of the stream matching the horizontal profile of the existing stream and banks in order to allow terrestrial passage for wildlife and to prevent undermining of the footings as applicable.
- e. Closed bottom culverts shall be embedded at least 25 percent of the maximum height of the culvert.
- f. No unconfined fill or excavation in flowing waters is allowed. In-stream construction work shall be conducted “in-the-dry” under no-flow conditions or by using cofferdams, temporary flume pipes, culverts, etc. Downstream flows shall be maintained during in-stream construction. It is recommended that project plans include pertinent details for working in-the-dry and maintaining downstream flows.
- g. Conditions (a) thru (e) immediately above do not apply to temporary stream crossings; however, in addition to conditions (f) immediately above, temporary stream crossings shall adhere to the following:
 - i. Be placed on geotextile fabric or other material where practicable to ensure restoration to the original grade. Soil may not be used to construct or stabilize these structures and rock shall be large enough to allow for easy removal without disrupting the streambed.
 - ii. Be designed and maintained to withstand and pass high flows. Water height shall be no higher than the top of the culvert’s inlet. A minimum culvert diameter of two feet is required to pass debris. Culverts shall be aligned to prevent bank erosion or streambed scour.
 - iii. Be equipped with energy dissipating devices installed downstream if necessary to prevent scour.
 - iv. Be designed and maintained to prevent soil from entering the waterbody.
 - v. Be removed upon the completion of work. Impacts to the streambed or banks requires restoration to their original condition using the methods in (a) above.

PCN Conditions for Stream Work and Crossings:

- a. Crossings are recommended to meet the conditions for SV; written justification shall be provided for any deviation from SV conditions.
- b. Crossings shall be designed using the least intrusive and environmentally damaging method following this sequential minimization process: 1) spans with no stream impacts, 2) spans with stream impacts, and 3) embedded culverts with Stream Simulation, Stream Smart, or Habitat Connectivity.

Additional Conditions for Wetland Crossings:

a. New and replacement wetland crossings that are permanent shall be constructed in such a manner as to preserve hydraulic and ecological connectivity, at its present level, between the wetlands on either side of the road. Crossing structures commonly include but are not limited to spans and culverts. To meet this condition, spans or culverts should be placed at least every 50 feet with an opening at least 2 feet high and 3 feet wide at ground level. Closed bottom culverts should be embedded at least 6 inches and should have a natural bottom substrate within the structure. Alternative crossing designs that preserve wetland hydraulic and ecological connectivity (e.g. "rock sandwiches") may also be considered.

b. Any work that results in flooding, or impacts to wetland drainage from the upgradient side of the wetland crossing does not qualify for SV.

c. In the case of non-compliance, the permittee shall take necessary measures to correct wetland damage due to lack of hydraulic and ecological connectivity.

30. Utility Line Installation and Removal.

a. Utility lines in jurisdictional waters should be installed subsurface and shall be maintained in such a way so that they remain subsurface. If it is necessary to discharge dredged or filled material to keep such utility lines buried or restore them to their original subsurface condition, a PCN and written verification from the Corps may be required (e.g., in the case of side casting into wetlands from utility trenches).

b. For subsurface utility lines the bottom and side slope cover associated with the initial installation under Federal Navigation Projects (FNPs) is a technical determination. The depth requirement varies based on geotechnical (composition of bottom materials and layering), hydraulic (current, or wave induced scour depth), navigation (propeller induced scour depth and ships' anchor penetration), maintenance dredging (penetration of barge spuds), construction factors (energy from blasting potentially transmitted to utility crossings), physical conditions (exposed open water conditions or sheltered/harbor conditions), and the proposed location of the utility crossing within any FNP or within navigable waters, including areas dredged by others. On a case-by-case basis, the Corps will determine the depth and cover requirements for each proposed utility crossing. Additional conditions to the GP will be attached to address pre and post installation requirements. In waterways that do not have existing FNPs, this depth should be taken as two feet below the existing bottom or maximum depth of proposed dredging, as applicable.

c. Aerial utility lines crossing navigable waters require PCN and shall meet minimum clearances per 33 CFR 322.5(i).

d. For horizontal directional drilling work, returns of drilling fluids to the surface (i.e., frac-outs) are not authorized and require restoration to the maximum extent practicable in accordance with the terms and conditions of these GPs. The permittee and its contractor shall have onsite and shall implement the procedures detailed in a frac-out contingency plan for monitoring drilling operations and for the immediate containment, control and recovery/removal of drilling fluids released into the environment should a discharge of material occur during drilling operations.

e. For new installations within waters of the U.S., any abandoned or inactive utility lines should be removed and faulty lines (e.g., leaking hazardous substances, petroleum products, etc.) shall be removed or repaired to the extent practicable. A PCN is required if they are to remain in place, e.g., to protect sensitive areas or ensure safety.

f. No work shall drain a water of the U.S. by providing a conduit for water on or below the surface. Trench plugs installed along pipelines may be effective.

g. Trenches should be backfilled with native sediment immediately after completion of work.

h. Pre-construction elevations should be re-established. Any additional material needed to accomplish this should be of consistent type and grain-size as the existing substrate sediment.

i. Utility line activities in non-tidal waters adjacent to special aquatic sites, and all work in tidal waters should utilize horizontal directional drilling as practicable.

31. Storage of Seasonal Structures. Seasonal or recreational structures such as pier sections, floats, aquaculture structures, etc. that are removed from the waterway for a portion of the year shall be stored in an upland location and not in wetlands, tidal wetlands, their substrate, or on mudflats. These seasonal structures may be stored on the fixed, pile-supported portion of a structure that is waterward of the mean high water mark or the ordinary high water mark, e.g. the storage of a ramp or gangway on the pile-supported pier. Seasonal storage of structures in navigable waters, e.g., in a protected cove, requires prior Corps approval and local harbor master approval.

32. Aquaculture. Activities involving the cultivation of Atlantic salmon and other salmonids, or other federally-listed threatened or endangered species are not eligible for authorization under these GPs. All other aquaculture activities shall adhere to all applicable GCs including but not limited to:

- a. GC 3 (Other Permits) In particular, permittees shall maintain a current State of Maine Department of Marine Resources lease or license.
- b. GC 10 (Corps Projects and Property)
- c. GC 11 (Navigation)
- d. GC 16 (Federal Threatened and Endangered Species)
- e. GC 17 (Essential Fish Habitat)
- f. GC 18 (Aquatic Life Movements and Management of Water Flows)
- g. GC 31 (Storage of Seasonal Structures)

Additional conditions to meet SV eligibility criteria for Tidal Aquaculture:

- a. Shall not exceed 400 square feet in area.
- b. Shall receive signed approval from Harbor master or appropriate Town Official.
- c. Shall not include enclosures or impoundments.
- d. Shall not be located in or within a distance of three times the authorized depth of a FNP.
- e. Shall not be located in or impinge upon the value of National Lands and Federal Properties including but not limited to National Parks and National Wildlife Refuges.
- f. Shall not impact special aquatic sites (SAS, incl. submerged aquatic vegetation, SAV), impacts to natural rocky habitats are ≤ 100 square feet, and impacts to intertidal and shellfish areas are $\leq 1,000$ square feet.
- g. No structures, cages, gear, or shell hash shall be located in/within 25 feet of SAV.
- h. All gear, except for mooring tackle, when not in use on the site shall be stored in an upland location above the mean high water mark and not on wetland (incl. salt marsh).

33. Permit(s)/Authorization Letter On-Site. The permittee shall ensure that a copy of the terms and conditions of these GPs and any accompanying authorization letter with attached plans are at the site of the work authorized by these GPs whenever work is being performed and that all construction personnel performing work which may affect waters of the U.S. are fully aware of the accompanying terms and conditions. The entire permit authorization shall be made a part of any and all contracts and subcontracts for work that affects areas of Corps jurisdiction at the site of the work authorized by these GPs. This shall be achieved by including the entire permit authorization in the specifications for work. The term "entire permit authorization" means all terms and conditions of the GPs, the GPs, and the authorization letter (including its drawings, plans, appendices and other attachments) and subsequent permit modifications as applicable. If the authorization letter is issued after the construction specifications, but before receipt of bids or quotes, the entire permit authorization shall be included as an addendum to the specifications. If the authorization letter is issued after receipt of bids or quotes, the entire permit authorization shall be included in the contract or subcontract. Although the permittee may assign various aspects of the work to different contractors or subcontractors, all contractors and subcontractors shall be obligated by contract to comply with all environmental protection provisions contained within the entire GP authorization, and no contract or subcontract shall require or allow unauthorized work in areas of Corps jurisdiction.

34. Inspections. The permittee shall allow the Corps to make periodic inspections at any time deemed necessary in order to ensure that the work is eligible for authorization under these GPs, is being, or has been performed in accordance with the terms and conditions of these GPs. To facilitate these inspections, the permittee shall

complete and return to the Corps the Work-Start Notification Form and the Compliance Certification Form when either is provided with an authorization letter. The Corps may also require post-construction engineering drawings and/or photographs for completed work or post-dredging survey drawings for any dredging work to verify compliance.

35. Maintenance. The permittee shall maintain the activity authorized by these GPs in good condition and in conformance with the terms and condition of these permits. This does not include maintenance dredging, related disposal, or beach nourishment projects, which are subject to review thresholds for GP 5 on page 30, unless specified in written authorization from the Corps.

36. Federal Liability. In issuing these permits, the Federal Government does not assume any liability for the following:

- a. Damages to the permitted project or uses thereof as a result of other permitted or unpermitted activities or from natural causes;
- b. Damages to the permitted project or uses thereof as a result of current or future activities undertaken by or on behalf of the U.S. in the public interest;
- c. Damages to persons, property, or to other permitted or unpermitted activities or structures caused by the activity authorized by this permit;
- d. Design or construction deficiencies associated with the permitted work; or
- e. Damage claims associated with any future modification, suspension, or revocation of this permit.

37. Property Rights. Per 33 CFR 320.4(g)(6), these GPs do not convey any property rights, either in real estate or material, or any exclusive privileges, nor does it authorize any injury to property or invasion of rights or any infringement of federal, state, or local laws or regulations.

38. Previously Authorized Activities.

- a. Projects that received prior authorization from the Corps (via Category 1 or 2) and that completed authorized work under the previous nationwide permits, programmatic permits, regional general permits or letters of permission, shall remain authorized in accordance with the original terms and conditions of those authorizations, including their terms, general conditions, expiration date, and any special conditions provided in a written verification.
- b. Activities authorized pursuant to 33 CFR Part 330.3 (“Activities occurring before certain dates”) are not affected by these GPs.
- c. Any work not commenced, not under contract to commence, nor completed that was originally authorized by the Corps under the GP in effect between October 13, 2015 and October 13, 2020 remains authorized subject to the terms and general conditions of this GP along with any special conditions included in written authorizations. Exception: if previously authorized work has not commenced or not under contract to commence and a new federally-listed threatened or endangered species may be affected, the Corps shall consult with the U.S. Fish and Wildlife Service or NOAA Fisheries prior to re-authorizing the work under these GPs. Requests for re-authorization shall include an Official Species List per GC 16.

39. Transfer of GP Verifications. If the permittee sells the property associated with a GP verification, the permittee may transfer the GP verification to the new owner by submitting a letter to the Corps to validate the transfer. A copy of the GP verification shall be attached to the letter, the letter shall contain the name, address, phone number and email of the transferee (new owner), shall include the following statement and signature, and be mailed to: U.S. Army Corps of Engineers, Maine Project Office, 442 Civic Center Drive, Suite 350, Augusta, Maine 04330:

“When the structures or work authorized by these GPs are still in existence at the time the property is transferred, the terms and conditions of these GPs, including any special conditions, will continue to be binding on the new owner(s) of the property.”

Transferee Printed Name

Transferee Signature

Date

40. Modification, Suspension, and Revocation. These GPs and any individual authorization issued thereof may be either modified, suspended, or revoked, in whole or in part, pursuant to the policies and procedures of 33 CFR 325.7, and any such action shall not be the basis for any claim for damages against the U.S.

41. Special Conditions. The Corps may independently or in coordination with federal resource agencies impose special conditions on a project authorized pursuant to these GPs that are determined necessary to minimize adverse navigational and/or environmental effects, or based on any other factor of the public interest. Failure to comply with all terms and conditions of the authorization, including special conditions, constitutes a permit violation and may subject the permittee to criminal, civil or administrative penalties and/or an ordered restoration.

42. False or Incomplete Information. If the Corps makes a determination regarding the eligibility of a project under these GPs and subsequently discovers that it has relied on false, incomplete or inaccurate information provided by the permittee, the Corps may determine that the GP authorization is not valid; modify, suspend or revoke the authorization; and the U.S. Government may institute legal proceedings.

43. Abandonment. If the permittee decides to abandon the activity authorized under these GPs, unless such abandonment is merely the transfer of property to a third party, he/she may be required to restore the area to the satisfaction of the Corps.

44. Enforcement cases. These GPs do not apply to any existing or proposed activity in Corps jurisdiction associated with an ongoing Corps or EPA enforcement action, until such time as the enforcement action is resolved or the Corps or EPA, as appropriate, determines that the activity may proceed independently without compromising the enforcement action.

45. Duration of Authorization.

a. These GPs expire on October 14, 2025 unless otherwise specifically indicated in an individual authorization letter. Activities authorized under these GPs that have either commenced or are under contract to commence in reliance upon this authorization will have an additional year from the expiration date to complete the work. The permittee must be able to document to the Corps' satisfaction that the activity commenced or was under contract to commence by the expiration date of these GPs. If work is not completed within the one year extended timeframe, the permittee must contact the Corps. The Corps may issue a new authorization, provided the activity meets the applicable terms and conditions of the Maine GPs that are in effect at the time.

b. Activities authorized under these GPs will remain authorized until these GPs expire, unless discretionary authority has been exercised on a case-by-case basis to modify, suspend, or revoke the authorization in accordance with 33 CFR 325.2(e)(2). Activities completed under the SV or PCN authorizations of these GPs will continue to be authorized after its expiration date.

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Tammy R. Turley
Chief, Regulatory Division

V. MAINE GENERAL PERMITS

An activity is authorized under General Permits 1 through 23 listed below only if that activity and the permittee satisfy all of the applicable GP terms and general conditions. Any activity not specifically listed may still be eligible for authorization under these GPs; prospective permittees are advised to contact the Corps for specific eligibility determination.

1. **Repair, Replacement, and Maintenance of Authorized Structures and Fills;**

Repair, rehabilitation, or replacement of any previously authorized, currently serviceable structure, or fill and minor expansions thereof.

2. **Moorings**

New moorings and mooring fields, the relocation of previously authorized moorings, expansions, boundary reconfigurations or modifications of previously authorized mooring fields, conversion of mooring types (e.g. private to rental), and maintenance and replacement of moorings. Moored floats, lobster cars, rafts, and similar float structures are not included in this GP.

3. **Structures, Floats and Lifts**

New, expansions, reconfigurations or modifications of structures for navigational access in waters of the U.S. including but not limited to temporary/seasonal or permanent pile and crib-supported piers, floats, stairs, shore outhauls, and boat and float lifts/ways. Floats may include lobster cars, work floats, moored floats, swim floats, and shellfish upweller floats.

4. **Aids to Navigation, and Temporary Recreational Structures**

Aids to navigation and regulatory markers which are approved by and installed in accordance with the requirements of the U.S. Coast Guard (see 33 CFR, chapter I, subchapter C, part 66) and temporary buoys, markers, small floating docks, and similar structures placed for recreational use during specific events such as fireworks displays, water skiing competitions, and boat races or seasonal use.

5. **Dredging, Disposal of Dredged Material, Beach Nourishment, and Rock Removal and Relocation**

New, maintenance, and improvement dredging, including: a) Disposal of dredged material at a confined aquatic disposal, beach nourishment, near shore, designated open water or ocean water disposal site(s), provided the Corps finds the dredged material to be suitable for such disposal; (b) Beach nourishment not associated with dredging; (c) Rock removal and relocation for navigation.

6. **U.S. Coast Guard Approved Bridges and Causeways**

Discharges of dredged or fill material incidental to the construction and modification of bridges across navigable waters of the U.S., including cofferdams abutments, foundation seals, piers, approach fills, and temporary construction and access fills provided that the USCG authorizes the construction of the bridge structure under Section 9 of the Rivers and Harbors Act of 1899 or other applicable laws.

7. **Bank and Shoreline Stabilization Including Living Shorelines**

Bank stabilization activities necessary for erosion protection along the banks of lakes, ponds, streams, and marine/tidal waters. Includes bulkheads, seawalls, riprap, revetments or slope protection & similar structures as well as vegetative planting, soil bioengineering or alternative techniques that are a combination of the two (i.e. living shorelines), specifically for the purpose of shoreline protection.

8. **Residential, Commercial and Institutional Developments, and Recreational Facilities**

Discharges of dredged or fill material into waters of the U.S for the construction or expansion of: residences and residential subdivisions; commercial and institutional buildings or subdivisions; and recreational facilities; and attendant features including but not limited to roads, parking lots, garages, stormwater management facilities, yards, and utilities.

9. Utility Line Activities

Activities required for (a) the construction, maintenance, relocation, repair, & removal of utility lines, including outfall and intake structures, and the associated excavation, backfill, or bedding for utility lines; (b) the construction, maintenance or expansion of utility line substation facilities associated with a power/utility line in non-tidal waters; and (c) the construction and maintenance of foundations for overhead utility line towers, poles, and anchors provided the foundations are the minimum size necessary and separate footings for each tower leg (rather than a larger single pad) are used where feasible. This GP authorizes the construction of access roads to facilitate construction of the above activities provided the activity, in combination with all other activities included in one single and complete project.

10. Linear Transportation Projects

Activities required for the construction, expansion, modification, or improvement of linear transportation projects (e.g., driveways, roads, highways, railways, trails, airport runways, and taxiways) and attendant features.

11. Mining Activities

Temporary or permanent discharges of dredged or fill material into waters of the U.S. for mining activities.

12. Boat Ramps and Marine Railways

Temporary or permanent discharges of dredged or fill material, excavation and other work in waters of the U.S. required for the construction of temporary or permanent boat ramps and marine railways.

13. Land and Water-Based Renewable Energy Generation Facilities and Hydropower Projects

Structures and work and discharges of dredged or fill material into waters of the U.S. for the construction, expansion, modification or removal of: (a) land-based renewable energy production facilities (e.g. solar and wind) and their attendant features; (b) water-based wind or hydrokinetic renewable energy generation pilot projects and their attendant features; and (c) discharges of dredged or fill material associated with hydropower projects. Attendant features may include, but are not limited to, land-based collection and distribution facilities, control facilities, and parking lots.

14. Reshaping Existing Drainage Ditches and Mosquito Management

Discharges to modify the cross-sectional configuration of currently serviceable drainage ditches constructed in waters of the U.S., for the purpose of improving water quality by regrading the drainage ditch with gentler slopes, which can reduce erosion, increase growth of vegetation, and increase uptake of nutrients and other substances by vegetation. Also authorized are mosquito reduction activities.

15. Response Operations for Oil or Hazardous Substances

Activities conducted in response to a discharge or release of oil and hazardous substances that are subject to the National Oil and Hazardous Substances Pollution Contingency Plan (40 CFR 300) including containment, cleanup, and mitigation efforts, provided activities are done under either (i) The Spill Prevent, Control & Countermeasure Plan required by 40 CFR 112.3; (ii) The direction or oversight of the Federal on-site coordinator designated by 40 CFR 300; or (iii) Any approved existing State, regional or local contingency plan provided that the Regional Response Team (if one exists in the area) concurs with the proposed response efforts or does not object to the response effort. Activities required for the cleanup of oil releases in waters of the U.S. from electrical equipment that are governed by EPA's polychlorinated biphenyl (PCB) spill response regulations at 40 CFR 761. Booms placed in tidal waters. Use of temporary structures & fills for spill response training exercises.

16. Cleanup of Hazardous and Toxic Waste

Specific activities to effect the containment, stabilization or removal of hazardous or toxic waste materials, including court ordered remedial action plans or related settlements which are performed, ordered or sponsored by a government agency with established legal or regulatory authority.

17. Scientific Measurement Devices

Scientific devices for measuring and recording scientific data, such as staff gauges, tide and current gauges, meteorological stations, water recording and biological observation devices, water quality testing and improvement devices, and similar structures.

18. Survey Activities

Survey activities such as soil borings, core sampling, seismic exploratory operations, plugging of seismic shot holes and other exploratory-type bore holes, exploratory trenching and historic resources surveys (but not recovery).

19. Agricultural Activities

Regulated discharges of dredged or fill material in non-tidal waters of the U.S. for agricultural activities, including the construction of building pads for farm buildings. Authorized activities include: (a) installation, placement, or construction of drainage tiles, ditches, or levees; mechanized land clearing; land leveling; the relocation of existing serviceable drainage ditches; and similar activities; (b) construction of farm ponds, excluding perennial streams, provided the farm pond is used solely for agricultural purposes; and (c) discharges of dredged or fill material to relocate existing serviceable drainage ditches constructed in non-tidal streams.

20. Fish and Wildlife Harvesting, Enhancement, and Attraction Devices

Activities in waters of the U.S. associated with fish and wildlife harvesting devices including pound nets, crab and lobster traps, crab dredging, eel pots, duck blinds, and clam and oyster digging, fish aggregating devices, and small fish attraction devices such as open water fish concentrators (sea kites, etc.). This GP does not include aquaculture activities.

21. Habitat Restoration, Establishment and Enhancement Activities

Activities in waters of the U.S. associated with the restoration, enhancement and establishment of non-tidal and tidal wetlands and riparian areas, including invasive, non-native or nuisance species control; the restoration and enhancement of non-tidal streams and other non-tidal open waters; the relocation of non-tidal waters, including non-tidal streams & associated wetlands for reestablishment of a natural stream morphology and reconnection of the floodplain; the restoration and enhancement of shellfish, finfish and wildlife; and the rehabilitation or enhancement of tidal streams, tidal wetlands and tidal open waters; provided those activities result in net increases in aquatic resource functions and services. Also included are shellfish enhancement measures including but not limited to “brushing”, clam pots, boxes, and netting.

22. Stream and Wetland Work and Crossings

Activities required for the construction, expansion, modification, or improvement of linear transportation projects that cross waters of the U.S. (e.g., driveways, roads, highways, railways, trails, airport runways, and taxiways) and attendant features. Crossing structures include, but are not limited to temporary or permanent jurisdictional spans, bridges, culverts, and fords. Any stream channel modification is limited to the minimum necessary to construct or protect the project; such modifications must be in the immediate vicinity of the project.

23. Aquaculture

The installation of buoys, floats, racks, trays, nets, lines or other structures in waters of the U.S. for the containment and cultivation of fish, shellfish and seaweed/kelp. Also authorized are anchored upweller floats, small-scale shellfish hatchery seawater intake/discharge structures, and discharges of dredged or fill material associated with cultivation such as the placement of cultch or spatting-shell on bottom.

USER NOTE: All Self-Verification and Pre-Construction Notification activities shall comply with all applicable terms (pages 1 - 4), General Conditions (pages 5 - 19), and additional terms below.

GENERAL PERMITS FOR THE STATE OF MAINE

A. INLAND WATERS AND WETLANDS	Inland Waters and Wetlands are defined as waters that are regulated under Section 404 of the Clean Water Act, including rivers, streams, lakes, ponds, and wetlands, and <i>excludes Section 10 Navigable Waters of the U.S.</i> The jurisdictional boundaries are the ordinary high water mark (OHWM) in the absence of adjacent wetlands; beyond the OHWM to the limit of adjacent wetlands when adjacent wetlands are present; and the wetland limit when only wetlands are present. For the purposes of these GPs and designated activities, fill placed in the area between the mean high water mark (MHW) and the high tide line (HTL), and in the bordering and contiguous wetlands to tidal waters are reviewed in the Navigable Waters section below beginning on page 28.	
	Activities not meeting the Self-Verification terms below require Pre-Construction Notification and activities not meeting the Pre-Construction Notification terms below require an application for an Individual Permit (IP).	
GENERAL PERMIT #	SELF-VERIFICATION (SV)	PRE-CONSTRUCTION NOTIFICATION (PCN)
1. Repair, Replacement, and Maintenance of Authorized Structures and Fills (for stream crossings see GP 22)	Repair, replacement, and maintenance of existing, currently serviceable, authorized fills with no expansion or change in use, provided: • Conditions of the original authorization apply. • Minor deviations in fill design allowed. • The repair, rehabilitation, or replacement of those structures or fills destroyed or damaged by storms, floods, fire or other discrete events is authorized, provided the work is commenced, or is under contract to commence, within two years of the date of their destruction or damage. • Drawdown of impoundments for dam/levee repair does not exceed 18 months and one growing season (Apr-Sept).	Repair, replacement, and maintenance of existing authorized fills not eligible for SV, provided: • <3 acres of permanent and/or temporary inland waterway and/or wetland fill, and associated secondary impacts.
2. Moorings	Not Applicable – these activities in non-navigable inland waters do not require Corps authorization.	Not Applicable – these activities in non-navigable inland waters do not require Corps authorization.
3. Structures, Floats, and Lifts	Pile-supported structures, floats and lifts located in non-navigable inland waters do not require Corps authorization. Solid fill or crib-supported structures with <15,000 SF of permanent and/or temporary inland waterway and/or wetland fill, and associated secondary impacts.	Fill activities associated with structures, floats, and lifts not eligible for SV, provided: • <3 acres of permanent and/or temporary inland waterway and/or wetland fill, and associated secondary impacts.
4. Aids to Navigation and Temporary Recreational Structures	Not Applicable – these activities in non-navigable inland waters do not require Corps authorization.	Not Applicable – these activities in non-navigable inland waters do not require Corps authorization.
5. Dredging, Disposal of Dredged Material, Beach Nourishment, and Rock Removal and Relocation	Those activities with <15,000 SF of permanent and/or temporary inland waterway and/or wetland fill, and associated secondary impacts, provided: • No stream channelization, relocation, or loss of streambed including impoundments or discharges of tailings into streams.	Those activities not eligible for SV, provided: • <3 acres of permanent and/or temporary inland waterway and/or wetland fill, and associated secondary impacts.

	SELF-VERIFICATION (SV)	PRE-CONSTRUCTION NOTIFICATION (PCN)
6. U.S. Coast Guard Approved Bridges and Causeways	Not applicable in inland waters and wetlands; see B. Navigable Waters on page 31 below.	Not applicable in inland waters and wetlands; see B. Navigable Waters on page 31 below.
7. Bank and Shoreline Stabilization Including Living Shorelines (see also GC 28)	Bank and shoreline stabilization activities with <15,000 SF of permanent and/or temporary inland waterway and/or wetland fill, and associated secondary impacts, provided: • Fill is ≤500 LF in total length as measured below the plane of the OHWM, includes total if more than one stream bank. • Fill placed below the plane of the OHWM is ≤1 CY per linear foot. • There is no discharge in special aquatic sites other than wetlands. • Revetment is comprised of angular material. • In-stream work is limited to Jul. 15th to Sep. 30th • No structures angled steeper than 1H:1V.	Bank and shoreline stabilization activities not eligible for SV, provided: • <3 acres of permanent and/or temporary inland waterway and/or wetland fill, and associated secondary impacts.
8. Residential, Commercial and Institutional Developments, and Recreational Facilities	Those developments and facilities with <15,000 SF of permanent and/or temporary inland waterway and/or wetland fill, and associated secondary impacts. Fill area includes all temporary and permanent fill, and regulated discharges associated with excavation. Provided: • The historic fill and proposed fill area <15,000 SF specifically complies with GC 5 Single and Complete Projects. • No work in special aquatic sites other than wetlands.	Those developments and facilities not eligible for SV, provided: • <3 acres of permanent and/or temporary inland waterway and/or wetland fill, and associated secondary impacts. <i>Mechanical clearing of areas within Corps jurisdiction without grubbing or other soil disturbance >3 acres as a secondary impact may still be eligible for PCN at the discretion of the Corps.</i>
9. Utility Line Activities (see also GC 30)	Utility line activities with <15,000 SF of permanent and/or temporary inland waterway and/or wetland fill (excluding mats), and associated secondary impacts, provided: • There is no permanent change in pre-construction contours in waters in the U.S. • Material resulting from trench excavation is temporarily side cast into waters of the U.S. for <3 months and is placed in such a manner that is not dispersed by current or other forces. • The line does not run parallel to, or along a streambed. • No stream channelization, relocation, or loss of streambed including impoundments. • There is no discharge in special aquatic sites other than wetlands. • Construction mats of any area necessary to conduct activities provided mats are removed as soon as work is completed and shall be in place no longer than one single growing season. • In-stream work is limited to Jul. 15th to Sep. 30th • In-water work is conducted in-the-dry. • Intake structures that are dry hydrants used exclusively for firefighting activities with no stream impoundments. • Construction mats of any area necessary to conduct activities provided mats are removed as soon as work is completed and shall be in place no longer than one single growing season.	Utility line activities not eligible for SV, provided: • <3 acres of permanent and/or temporary inland waterway and/or wetland fill, and associated secondary impacts. <i>Mechanical clearing of areas within Corps jurisdiction without grubbing or other soil disturbance >3 acres as a secondary impact may still be eligible for PCN at the discretion of the Corps.</i>

	SELF-VERIFICATION (SV)	PRE-CONSTRUCTION NOTIFICATION (PCN)
10. Linear Transportation Projects <i>(for stream crossings refer to GP 22)</i>	Linear transportation activities with <15,000 SF of permanent and/or temporary inland waterway and/or wetland fill (excl. mats), and associated secondary impacts, provided: - The historic fill and proposed fill area <15,000 SF specifically complies with GC 5 Single and Complete Projects. - There is no discharge in special aquatic sites other than wetlands. - Construction mats of any area necessary to conduct activities provided mats are removed as soon as work is completed and shall be in place no longer than one single growing season.	Linear transportation activities not eligible for SV, provided: <3 acres of permanent and/or temporary inland waterway and/or wetland fill, and associated secondary impacts. <i>Mechanical clearing of areas within Corps jurisdiction without grubbing or other soil disturbance >3 acres as a secondary impact may still be eligible for PCN at the discretion of the Corps.</i>
11. Mining Activities	Mining activities with <15,000 SF of permanent and/or temporary inland waterway and/or wetland fill, and associated secondary impacts, provided: No stream channelization, relocation, or loss of streambed including impoundments.	Mining activities not eligible for SV, provided: <3 acres of permanent and/or temporary inland waterway and/or wetland fill, and associated secondary impacts.
12. Boat Ramps	Boat ramps with <15,000 SF of permanent and/or temporary inland waterway and/or wetland fill, and associated secondary impacts, and temporary fills.	Boat ramps not eligible for SV, provided: <3 acres of permanent and/or temporary inland waterway and/or wetland fill, and associated secondary impacts.
13. Land and Water-Based Renewable Energy Generation Facilities and Hydropower Projects	Those facilities and projects with <15,000 SF of permanent and/or temporary inland waterway and/or wetland fill, and associated secondary impacts, provided: - No stream channelization, relocation, or loss of streambed including impoundments. - No new water-based facilities are eligible.	Those facilities and projects not eligible for SV, provided: <3 acres of permanent and/or temporary inland waterway and/or wetland fill, and associated secondary impacts. <i>Mechanical clearing of areas within Corps jurisdiction without grubbing or other soil disturbance >3 acres as a secondary impact may still be eligible for PCN at the discretion of the Corps.</i>
14. Reshaping Existing Ditches and Mosquito Management	Not applicable in inland waters and wetlands; see B. Navigable Waters on page 33 below.	Not applicable in inland waters and wetlands; see B. Navigable Waters on page 33 below.
15. Response Operations for Oil or Hazardous Substances	The SVNf or a surrogate state reporting form may be submitted after-the-fact for response operations. This GP also authorizes the use of temporary structures and fills in waters of the U.S. for spill response training exercises with <15,000 SF of permanent and/or temporary inland waterway and/or wetland fill, and associated secondary impacts (<i>SVNF is required prior to the activity</i>).	Those response operations not eligible for SV, provided: <3 acres of permanent and/or temporary inland waterway and/or wetland fill, and associated secondary impacts.

	SELF-VERIFICATION (SV)	PRE-CONSTRUCTION NOTIFICATION (PCN)
16. Cleanup of Hazardous and Toxic Waste	Those cleanup activities with <15,000 SF of permanent and/or temporary inland waterway and/or wetland fill, and associated secondary impacts, provided: • No stream channelization, relocation, or loss of streambed including impoundments. • The activity does not involve establishing new disposal sites or expanding existing sites used for the disposal of hazardous or toxic waste.	Those cleanup activities not eligible for SV, provided: • <3 acres of permanent and/or temporary inland waterway and/or wetland fill, and associated secondary impacts. • The activity does not involve establishing new sites for the disposal of hazardous or toxic waste.
17. Scientific Measurements Devices	Those devices with <15,000 SF of permanent and/or temporary inland waterway and/or wetland fill, and associated secondary impacts, provided: • No biological sampling devices. • Devices do not restrict or concentrate movement of aquatic organisms. • Upon completion of use, the devices and any associated fills shall be removed in their entirety.	Those devices not eligible for SV, provided: • <3 acres of permanent and/or temporary inland waterway and/or wetland fill, and associated secondary impacts.
18. Survey Activities	Those survey activities with <15,000 SF of permanent and/or temporary inland waterway and/or wetland fill, and associated secondary impacts, provided: • Exploratory trenches are restored in accordance with GC 21. • No discharge of excavated material from test wells for oil and gas exploration (the plugging of such wells is authorized).	Those survey activities not eligible for SV, provided: • <3 acres of permanent and/or temporary inland waterway and/or wetland fill, and associated secondary impacts.
19. Agricultural Activities	Those agricultural activities subject to Corps jurisdiction with <15,000 SF of permanent and/or temporary inland waterway and/or wetland fill, and associated secondary impacts, provided: • No stream channelization, relocation, or loss of streambed including impoundments.	Those agricultural activities subject to Corps jurisdiction not eligible for SV, provided: • <3 acres of permanent and/or temporary inland waterway and/or wetland fill, and associated secondary impacts.
20. Fish and Wildlife Harvesting, Enhancement and Attraction Devices and Activities	Not applicable in inland waters and wetlands; see B. Navigable Waters on page 34 below.	Not applicable in inland waters and wetlands; see B. Navigable Waters on page 34 below.
21. Habitat Restoration, Establishment, and Enhancement	Those activities with <15,000 SF of permanent and/or temporary inland waterway and/or wetland fill, and associated secondary impacts, provided: • No water impoundments allowed. • No conversion of a stream to wetland or vice versa, a wetland to a pond or uplands, or one wetland type to another. • No dam removal.	Those activities not eligible for SV, provided: • <3 acres of permanent and/or temporary inland waterway and/or wetland fill, and associated secondary impacts.

	SELF-VERIFICATION (SV)	PRE-CONSTRUCTION NOTIFICATION (PCN)
22. Stream and Wetland Work and Crossings (see also GC 29)	Stream work and crossings with <15,000 SF of permanent and/or temporary inland waterway and/or wetland fill, and associated secondary impacts, provided: • No work in designated or proposed critical habitat for endangered species. • Crossings are designed and constructed using the techniques and principles outlined in Stream Simulation, Stream Smart, or Habitat Connectivity Design. • Crossings are designed to be 1.2 times bankfull width. • Crossings have a natural bottom substrate. • Crossings include a bank on both sides of the channel. • Closed bottom culverts are embedded at least 25% of the maximum width of the culvert. • In-stream work is limited to Jul. 15th to Sep. 30th • In-stream work is conducted “in-the-dry”. • No slip lining. • No culvert extensions. • No stream channelization, relocation, or loss of streambed including impoundments. Wetland work and crossings, provided: • No flooding or impacts to wetland drainage from the upgradient side of the crossing.	Stream and Wetland Work and Crossings not eligible for SV, provided: • <3 acres of permanent and/or temporary inland waterway and/or wetland fill, and associated secondary impacts.
23. Aquaculture (see also GC 32)	Aquaculture activities with <15,000 SF of permanent and/or temporary inland waterway and/or wetland fill, and associated secondary impacts, provided: • No water impoundments allowed. • No conversion of i) a stream to wetland or vice versa, a wetland to a pond or uplands, and ii) one wetland type to another.	Aquaculture activities not eligible for SV, provided: • <3 acres of permanent and/or temporary inland waterway and/or wetland fill, and associated secondary impacts.

USER NOTE: All Self-Verification and Pre-Construction Notification activities shall comply with all applicable terms (pages 1 - 4), General Conditions (pages 5 - 19), and additional terms below.

B. NAVIGABLE WATERS	Navigable Waters of the U.S. are defined as those waters that are subject to the ebb and flow of the tide in addition to the non-tidal portions of the following federally-designated waters in Maine (the Kennebec River to Moosehead Lake, the Penobscot River to the confluence of the East and West Branch at Medway and, Lake Umbagog within the State of Maine) (Section 10 Rivers and Harbors Act of 1899). The jurisdictional limits are the mean high water mark (MHW) in tidal waters and the ordinary high water mark (OHWM) in non-tidal portions of the federally-designated navigable rivers. For the purposes of these GPs, fill placed in the area between the mean high water mark (MHW) and the high tide line (HTL), and in the bordering and contiguous wetlands to tidal waters are also reviewed in this Navigable Waters section. Activities not meeting the Self-Verification terms below require Pre-Construction Notification and activities not meeting the Pre-Construction Notification terms below require an application for an Individual Permit.	
GENERAL PERMIT # 1. Repair, Replacement, and Maintenance of Authorized Structures and Fills <i>*See GC 25 for pile driving and removal conditions.</i>	SELF-VERIFICATION Repair, replacement, or maintenance of previously authorized, currently serviceable structures or fills, provided: • Conditions of the original authorization apply. • No expansion or change in use. Shall be rebuilt in same footprint, however minor deviations in design allowed. • The repair, rehabilitation, or replacement of those structures or fills destroyed or damaged by storms, floods, fire or other discrete events is authorized, provided that work is commenced, or is under contract to commence, within two years of the date of their destruction or damage. • In-water work is conducted “in-the-dry” (see GC 24). • No impacts to special aquatic sites (SAS) (incl. submerged aquatic vegetation, SAV), impacts to natural rocky habitat ≤100 SF, and impacts to intertidal area ≤1,000 SF • Slope stabilization is ≤500 LF in total length as measured below the plane of the HTL and is ≤200 LF in total length as measured below the plane of the MHW or OHWM. Vertical structures are ≤200 LF in total length as measured below the plane of the MHW or OHWM and are ≤18 inches waterward of existing face. • Dam and flood control, or levee work does not alter water levels or flood elevations. • Discharge of accumulated bottom sediments from or through a dam is not more than <i>de minimus</i>. • Tide gate work has a Corps-approved operation and maintenance plan and no effect to hydraulic regime, or tide gates that solely convey stormwater and/or Maine National Pollutant Discharge Elimination System-permitted discharges.	PRE-CONSTRUCTION NOTIFICATION Repair, replacement, or maintenance of previously authorized structures or fills not eligible for SV, provided: • ≤0.5 acre temporary or permanent impacts, fill, excavation, and/or secondary impacts. • Temporary and/or permanent fill or excavation in SAV <1,000 SF • Permanent fill or excavation in other SAS <4,300 SF

	SELF-VERIFICATION (SV)	PRE-CONSTRUCTION NOTIFICATION (PCN)
2. Moorings	Private, non-commercial, non-rental, single-boat moorings, provided: • Authorized by the local harbormaster/town. • Not associated with any boating facility (e.g. marinas). • Not located within a Federal Navigational Project (other than in a Federal Anchorage) or within a distance of three times the authorized depth of a Federal Navigation Project. Moorings in a Federal Anchorage must not be associated with a boating facility and must not be for rent. • No interference with navigation. • Mooring is not located in SAS (incl. SAV) or intertidal areas. Minor relocation of previously authorized moorings, provided: • Authorized by the local harbormaster/town. • Relocation is not within a Federal Navigational Project (other than in a Federal Anchorage) or within a distance of three times the authorized depth of a Federal Navigation Project. • No interference with navigation. • Relocated mooring is not located in SAS (incl. SAV) or intertidal areas. <i>*SV Moorings above do not require a SVNf.</i>	Moorings not eligible for SV and don't require an IP. This includes private moorings with no harbormaster or means of local approval or moorings associated with a boating facility (e.g. marina). <i>Locating new moorings in SAS (incl. SAV) shall be avoided to the maximum extent practicable. If SAS cannot be avoided, consideration shall be given to alternative mooring systems that prevents mooring chains from resting or dragging on the bottom substrate at all tides.</i> An IP is required for moorings located within the horizontal limits, or with moored vessels that extend into the horizontal limits of a Federal Navigation Project (other than in a Federal Anchorage).
3. Structures, Floats, and Lifts	Reconfiguration of such existing authorized structures with all intertidal work conducted "in-the-dry" (see GC 24). Minor relocation of previously authorized floats provided: • Relocation is not into a Federal Navigation Project or within a distance of three times the authorized depth of a Federal Navigation Project (other than a Federal Anchorage). • No interference with navigation. • Not relocated in or within 25 feet of SAV. • Seasonal floats are stored above the MHW and not on wetland (incl. salt marsh). New private, non-commercial ramp and float structures attached to land (no piers) or new floats provided: • Not located in or within a distance of three times the authorized depth of a Federal Navigation Project. • No interference with navigation. • No structure extends across >25% of the waterway width at mean low water. • Not located in or within 25 feet of SAV. • Ramp is <150 LF over salt marsh waterward of the MHW and is $\geq 1:1$ height:width ratio over salt marsh.	New structures, floats, and/or lifts including floatways/skidways, built to access waterway (both seasonal and permanent). Includes pile-supported, solid fill-supported, and crib-supported structures. Also includes expansions to existing authorized boating facilities (e.g. marinas). Provided: • <1 acre temporary or permanent impacts, fill, excavation, and/or secondary impacts. • Temporary and/or permanent fill or excavation in SAV <1,000 SF • Permanent fill or excavation in other SAS <4,300 SF <i>*See GC 25 for pile driving and pile removal conditions.</i> Compliance with the following is recommended: • <i>Lowermost part of floats are ≥ 18 inches above the substrate during all tides.</i> • <i>Structures are $\geq 1:1$ height:width ratio over salt marsh.</i> • <i>Structures and floats are not located in or within 25 feet of SAV.</i> • <i>Moored vessels are not positioned over SAV.</i> • <i>Structures attached to land are located ≥ 25 feet from the property line (The Corps may require a letter of no objection from the abutter if located within 25 feet of the property line.)</i>

Cont'd below on page 30

	SELF-VERIFICATION (SV)	PRE-CONSTRUCTION NOTIFICATION (PCN)
<i>Cont'd from page 29</i>	- Ramp and floats attached to land are located ≥ 25 feet from the property line. - Seasonal ramp and floats are stored above the HTL and not on wetland (incl. salt marsh). Compliance with the following is recommended: <i>Lowermost part of floats is ≥ 18 inches above the substrate during all tides.</i>	<i>No structure extends across >25% of the waterway width at mean low water.</i> <i>Not located within a distance of three times the authorized depth of a Corps Federal Navigation Project.</i> An IP is required for structures, floats, and/or lifts including floatways/skidways, located in such that they and/or vessels docked or moored at them are within the horizontal limits of a Corps Federal Navigation Project. An IP is also required for structures and floats associated with a new or previously unauthorized boating facility (e.g. marinas).
4. Aids to Navigation and Temporary Recreational Structures	Aids to navigation and regulatory markers which are approved by and installed in accordance with the requirements of the U.S. Coast Guard. (See 33 CFR 66, Chapter I, subchapter C). <i>*These SV Aids do not require a SVNf.</i> Temporary buoys, markers, floats, etc. for recreational use during specific events, provided: - They are removed within 30 days after the specific event has concluded. - No interference with navigation. - No impact to SAV.	Aids and temporary structures not eligible for SV.
5. Dredging, Disposal of Dredged Material, Beach Nourishment, and Rock Removal and Relocation	Maintenance dredging of <1,000 CY for navigational purposes with upland disposal including return water from upland contained disposal area, provided: - Proper siltation controls are used. - No expansion of footprint. - No dredging in or within a distance of three times the authorized depth of a Federal Navigation Project. - Dredging operation is limited to Nov. 8th to Apr. 9th (it is recommended that in areas populated by winter flounder, dredging should cease by March 15th). - No impacts to SAS (incl. SAV), impacts to natural rocky habitat ≤ 100 SF, and impacts to intertidal area $\leq 1,000$ SF - No dredging within 25 feet of SAV. - No dredging in or within 100 feet of shellfish areas. - No blasting. - No dredging in designated or proposed critical habitat for endangered species.	Maintenance dredging not eligible for SV and new dredging <25,000 CY Includes return water from upland contained disposal areas. Disposal includes: - Upland. - Beach nourishment (above MHW line) of any area provided the dredging's primary purpose is navigation or the sand is from an upland source. - Open water & confined aquatic disposal if Corps finds the material suitable. Beach nourishment associated with dredging when the primary purpose is not navigation requires at least a PCN. Temporary and/or permanent fill or excavation in SAV <1,000 SF and Permanent fill or excavation in other SAS <4,300 SF

	SELF-VERIFICATION (SV)	PRE-CONSTRUCTION NOTIFICATION (PCN)
6. U.S. Coast Guard Approved Bridges and Causeways	Discharges of dredged or fill material associated with U.S. Coast Guard Approved Bridges and Causeways, provided: • In-water work is conducted “in-the-dry” (see GC 24). • Discharge of dredged or fill material <15,000 SF • No impacts to SAS (incl. SAV), impacts to natural rocky habitat ≤100 SF, and impacts to intertidal area ≤1,000 SF Compliance with the following is recommended: • <i>Discharge of dredged or fill material should not occur within 100 feet of SAV or within 25 feet of natural rocky habitat or other SAS.</i> <i>Note: new causeways and approach fills are not eligible for SV.</i>	Discharges of dredged or fill material associated with U.S. Coast Guard Approved Bridges and Causeways not eligible for SV, provided: • <1 acre temporary or permanent impacts, fill, excavation, and/or secondary impacts. • Temporary and/or permanent fill or excavation in SAV <1,000 SF • Permanent fill or excavation in other SAS <4,300 SF
7. Bank and Shoreline Stabilization Including Living Shorelines (see also GC 28)	Bank and shoreline stabilization activities, provided: • In-water work is conducted “in-the-dry” (see GC 24). • Fill is ≤500 LF in total length as measured below the plane of the HTL and is ≤200 LF in total length as measured below the plane of the MHW or OHWM (includes total for more than one bank). Replacement vertical structures are ≤200 LF in total length as measured below the plane of the MHW or OHWM and are ≤18 inches waterward of existing face. • Fill placed below HTL is ≤1 CY per linear foot. • Stone revetment is comprised of angular material. • No fills angled steeper than 1H:1V. • No impacts to SAS (incl. SAV), impacts to natural rocky habitat ≤100 SF, and impacts to intertidal or shellfish areas ≤1,000 SF • No new groins, breakwaters, or jetties.	Bank and shoreline stabilization activities not eligible for SV, provided: • <1 acre temporary or permanent impacts, fill, excavation, and/or secondary impacts, provided: • Temporary and/or permanent fill or excavation in SAV <1,000 SF • Permanent fill or excavation in other SAS <4,300 SF
8. Residential, Commercial and Institutional Developments, and Recreational Facilities	Not Eligible	Residential, commercial and institutional developments and recreational facilities, provided: • <1 acre temporary or permanent impacts, fill, excavation, and/or secondary impacts, provided: • Temporary and/or permanent fill or excavation in SAV <1,000 SF • Permanent fill or excavation in other SAS <4,300 SF Conversions of previously authorized pile-supported buildings over navigable waters to residences, offices, or other non-water dependent uses require PCN. Floating house boats or businesses on floats require PCN.

	SELF-VERIFICATION (SV)	PRE-CONSTRUCTION NOTIFICATION (PCN)
9. Utility Line Activities (see also GC 30)	Repair, replacement, or maintenance of previously authorized, currently serviceable utilities with no expansion or change in use, provided: • Conditions of the original authorization apply. • In-water work limited to Nov. 8th to Apr. 9th. • Trenching or filling confined to existing footprint and <100 LF; trenches shall be backfilled immediately. • Jet-plow, fluidization, or other direct burial methods confined to existing footprint and <200 LF • No impacts to SAS (incl. SAV), impacts to natural rocky habitat ≤100 SF, and impacts to intertidal or shellfish areas ≤1,000 SF • No work in designated or proposed critical habitat for endangered species. New work in, over, or under navigable waters including new outfalls and any intake structure work requires PCN. Aerial utility lines over navigable waters requires PCN.	Those utility activities not eligible for SV, provided: • <1 acre temporary or permanent impacts, fill, excavation, and/or secondary impacts. • Temporary and/or permanent fill or excavation in SAV <1,000 SF • Permanent fill or excavation in other SAS <4,300 SF
10. Linear Transportation Projects (for stream crossings refer to GPs 6 and 22)	Not Eligible	Linear transportation projects, provided: • <1 acre temporary or permanent impacts, fill, excavation, and/or secondary impacts. • Temporary and/or permanent fill or excavation in SAV <1,000 SF • Permanent fill or excavation in other SAS <4,300 SF
11. Mining Activities	Not Eligible	Not Eligible
12. Boat Ramps and Marine Railways	No new boat ramps or marine railways. In-water work is conducted “in-the-dry” (see GC 24). No impacts to SAS (incl. SAV), impacts to natural rocky habitat ≤100 SF, and impacts to intertidal or shellfish areas ≤1,000 SF Boat ramp and marine railway work not eligible for maintenance (i.e. not currently serviceable) may be replaced “in-kind” with minor deviations provided: • Work is confined to the intertidal zone. • No impacts to SAS (incl. SAV), impacts to natural rocky habitat ≤100 SF, and impacts to intertidal or shellfish areas ≤1,000 SF	Those ramps and railways not eligible for SV, provided: • <1 acre temporary or permanent impacts, fill, excavation, and/or secondary impacts, provided: • Temporary and/or permanent fill or excavation in SAV <1,000 SF • Permanent fill or excavation in other SAS <4,300 SF

	SELF-VERIFICATION (SV)	PRE-CONSTRUCTION NOTIFICATION (PCN)
13. Land and Water-Based Renewable Energy Generation Facilities and Hydropower Projects	Not Eligible	Work associated with those facilities and projects, provided: • <1 acre temporary or permanent impacts, fill, excavation, and/or secondary impacts. • Temporary and/or permanent fill or excavation in SAV <1,000 SF • Permanent fill or excavation in other SAS <4,300 SF For each single and complete project, no more than 10 generation units (e.g., wind turbines or hydrokinetic devices) may be authorized. No new impoundments.
14. Reshaping Existing Ditches and Mosquito Management	≤500 LF of drainage ditch will be modified. The reshaping of the ditch cannot increase drainage capacity beyond the original as-built capacity nor can it expand the area drained by the ditch as originally constructed (i.e., the capacity of the ditch shall be the same as originally constructed and it cannot drain additional wetlands or other waters of the U.S.). No new ditches or relocation of drainage ditches constructed in waters of the U.S.; the location of the centerline of the reshaped drainage ditch shall be approximately the same as the location of the centerline of the original drainage ditch. No impacts to SAS (incl. SAV), impacts to natural rocky habitat ≤100 SF, and impacts to intertidal or shellfish areas ≤1,000 SF	Those activities not eligible for SV, provided: • <1 acre temporary or permanent impacts, fill, excavation, and/or secondary impacts. • Temporary and/or permanent fill or excavation in SAV <1,000 SF • Permanent fill or excavation in other SAS <4,300 SF
15. Response Operations for Oil or Hazardous Substances	The SVNf or a surrogate state reporting form may be submitted after-the-fact for spill response activities. This GP also authorizes the use of temporary structures and fills in waters of the U.S. for spill response training exercises (<i>SVNF is required prior to the activity</i>), provided: • No impacts to SAS (incl. SAV), impacts to natural rocky habitat ≤100 SF, impacts to intertidal or shellfish areas ≤1,000 SF, and impacts to tidal resources <0.5 acre	Those response operations not eligible for SV, provided: • <1 acre temporary or permanent impacts, fill, excavation, and/or secondary impacts. • Temporary and/or permanent fill or excavation in SAV <1,000 SF • Permanent fill or excavation in other SAS <4,300 SF
16. Cleanup of Hazardous and Toxic Waste	Only booms placed for hazardous and toxic waste containment and absorption and prevention are eligible for SV. <i>A SVNf is not required for these eligible containment booms.</i>	Cleanup activities not eligible for SV, provided: • <1 acre temporary or permanent impacts, fill, excavation, and/or secondary impacts. • Temporary and/or permanent fill or excavation in SAV <1,000 SF • Permanent fill or excavation in other SAS <4,300 SF An IP is require for the establishment of new disposal sites or expanding existing sites used for the disposal of hazardous or toxic waste.

	SELF-VERIFICATION (SV)	PRE-CONSTRUCTION NOTIFICATION (PCN)
17. Scientific Measurements Devices	Those scientific measurements devices, provided: • Devices do not restrict or concentrate movement of aquatic organisms. • No interference with navigation. • No blasting. • No biological sampling devices. • No impacts to SAS (incl. SAV), impacts to natural rocky habitat ≤ 100 SF, impacts to intertidal areas $\leq 1,000$ SF, and impacts to tidal resources ≤ 0.5 acre • Upon completion of use, the devices and any associated structures or fills are removed in their entirety.	Those scientific measurements devices not eligible for SV, provided: • <1 acre temporary or permanent impacts, fill, excavation, and/or secondary impacts. • Temporary and/or permanent fill or excavation in SAV $<1,000$ SF • Permanent fill or excavation in other SAS $<4,300$ SF
18. Survey Activities	Those survey activities, provided: • No blasting. • No interference with navigation. • No seismic exploratory operations. • No oil and gas exploration. • No trenching or other silt-producing activities. • No fill for roads or construction pads. • No impacts to SAS (incl. SAV), impacts to natural rocky habitat ≤ 100 SF, impacts to intertidal areas $\leq 1,000$ SF, and impacts to tidal resources <0.5 acre • No blasting. • No biological sampling devices. <i>A SVNf is not required for required sediment sampling for Corps-regulated dredge proposals.</i>	Those survey activities not eligible for SV, provided: • <1 acre temporary or permanent impacts, fill, excavation, and/or secondary impacts. • Temporary and/or permanent fill or excavation in SAV $<1,000$ SF • Permanent fill or excavation in other SAS $<4,300$ SF
19. Agricultural Activities	Not Eligible	Not Eligible
20. Fish and Wildlife Harvesting, Enhancement and Attraction Devices and Activities <i>(for aquaculture refer to GP 23)</i>	Those devices and activities, provided: • No impacts to SAS (incl. SAV), impacts to natural rocky habitat ≤ 100 SF, impacts to intertidal areas $\leq 1,000$ SF, and impacts to tidal resources ≤ 0.5 acre • No interference with navigation. • No artificial reefs or enclosures • No impoundments or semi-impoundments for the culture or holding of motile species such as lobster, or the use of covered oyster trays or clam racks. • Structures and shell hash should not be located within 25 feet of SAV. • All gear, except for mooring tackle, when not in use on the site is stored in an upland location above the MHWL and not on wetland (incl. salt marsh). <i>A SVNf is not required for these eligible devices and activities.</i>	Those devices and activities not eligible for SV, provided: • <1 acre temporary or permanent impacts, fill, excavation, and/or secondary impacts. • Temporary and/or permanent fill or excavation in SAV $<1,000$ SF • Permanent fill or excavation in other SAS $<4,300$ SF Impoundments or semi-impoundments of waters of the U.S. for the culture or holding of motile species such as lobster and new fish weirs with an impounded area <0.5 acre

	SELF-VERIFICATION (SV)	PRE-CONSTRUCTION NOTIFICATION (PCN)
21. Habitat Restoration, Establishment, and Enhancement	Those activities, provided: • No impacts to SAS (incl. SAV), impacts to natural rocky habitat ≤100 SF, impacts to intertidal areas ≤1,000 SF, and impacts to tidal resources <0.5 acre • No thin layer deposition for salt marsh restoration. • SAS planting and transplanting is <100 SF • No artificial or living reefs. • The activity is authorized in writing by a local, state, or non-Corps federal environmental agency. Water impoundments require PCN. • No conversion of i) a stream to wetland or vice versa, wetland to a pond or uplands, and ii) one wetland type to another. • No dam removal.	Those activities not eligible for SV provided those activities are proactive and result in net increases in aquatic resource functions and services.
22. Stream and Wetland Work and Crossings (see also GC 29) <i>(see GP 6 for bridges & causeways)</i>	Not Eligible	Those crossings of tidal navigable water not including bridges and causeways, provided: • <1 acre temporary or permanent impacts, fill, excavation, and/or secondary impacts. • Temporary and/or permanent fill or excavation in SAV <1,000 SF • Permanent fill or excavation in other SAS <4,300 SF
23. Aquaculture* (see also GC 32)	Shellfish and marine algae installations that do not exceed 400 SF in area, provided: • Signed approval from Harbormaster or appropriate Town Official. • No enclosures or impoundments. • Not located in or within a distance of three times the authorized depth of a Federal Navigation Project. • Not located in or impinge upon the value of any National Lands or Federal Properties. • No impacts to SAS (incl. SAV), impacts to natural rocky habitat ≤100 SF, and impacts to intertidal and shellfish areas ≤1,000 SF • No structures, cages, gear, or shell hash located in/within 25 feet of SAV. • All gear, except for mooring tackle, when not in use on the site is stored in an upland location above the MHW and not on wetland (incl. salt marsh).	Shellfish, finfish, and marine algae aquaculture (with the exception of Atlantic salmon and any other salmonid, or other federally-listed endangered or threatened species), or other aquaculture facilities with no more than minimal individual and cumulative impacts to environmental resources or navigation. This is inclusive but not limited to cages, nets, bags, racks, long lines, fences, posts, poles, predator screening, etc. *State of Maine Aquaculture guidelines are provided at: www.maine.gov/dmr/aquaculture/index.html



Section VI: Self-Verification Notification Form
(for all tidal and non-tidal projects in Maine subject to Corps jurisdiction)

**US Army Corps
of Engineers®**
New England District

At least two weeks before work commences, complete all fields (write “none” if applicable) below or use the fillable form found at www.nae.usace.army.mil/Missions/Regulatory/State-General-Permits/Maine-General-Permit/ The two-week lead time is not required for emergency situations. **Send this form, an Official Species List, and project plans to the following email address: cenae-r-me@usace.army.mil**

Maine Project Office
U.S. Army Corps of Engineers
442 Civic Center Drive, Suite 350
Augusta, Maine 04330

State Permit #: _____
Date of State Permit: _____
State Project Manager: _____

Permittee: _____
Address, City, State, Zip: _____
Email, Phone: _____

Agent: _____
Address, City, State, Zip: _____
Email, Phone: _____

Contractor: _____
Address, City, State, Zip: _____
Email, Phone: _____

Project Name: _____
Address, City, State, Zip: _____
Lat °N, Long °W: _____ Tax Map/Lot: _____
Waterway Name: _____
Description of Work: _____

Proposed Starting Date: _____ Proposed Finish Date: _____
Area of wetland impact (SF): Permanent: _____ Temporary: _____
Area of waterway impact (SF): Permanent: _____ Temporary: _____

Work will be done under the following Section V General Permits (circle all that apply):

I. Inland Waters and wetlands: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
II. Navigable Waters: 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23

Have MHPC and all five federally-recognized tribes in Maine been notified of the proposed work? _____ Yes _____ No

Your signature below, as permittee, indicates that you accept and agree to comply with the terms, eligibility criteria, and general conditions for Self-Verification under the Maine General Permit.

Permittee Signature: _____ Date: _____



**US Army Corps
of Engineers®**
New England District

Section VII: Content of a Pre-Construction Notification

In addition to the following required information, the applicant must provide additional information as the Corps deems essential to make a public interest determination including, where applicable, a determination of compliance with the Section 404(b)(1) guidelines or ocean dumping criteria. Such additional information may include environmental data and information on alternate methods and sites as may be necessary for the preparation of the required environmental documentation. For a more comprehensive checklist, go to www.nae.usace.army.mil/missions/regulatory >> Forms >> Application and Plan Guideline Checklist. Please check with the Corps for project-specific requirements.

Information required for all projects:

- ☐ DIGITAL SUBMISSIONS ARE ENCOURAGED (email PCN to cenae-r-me@usace.army.mil)
- ☐ Completed Corps application form (ENG Form 4345 attached below or found electronically at www.usace.army.mil/Missions/Civil-Works/Regulatory-Program-and-Permits/Obtain-a-Permit) or appropriate state application form. Forms may need to be supplemented to include the information noted below.
- ☐ Proof of notification to MHPC and all five federally-recognized tribes (see Section VIII for contact info).
- ☐ Official Species List for any federally-listed endangered or threatened species and email address of the person who generated the list.
- ☐ Drawings, sketches, or plans (detailed engineering plans and specifications are not required) that are legible, reproducible (color is encouraged, but features must be distinguishable in black and white), no larger than 8.5"x11", with bar scale (plans overlaid on aerial photos are discouraged). Wetland area impact sheets shall have the highest resolution possible to show work within Corps jurisdiction (do not just reduce project overview or cut large-scale plan into quadrant sheets). Provide locus map and a plan overview of the entire property with a key index to the individual impact sheets. A locus map be on a section of color USGS topographic map.
- ☐ Include:
 - ☐ All direct, secondary, permanent and temporary effects the project would cause, including the anticipated amount of impacts to waters of the U.S. expected to result from the activity, in acres, linear feet, or other appropriate unit of measure.
 - ☐ Any historic permanent fill associated with each single and complete project.
 - ☐ Cross-section views of all wetland and waterway fill areas and wetland replication areas.
 - ☐ Document on project plans wetlands, other special aquatic sites (SAS) including vegetated shallows (or submerged aquatic vegetation, SAV) and mudflats, natural rocky habitat, shellfish areas, vernal pools, and other waters, such as lakes and ponds, and perennial, and intermittent streams on the project site (GC1).
 - ☐ MLW line, MHW mark, and HTL elevations in tidal waters. Show OHWM elevation in lakes and non-tidal streams.
 - ☐ **Existing and proposed conditions.**
- ☐ Volume, type, and source of fill material to be discharged into waters and wetlands, including the area(s) (in square feet or acres) of fill in wetlands, below OHWM in inland waters and below the HTL in coastal waters.
- ☐ If applicable, a restoration plan showing how all temporary fills and structures will be removed and the area restored to pre-project conditions (see GC 21).

Information that may be required:

- Photographs of wetland/waterway to be impacted. Photos at low tide are preferred for work in tidal waters.
- For drawings, sketches, or plans:
 - The vertical datum for all coastal projects and projects in towns bordering coastal waters shall be in U.S. survey feet and referenced to MLLW and include current tidal epoch, with a reference chart showing conversion factor to the North American Vertical Datum of 1988. Do not use local datum. See www.nae.usace.army.mil/missions/regulatory >> Forms and Publications >> Vertical Datum - FEMA (Jul 2007);
 - The horizontal state plane coordinates shall be shown on plan and elevation views and shall be in the North American Datum of 1983 (NAD83) State Plane Coordinate System in U.S. survey feet.
- For the construction of a filled area or pile or float-supported platform, the use of, and specific structures to be erected on, the fill or platform.
- For the discharge of dredged or fill material into waters of the U.S. or the transportation of dredged material for the purpose of disposing of it in ocean waters, the source of the material; the purpose of the discharge, a description of the type, composition and quantity of the material; the method of transportation and disposal of the material; and the location of the disposal site.
- For the discharge of dredged or fill material into waters of the U.S., include a statement describing how impacts to waters of the U.S. are to be avoided and minimized. Include either a statement describing how impacts to waters of the U.S. are to be compensated for or a statement explaining why compensatory mitigation should not be required for the proposed impacts.
- Purpose and need for the proposed activity;
- Limits and coordinates of any Federal Navigation Project in the vicinity of the project area.
- Limits and coordinates of any proposed mooring field, reconfiguration zone or aquaculture activity. Provide coordinates for all corners;
- Schedule of construction/activity;
- Names and addresses of adjoining property owners;
- Location and dimensions of adjacent structures;
- Alternatives analysis;
- Wetland delineation data sheets;
- List of authorizations required by other federal, interstate, state, or local agencies for the work, including all approvals received or denials already made.
- Identification and description of potential impacts to Essential Fish Habitat (see GC 17).
- Identification of potential discharges of pollutants to waters, including potential impacts to impaired waters, in the project area.
- Invasive Species Control Plan (see GC 22). For sample control plans, see www.nae.usace.army.mil/Missions/Regulatory/Invasive-Species
- Wildlife Action Plan (WAP) maps. Contact the Maine Department of Inland Fisheries & Wildlife (Section VIII) or online at www.maine.gov/ifw/wildlife/conservation/action_plan.html

Information for dredging projects that may be required:

- Sediment testing, including physical (e.g., grain-size analysis), chemical and biological testing. For projects proposing open water disposal, applicants must contact the Corps as early as possible regarding sampling and testing protocols. Sampling and testing of sediments without such contact should not occur and if done, would be at the applicant's risk.
- The area in square feet and volume of material to be dredged below mean high water.
- Existing and proposed water depths.
- Type of dredging equipment to be used.
- Nature of material (e.g., silty sand).
- Any existing sediment grain size and bulk sediment chemistry data for the proposed or any nearby projects.
- Information on the location and nature of municipal or industrial discharges and occurrence of any contaminant spills in or near the project area.
- Shellfish survey.
- Location of the disposal site (include locus sheet).
- Identification and description of any potential impacts to Essential Fish Habitat.
- Delineation of submerged aquatic vegetation (e.g., eelgrass beds).

Information for tidal crossing projects that may be required:

- A graphic longitudinal elevation profile plot of the tidal stream channel thalweg, both up and downstream of the proposed project site. Thalweg elevations shall extend from the crossing to beyond the zone of scour, channel widening, or other channel alteration resulting from the present or pre-existing crossings. The profile plot should include labeled elevations for the:
 - crossing invert and top of the inlet and outlet
 - roadbed crown
 - lowest and highest recorded tides at the site
 - reference datums, such as MLLW, MHHW, and astronomical high tide
 - hydraulic controls and nearest crossings that could influence or be influenced by the proposed crossing
- A graphic plot of continuous tidal water levels recorded up and downstream, simultaneously, of the proposed crossing for an entire lunar cycle. The water level plot should include labeled elevations for the:
 - crossing invert and crossing top at the inlet and outlet
 - roadbed crown
 - reference datums, such as MLLW, MHHW, and astronomical high tide
- A map showing projected extents of maximum flooding within the area influenced by the crossing under current conditions and as a result of sea level rise. The present minimum sea level rise scenario suggested for planning purposes by the Maine Climate Council Scientific and Technical Subcommittee is the Intermediate Scenario, which projects an increase of 3.0-4.6 feet by 2100.

Information for aquaculture projects that may be required:

- Maine Aquaculture guidelines and joint Corps/Maine DMR applications may be found at:
www.maine.gov/dmr/aquaculture/index.htm
- In addition to the information required above, applications should also include:
 - Results of coordination with Harbor Master and U.S. Coast Guard
 - Whether canopy predator nets are being used.

U.S. Army Corps of Engineers (USACE) APPLICATION FOR DEPARTMENT OF THE ARMY PERMIT 33 CFR 325. The proponent agency is CECW-CO-R.			Form Approved - OMB No. 0710-0003 Expires: 02-28-2022		
The public reporting burden for this collection of information, OMB Control Number 0710-0003, is estimated to average 11 hours per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding the burden estimate or burden reduction suggestions to the Department of Defense, Washington Headquarters Services, at whs.mc-alex.esd.mbx.dd-dod-information-collections@mail.mil . Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to any penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number. PLEASE DO NOT RETURN YOUR APPLICATION TO THE ABOVE EMAIL.					
PRIVACY ACT STATEMENT					
Authorities: Rivers and Harbors Act, Section 10, 33 USC 403; Clean Water Act, Section 404, 33 USC 1344; Marine Protection, Research, and Sanctuaries Act, Section 103, 33 USC 1413; Regulatory Programs of the Corps of Engineers; Final Rule 33 CFR 320-332. Principal Purpose: Information provided on this form will be used in evaluating the application for a permit. Routine Uses: This information may be shared with the Department of Justice and other federal, state, and local government agencies, and the public and may be made available as part of a public notice as required by Federal law. Submission of requested information is voluntary, however, if information is not provided the permit application cannot be evaluated nor can a permit be issued. One set of original drawings or good reproducible copies which show the location and character of the proposed activity must be attached to this application (see sample drawings and/or instructions) and be submitted to the District Engineer having jurisdiction over the location of the proposed activity. An application that is not completed in full will be returned. System of Record Notice (SORN). The information received is entered into our permit tracking database and a SORN has been completed (SORN #A1145b) and may be accessed at the following website: http://dpcl.dod.mil/Privacy/SORNsIndex/DOD-wide-SORN-Article-View/Article/570115/a1145b-ce.aspx					
(ITEMS 1 THRU 4 TO BE FILLED BY THE CORPS)					
1. APPLICATION NO.		2. FIELD OFFICE CODE		3. DATE RECEIVED	4. DATE APPLICATION COMPLETE
(ITEMS BELOW TO BE FILLED BY APPLICANT)					
5. APPLICANT'S NAME First - Middle - Last - Company - E-mail Address -			8. AUTHORIZED AGENT'S NAME AND TITLE (agent is not required) First - Middle - Last - Company - E-mail Address -		
6. APPLICANT'S ADDRESS: Address- City - State - Zip - Country -			9. AGENT'S ADDRESS: Address- City - State - Zip - Country -		
7. APPLICANT'S PHONE NOs. w/AREA CODE a. Residence b. Business c. Fax			10. AGENTS PHONE NOs. w/AREA CODE a. Residence b. Business c. Fax		
STATEMENT OF AUTHORIZATION					
11. I hereby authorize, _____ to act in my behalf as my agent in the processing of this application and to furnish, upon request, supplemental information in support of this permit application.					
_____ SIGNATURE OF APPLICANT			_____ DATE		
NAME, LOCATION, AND DESCRIPTION OF PROJECT OR ACTIVITY					
12. PROJECT NAME OR TITLE (see instructions)					
13. NAME OF WATERBODY, IF KNOWN (if applicable)			14. PROJECT STREET ADDRESS (if applicable) Address		
15. LOCATION OF PROJECT Latitude: N Longitude: W			City - State- Zip-		
16. OTHER LOCATION DESCRIPTIONS, IF KNOWN (see instructions) State Tax Parcel ID Municipality Section - Township - Range -					

17. DIRECTIONS TO THE SITE

18. Nature of Activity (Description of project, include all features)

19. Project Purpose (Describe the reason or purpose of the project, see instructions)

USE BLOCKS 20-23 IF DREDGED AND/OR FILL MATERIAL IS TO BE DISCHARGED

20. Reason(s) for Discharge

21. Type(s) of Material Being Discharged and the Amount of Each Type in Cubic Yards:

Type	Type	Type
Amount in Cubic Yards	Amount in Cubic Yards	Amount in Cubic Yards

22. Surface Area in Acres of Wetlands or Other Waters Filled (see instructions)

Acres
or
Linear Feet

23. Description of Avoidance, Minimization, and Compensation (see instructions)

24. Is Any Portion of the Work Already Complete? ☐ Yes ☐ No IF YES, DESCRIBE THE COMPLETED WORK

25. Addresses of Adjoining Property Owners, Lessees, Etc., Whose Property Adjoins the Waterbody (if more than can be entered here, please attach a supplemental list).

a. Address-

City - State - Zip -

b. Address-

City - State - Zip -

c. Address-

City - State - Zip -

d. Address-

City - State - Zip -

e. Address-

City - State - Zip -

26. List of Other Certificates or Approvals/Denials received from other Federal, State, or Local Agencies for Work Described in This Application.

AGENCY	TYPE APPROVAL*	IDENTIFICATION NUMBER	DATE APPLIED	DATE APPROVED	DATE DENIED

* Would include but is not restricted to zoning, building, and flood plain permits

27. Application is hereby made for permit or permits to authorize the work described in this application. I certify that this information in this application is complete and accurate. I further certify that I possess the authority to undertake the work described herein or am acting as the duly authorized agent of the applicant.

SIGNATURE OF APPLICANT

DATE

SIGNATURE OF AGENT

DATE

The Application must be signed by the person who desires to undertake the proposed activity (applicant) or it may be signed by a duly authorized agent if the statement in block 11 has been filled out and signed.

18 U.S.C. Section 1001 provides that: Whoever, in any manner within the jurisdiction of any department or agency of the United States knowingly and willfully falsifies, conceals, or covers up any trick, scheme, or disguises a material fact or makes any false, fictitious or fraudulent statements or representations or makes or uses any false writing or document knowing same to contain any false, fictitious or fraudulent statements or entry, shall be fined not more than \$10,000 or imprisoned not more than five years or both.

Section VIII: Agency Contacts

1. Federal

U.S. Army Corps of Engineers
Maine Project Office
442 Civic Center Drive, Suite 350
Augusta, Maine 04330
(207) 623-8367; (207) 623-8206 (fax)
Email: cenae-r-me@usace.army.mil

U.S. Environmental Protection Agency
5 Post Office Square
Suite 100 (OEP05-2)
Boston, Massachusetts 02109-3912
(617) 918-1589

U.S. Fish and Wildlife Service
Maine Field Office
P.O. Box A
East Orland, Maine 04431
(207) 469-7300; (207) 902-1588 (fax)
(Federal endangered species)

National Marine Fisheries Service
Maine Field Office
17 Godfrey Drive, Suite 1
Orono, Maine 04473
(207) 866-7379; (207) 866-7342 (fax)
(Federal endangered species)

FEMA Region 1
Federal Insurance and Mitigation Division
99 High Street 6th Floor
Boston, Massachusetts 02110
(floodplains)

Federal Emergency Management Agency
99 High Street
Boston, Massachusetts 02110
(877) 336-2734
(Floodplain Management)

National Marine Fisheries Service
55 Great Republic Drive
Gloucester, Massachusetts 01930
(978) 281-9102; (978) 281-9301 (fax)
(Federal endangered species & EFH)

National Park Service
North Atlantic Region
15 State Street
Boston, Massachusetts 02109
(617) 223-5203
(Wild and Scenic Rivers)

Commander (dpb)
First Coast Guard District
One South Street - Battery Building
New York, New York 10004-1466
(212) 668-7021; (212) 668-7967 (fax)
(bridge permits)

2. State of Maine

a. Department of Environmental Protection (State permits & Water Quality Certifications)

Augusta Regional Office
17 State House Station
Augusta, Maine 04333
(207) 287-7688

Southern Maine Regional Office
312 Canco Road
Portland, Maine 04103
(201) 822-6300

Eastern Maine Regional Office
106 Hogan Road
Bangor, Maine 04401
(207) 941-4570

Northern Maine Regional Office
1235 Central Drive
Presque Isle, Maine 04769
(207) 764-0477

b. Department of Agriculture, Conservation and Forestry

i. Maine Land Use Planning Commission (LUPC) (*State permits & Water Quality Certifications for the unorganized areas of the State*)

Augusta Office
22 State House Station
Augusta, Maine 04333-0022
(207) 287-2631; (207) 287-7439 (fax)

Downeast Regional Office
106 Hogan Road, Suite 8
Bangor, Maine 04401
(207) 215-4685; (207) 941-4222 (fax)

Greenville Regional Office
43 Lakeview Drive
P.O. Box 1107
Greenville, Maine 04441
(207) 695-2466; (207) 695-2380 (fax)

Ashland Regional Office
45 Radar Road
Ashland, Maine 04732-3600
(207) 435-7963; (207) 435-7184 (fax)

Western Region Office
932 U.S. Route 2
East Wilton, Maine 04992
(207) 670-7492; (207) 287-7439 (fax)

Eastern Region Office
191 Main Street
East Millinocket, Maine 04430
(207) 399-2176; (207) 746-2243 (fax)

ii. Maine Coastal Program

21 State House Station
Augusta, Maine 04333
(207) 707-2324; (207) 624-6024 (fax)
(*CZM consistency determinations*)

iii. Division of Parks and Public Lands

22 State House Station
Augusta, Maine 04333
(207) 287-3061; (207) 287-6170 (fax)
(*submerged lands leases*)

iv. Maine Floodplain Management Program

17 Elkins Lane
Augusta, Maine 04333
(207) 287-8063
(*floodplains*)

c. Department of Marine Resources

21 State House Station
Augusta, Maine 04333
(207) 633-9500; (207) 624-6024 (fax)
(*aquaculture leases/licenses*)

3. Historic Properties

a. State Historic Preservation Officer (SHPO)

Kirk F. Mohny, Director
Maine Historic Preservation Commission
65 State House Station
Augusta, Maine 04333-0065
(207) 287-2132; (207) 287-2335 (fax)

b. Tribal Historic Preservation Officers (THPOs)

Houlton Band of Maliseet Indians
88 Bell Road
Littleton, Maine 04730
(207) 532-4273, x215; (207) 532-6883 (fax)
istjohn@maliseets.com

Passamaquoddy Tribe of Indians
Pleasant Point Reservation
P.O. Box 343
Perry, Maine 04667
(207) 853-2600; (207) 853-6039 (fax)
soctomah@gmail.com

Passamaquoddy Tribe of Indians
Indian Township Reservation
P.O. Box 301
Princeton, Maine 04668
(207) 796-2301; (207) 796-5256 (fax)
soctomah@gmail.com

Aroostook Band of Micmacs
7 Northern Road
Presque Isle, Maine 04769
(207) 764-1972; (207) 764-7667 (fax)
jdennis@micmac-nsn.gov

Penobscot Nation
Cultural and Historic Preservation Dept.
12 Wabanaki Way
Indian Island, Maine 04468
(207) 817-7471
chris.sockalexis@penobscotnation.org

Section IX: Definitions

Action Area: The “Endangered Species Consultation Handbook – Procedures for Conducting Consultation and Conference Activities Under Section 7 of the ESA,” defines action area as “all areas to be affected directly or indirectly by the federal action and not merely the immediate area involved in the action. [50 CFR 402.02].”

Agricultural Activities: The Clean Water Act exempts certain discharges associated with normal farming, ranching, and forestry activities such as plowing, cultivating, minor drainage, and harvesting for the production of food, fiber, and forest products, or upland soil and water conservation practices (Section 404(f)(1)(A)). Prospective permittees are strongly advised to contact the Corps for a determination of whether their activity is exempt or requires a permit.

Attendant Features: Occurring with or as a result of; accompanying.

Aquatic Habitat Restoration, Establishment and Enhancement: The Corps will decide if a project qualifies and must determine in consultation with federal and state agencies that the net effects are beneficial. The Corps may refer to Nationwide Permit 27 published in the January 6, 2017 Federal Register. Activities authorized here may include, but are not limited to: the removal of accumulated sediments; the installation, removal, and maintenance of small water control structures, dikes, and berms; the installation of current deflectors; the enhancement, restoration, or establishment of riffle and pool stream structure; the placement of in-stream habitat structures; modifications of the stream bed and/or banks to restore or establish stream meanders; the backfilling of artificial channels and drainage ditches; the removal of existing drainage structures; the construction of small nesting islands in inland waters; the construction of open water areas; the construction of native shellfish species habitat over unvegetated bottom for the purpose of habitat protection or restoration in tidal waters; shellfish seeding; activities needed to reestablish vegetation, including plowing or disking for seed bed preparation and the planting of appropriate wetland species; mechanized land clearing to remove non-native invasive, exotic, or nuisance vegetation; and other related activities. Only native plant species shall be planted at the site.

Biodegradable: A material that decomposes into elements found in nature within a reasonably short period of time and will not leave a residue of plastic or a petroleum derivative in the environment after degradation. Examples of biodegradable materials include jute, sisal, cotton, straw, burlap, coconut husk fiber (coir) or excelsior. In contrast, degradable plastics break down into plastic fragments that remain in the environment after degradation.

Boating facilities: These provide, rent or sell mooring space, such as marinas, yacht clubs, boat yards, dockominiums, town facilities, land/home owners, etc. Not classified as boating facilities are piers shared between two abutting properties or town mooring fields that charge an equitable user fee based on the actual costs incurred.

Bordering and Contiguous Wetlands: A bordering wetland is immediately next to its adjacent waterbody and may lie at, or below, the ordinary high water mark (mean high water mark in navigable waters) of that waterbody and is directly influenced by its hydrologic regime. Contiguous wetlands extend landward from their adjacent waterbody to a point where a natural or manmade discontinuity exists. Contiguous wetlands include bordering wetlands as well as wetlands that are situated immediately above the ordinary high water mark and above the normal hydrologic influence of their adjacent waterbody.

Brushing: The placement of tree boughs, wooden lath structure, or small-mesh fencing on mudflats, or any bottom disturbance (e.g., disking, plowing, raking, etc.), to enhance recruitment of shellfish.

Buffer Zone: The buffer zone of an FNP is equal to three times the authorized depth of the FNP.

Construction mats: Constructions, swamp and timber mats (herein referred to as “construction mats”) are generic terms used to describe structures that distribute equipment weight to prevent wetland damage while facilitating passage and providing work platforms for workers and equipment. They are comprised of sheets or mats made from a variety of materials in various sizes. A timber mat consists of large timbers bolted or cabled together. Corduroy roads, which are not considered to be construction mats, are cut trees and/or saplings with the

crowns and branches removed, and the trunks lined up next to one another. Corduroy roads are typically installed as permanent structures. Like construction mats, they are considered as fill whether they are installed temporarily or permanently.

Cumulative effects: See “Direct, secondary, and cumulative effects.”

Currently Serviceable: Useable as-is or with some maintenance, but not so degraded as to essential require reconstruction.

Direct, secondary, and cumulative effects:

Direct Effects: The loss of aquatic ecosystem within the footprint of the discharge of dredged or fill material. Direct effects are caused by the action and occur at the same time and place.

Secondary Effects: These are effects on an aquatic ecosystem that are associated with a discharge of dredged or fill materials, but do not result from the actual placement of the dredged or fill material. Information about secondary effects on aquatic ecosystems shall be considered prior to the time final Section 404 action is taken by permitting authorities. Some examples of secondary effects on an aquatic ecosystem are a) aquatic areas drained, flooded, fragmented, or mechanically cleared, b) fluctuating water levels in all impoundment and downstream associated with the operation of a dam, c) septic tank leaching and surface runoff from residential or commercial developments on fill, and d) leachate and runoff from a sanitary landfill located in waters of the U.S. See 40 CFR 230.11(h).

Cumulative Effects: The changes in an aquatic ecosystem that are attributable to the collective effect of a number of individual 1) discharges of dredged or fill material, or 2) structures. Although the impact of a particular discharge may constitute a minor change in itself, the cumulative effect of numerous such piecemeal changes can result in a major impairment of the water resources and interfere with the productivity and water quality of existing aquatic ecosystems. See 40 CFR 230(g).

Dredging:

Maintenance Dredging: Includes areas and depths previously authorized by the Corps and dredged.

The Corps may require proof of authorization. Maintenance dredging typically refers to the routine removal of accumulated sediment from channel beds to maintain the design depths of navigation channels, harbors, marinas, boat launches and port facilities. Routine maintenance dredging is conducted regularly for navigational purposes (typically at least once every ten years) and does not include any expansion of the previously dredged area or depth. The Corps may review a maintenance dredging activity as new dredging if sufficient time has elapsed to allow for the colonization of SAS, shellfish, etc. The main characteristics of maintenance dredging projects are variable quantities of material; soft, uncompacted soil; contaminant content possible; thin layers of material; occurring in navigation channels and harbors; repetitive activity

New Dredging: Dredging of an area or to a depth that has never been authorized by the Corps or dredged.

Dredged material & discharge of dredged material: These are defined at 323.2(c) and (d). The term dredged material means material that is excavated or dredged from waters of the U.S.

Essential Fish Habitat (EFH): This is broadly defined to include those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity.

Fill material & discharge of fill material: These are defined at 323.2(e) and (f). The term fill material is defined as material placed in waters of the U.S. where the material has the effect of either replacing any portion of a water of the U.S. with dry land or changing the bottom elevation of any portion of a water of the U.S.

Fill area: Fill area includes all temporary and permanent fill (including mats), and regulated discharges associated with excavation.

Federal navigation projects (FNPs): These areas are maintained by the Corps; authorized, constructed and maintained on the premise that they will be accessible and available to all on equal terms; and are comprised of Federal Anchorages, Federal Channels and Federal Turning Basins. The buffer zone is equal to three times the authorized depth of a FNP. More information on the following FNPs is provided at www.nae.usace.army.mil/missions/navigation.aspx >> Navigation Projects.

Flume: An open artificial water channel, in the form of a gravity chute that leads water from a diversion dam or weir completely aside a natural flow. A flume can be used to measure the rate of flow.

Frac out: During normal drilling operations, drilling fluid travels up the borehole into a pit. When the borehole becomes obstructed or the pressure becomes too great inside the borehole, the ground fractures and fluid escapes to the surface.

Habitat Connectivity Design: projects designed and constructed for consistency with natural stream dimensions, profiles, and dynamics, in accordance with the following technical references: U.S. Forest Service guide (Forest Service Stream-Simulation Working Group 2008), augmented by documents published by the states of Washington (Barnard et al. 2013), Vermont (Bates and Kirn 2009) and California (Love and Bates 2009).

Independent utility: A test to determine what constitutes a single and complete non-linear project in the Corps regulatory program. A project is considered to have independent utility if it would be constructed absent the construction of other projects in the project area. Portions of a multi-phase project that depend upon other phases of the project do not have independent utility. Phases of a project that would be constructed even if the other phases were not built can be considered as separate single and complete projects with independent utility.

Individual Permit: A Department of the Army authorization that is issued following a case-by-case evaluation of a specific structure or work in accordance with the procedures of 33 CFR 322, or a specific project involving the proposed discharge(s) in accordance with the procedures of 33 CFR 323, and in accordance with the procedures of 33 CFR 325 and a determination that the proposed discharge is in the public interest pursuant to 33 CFR 320.

Living Shoreline: Living shorelines stabilize banks and shores in coastal waters along shores with small fetch and gentle slopes that are subject to low-to mid-energy waves. A living shoreline has a footprint that is made up mostly of native material. It incorporates vegetation or other living, natural “soft” elements alone or in combination with some type of harder shoreline structure (e.g., oyster or mussel reefs or rock sills) for added protection and stability. Living shorelines shall maintain the natural continuity of the land-water interface, and retain or enhance shoreline ecological processes. Living shorelines must have a substantial biological component, either tidal or lacustrine fringe wetlands or oyster or mussel reef structures.

Maintenance:

a. The repair, rehabilitation, or replacement of any previously authorized, currently serviceable structure or fill, or of any currently serviceable structure or fill authorized by 33 CFR 330.3 – “Activities occurring before certain dates,” provided that the structure or fill is not to be put to uses differing from those uses specified or contemplated for it in the original permit or the most recently authorized modification.

- Minor deviations in the structure’s configuration or filled area, including those due to changes in materials, construction techniques, or current construction codes or safety standards that are necessary to make repair, rehabilitation, or replacement are authorized.
- Currently serviceable means useable as is or with some maintenance, but not so degraded as to essentially require reconstruction.
- No seaward expansion for bulkheads or any other fill activity is considered SV maintenance.
- Only structures or fills that were previously authorized and are in compliance with the terms and condition of the original authorization can be maintained as a non-regulated activity under 33 CFR 323.4(a)(2), or in accordance with the SV or PCN thresholds in Section V.

b. The state’s maintenance provisions may differ from the Corps and may require reporting and written authorization from the state.

c. Contact the Corps to determine whether stream crossing replacements require a PCN.

d. Exempted Maintenance. In accordance with 33 CFR 323.4(a)(2), any discharge of dredged or fill material that may result from any of the following activities is not prohibited by or otherwise subject to regulation under Section 404 of the CWA: “Maintenance, including emergency reconstruction of recently damaged parts, of currently serviceable structures such as dikes, dams, levees, groins, riprap, breakwaters, causeways, bridge abutments or approaches, and transportation structures. Maintenance does not include any modification that changes the character, scope, or size of the original fill design.”

The following definition is also applicable:

Minor deviations: Deviations in the structure's configuration or filled area, including those due to changes in materials, construction techniques, or current construction codes or safety standards, which are necessary to make repair, rehabilitation, or replacement are permitted, provided the adverse environmental effects resulting from such repair, rehabilitation, or replacement are minimal.

Marina reconfiguration zone: A Corps-authorized area in which permittees may rearrange pile-supported structures and floats without additional authorizations. A reconfiguration zone does not grant exclusive privileges to an area or an increase in structure or float area.

Natural Rocky Habitats: Natural rocky habitats are intertidal and subtidal substrates composed of pebble-gravel, cobble, boulder, or rock ledge and outcrops. Manufactured stone (e.g. cut or engineered rip-rap) is not considered a natural rocky habitat. Natural rocky habitats are either found as pavement (consolidated pebble-gravel, cobble, or boulder areas) or as a mixture with fines (i.e. clay and sand) and other substrates.

Navigable waters of the U.S.: See Waters of the U.S. below.

Overall project: See "single and complete linear project" below.

Practicable: Available and capable of being done after taking into consideration cost, existing technology, and logistics in light of overall project purposes.

Permanent impacts: Permanent impacts means waters of the U.S. that are permanently affected by filling, flooding, excavation, or drainage because of the regulated activity. Permanent impacts include permanent discharges of dredged or fill material that change an aquatic area to dry land, increase the bottom elevation of a waterbody, or change the use of a waterbody.

Pre-construction notification (PCN): A request submitted by a prospective permittee to the Corps for confirmation that a particular activity is authorized by this GP. The request may be a permit application, letter, or similar document that includes information about the proposed work and its anticipated environmental effects. Pre-construction notification may be required by the terms and conditions of these GPs. A PCN may be voluntarily submitted in cases where PCN is not required and the project proponent wants confirmation that the activity is authorized under this GP.

Re-establishment: The manipulation of the physical, chemical, or biological characteristics of a site with the goal of returning natural/ historic functions to a former aquatic resource. Re-establishment results in rebuilding a former aquatic resource and results in again in aquatic resource area and functions.

Rehabilitation: The manipulation of the physical, chemical, or biological characteristics of a site with the goal of repairing natural/historic functions to a degraded aquatic resource. Rehabilitation results in a gain in aquatic resource function, but does not result in a gain in aquatic resource area. Restoration: The manipulation of the physical, chemical, or biological characteristics of a site with the goal of returning natural/historic functions to a former or degraded aquatic resource. For the purpose of tracking net gains in aquatic resource area, restoration is divided into two categories: re-establishment and rehabilitation.

Restoration: The manipulation of the physical, chemical, or biological characteristics of a site with the goal of returning natural/historic functions to a former or degraded aquatic resource. For the purpose of tracking net gains in aquatic resource area, restoration is divided into two categories: re-establishment and rehabilitation.

Riffle and pool complexes: Riffle and pool complexes are special aquatic sites under the 404(b)(1) Guidelines. Riffle and pool complexes sometimes characterize steep gradient sections of streams. Such stream sections are recognizable by their hydraulic characteristics. The rapid movement of water over a coarse substrate in riffles results in a rough flow, a turbulent surface, and high dissolved oxygen levels in the water. Pools are deeper areas associated with riffles. A slower stream velocity, a streaming flow, a smooth surface, and a finer substrate characterize pools.

Secondary effects: See “Direct, secondary, and cumulative effects.”

Shellfish Areas: Areas that currently support molluscan shellfish. Information regarding these locations can be obtained from the State of Maine GeoLibrary Data Catalog at: www.maine.gov/geolib/catalog.html

Shellfish seeding: The placement of shellfish seed and/or suitable substrate to increase shellfish production. Shellfish seed consists of immature individual shellfish or individual shellfish attached to shells or shell fragments (i.e., spat on shell). Suitable substrate may consist of shellfish shells, shell fragments, or other appropriate materials placed into waters for shellfish habitat.

Single and complete linear project: A linear project is a project constructed for the purpose of getting people, goods, or services from a point of origin to a terminal point, which often involves multiple crossings of one or more waterbodies at separate and distant locations. The term “single and complete project” is defined as that portion of the total linear project proposed or accomplished by one owner/developer or partnership or other association of owners/developers that includes all crossings of a single water of the U.S. (i.e., a single waterbody) at a specific location. For linear projects crossing a single or multiple waterbodies several times at separate and distant locations, each crossing is considered a single and complete project for the purposes of this GP. However, individual channels in a braided stream or river, or individual arms of a large, irregularly shaped wetland or lake, etc., are not separate waterbodies, and crossings of such features cannot be considered separately. The overall project, for purposes of this GP, includes all regulated activities that are reasonably related and necessary to accomplish the project purpose.

Single and complete non-linear project: For non-linear projects, the term “single and complete project” is defined at 33 CFR 330.2(i) as the total project proposed or accomplished by one owner/developer or partnership or other association of owners/developers. For non-linear projects, the single and complete project shall have independent utility (see definition).

Special aquatic sites (SAS): These are defined at 40 CFR 230 Subpart E. They include sanctuaries and refuges, wetlands, mud flats, vegetated shallows (submerged aquatic vegetation, SAV), coral reefs, and riffle and pool complexes.

Stream: The term “stream” in the document means rivers, streams, brooks, etc.

Stream bed: The substrate of the stream channel between the ordinary high water marks. The substrate may be bedrock or inorganic particles that range in size from clay to boulders. Wetlands contiguous to the stream bed, but outside of the ordinary high water marks, are not considered part of the stream bed.

Stream channelization: The manipulation of a stream’s course, condition, capacity, or location that causes more than minimal interruption of normal stream processes. A channelized stream remains a water of the United States.

Stream Simulation: A method for designing and building road-stream crossings intended to permit free and unrestricted movements of any aquatic species. Reference:
<https://www.nae.usace.army.mil/Missions/Regulatory/Stream-and-River-Continuity/>

Stream Smart Design: projects designed to allow the stream to act like a stream by passing fish and wildlife as well as the higher flows that come with large infrequent storms while protecting the stability of the road and public safety. Stream Smart Design follows the “Four S’s”: The culvert must SPAN the stream, allowing for passage of aquatic and terrestrial wildlife. The culvert has to be SET at the right elevation. The SLOPE of the culvert must match the stream. There must be SUBSTRATE (natural sediment) in the crossing. Reference:
www1.maine.gov/mdot/publications/docs/brochures/pocket_guide_stream_smart_web.pdf

Temporary impacts: Temporary impacts include waters of the U.S. that are temporarily filled, flooded, excavated, drained or mechanically cleared because of the regulated activity.

Temporal loss: The time lag between the loss of aquatic resource functions caused by the permitted impacts and the replacement of aquatic resource functions at the compensatory mitigation site(s) (33 CFR 332.2).

Utility line: Any pipe or pipeline for the transportation of any gaseous, liquid, liquescent, or slurry substance, for any purpose, and any cable, line, or wire for the transmission for any purpose of electrical energy, telephone, and telegraph messages, and radio and television communication. The term ‘utility line’ does not include activities that drain a water of the U.S., such as drainage tile or French drains, but it does apply to pipes conveying drainage from another area.

Vegetated shallows/Submerged Aquatic Vegetation (SAV): Permanently inundated areas that under normal circumstances support communities of rooted aquatic vegetation, such as eelgrass in marine systems as well as a number of freshwater species in rivers and lakes. Note: Eelgrass surveys should be conducted between May and October unless otherwise directed.

Vernal pools (VPs): The State of Maine, Department of Environmental Protection has specific protections for VPs. For the purposes of these GPs, VPs are depressional wetland basins that typically go dry in most years and may contain inlets or outlets, typically of intermittent flow. Vernal pools range in both size and depth depending upon landscape position and parent material(s). In most years, VPs support one or more of the following obligate indicator species: wood frogs (*Rana sylvatica*), spotted salamanders (*Ambystoma maculatum*), blue-spotted salamanders (*Ambystoma laterale*), and fairy shrimp (*Eubranchipus* sp.). However, they should preclude sustainable populations of predatory fish.

Water dependency: activity requiring access or proximity to or siting within a special aquatic site (SAS) to fulfill its basic project purpose.

Water diversions: Water diversions are activities such as bypass pumping (e.g., “dam and pump”) or water withdrawals. Temporary flume pipes, culverts or cofferdams where normal flows are maintained within the stream boundary’s confines aren’t water diversions. “Normal flows” are defined as no change in flow from pre-project conditions.

Weir: A barrier across a river designed to alter the flow characteristics. In most cases, weirs take the form of a barrier, smaller than most conventional dams, across a river that causes water to pool behind the structure (not unlike a dam) and allows water to flow over the top. Weirs are commonly used to alter the flow regime of the river, prevent flooding, measure discharge and help render a river navigable.

Waters of the United States (U.S.)

Waters of the U.S.: The term waters of the U.S. and all other terms relating to the geographic scope of jurisdiction are defined at 33 CFR 328. Also see Section 502(7) of the Federal CWA [33 USC 1352(7)]. Waters of the U.S. include jurisdictional wetlands. Not all waters and wetlands are jurisdictional. Contact the Corps with any questions regarding jurisdiction.

Navigable waters: Refer to 33 CFR 329. These waters include the following federally-designated navigable waters in New England. This list represents only those waterbodies for which affirmative determinations have been made; absence from this list shall not be taken as an indication that the waterbody is not navigable: In Maine, navigable waters are those waters that are subject to the ebb and flow of the tide in addition to the non-tidal portions of the following federally-designated waters in Maine (the Kennebec River to Moosehead Lake, the Penobscot River to the confluence of the East and West Branch at Medway and, Lake Umbagog within the State of Maine).

Non-tidal wetland: A non-tidal wetland is a wetland that is not subject to the ebb and flow of tidal waters. Non-tidal wetlands contiguous to tidal waters are located landward of the high tide line (i.e., spring high tide line).

Tidal wetland: A tidal wetland is a jurisdictional wetland that is inundated by tidal waters. Tidal waters rise and fall in a predictable and measurable rhythm or cycle due to the gravitational pulls of the moon and sun. Tidal waters end where the rise and fall of the water surface can no longer be practically measured in a predictable rhythm due to masking by other waters, wind, or other effects. Tidal wetlands are located channelward of the high tideline.

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