

MAINE TURNPIKE AUTHORITY

ADDENDUM NO. 1

CONTRACT 2026.07

CROSBY MAINTENANCE OFFICE BUILDING

The bid opening date is December 9, 2025 at 11:00 A.M.

A pre-bid conference was held on November 4, 2025 at 10:00 A.M. at Maine Turnpike Authority.

The following changes are made to the Proposal, Specifications and Plans. Refer to the Questions section for additional information.

GENERAL

All questions regarding Contract 2026.07 should be submitted by Noon on December 2, 2025 to be answered by Addendum on or before December 4, 2025. Questions received after that time may not be answered.

PROPOSAL

- Intentionally left blank.

SPECIFICATIONS

The following specification sections have been revised and reissued with this Addendum:

- Schedule of Bid Prices
- Section 633 – Propane Gas Utility
- Section 014533a – Code Required Special Inspections and Procedures
- Section 014533b – Statement of Special Inspections
- Section 072100 – Building Insulation
- Section 092110 – Gypsum Board Assemblies
- Section 230900 – Instrumentation and Control for Mechanical Systems

PLANS

Please make the following changes:

1. DRAWING C20-1 – SITE LAYOUT PLAN
 - a. Add the following General Notes:
“1. Pavement shimming is not required for the project. All trenches are to be repaired per Detail A3 on Sheet C50-1. All other remaining paving is considered full depth reconstruction.
2. Pavement shall be sawcut per detail A4 on Sheet C50-2. Detail includes the construction of a butt joint (milling) to match existing pavement.”
2. DRAWING A55-1 – STOREFRONT DETAILS
 - a. EXTERIOR WINDOW SHADES SCHEDULE– Add the following note:
“Multiple light windows can be served by a single window shade if span length is allowed by shade manufacturer”

QUESTIONS

The following are questions submitted to the Maine Turnpike Authority in writing.

Answers to the questions are noted. Bidders shall utilize this information in preparing their bid.

- Question 1: Please clarify which areas are to be milled, shimmed and overlayed?
How is the shim being paid for?
Answer: See revision to drawings and specifications issued as part of this Addendum.
- Question 2: A55-1 shows opaque shades to be inside face of glazing Type S09 - this is not noted in the window schedule on A55-1 (Room A115) please advise if this is to receive shades.
Answer: Note on A55-1 indicates “opaque treatment”. See Exterior Window Shade Schedule on drawing A55-1 for openings to receive shades.
- Question 3: Please confirm that Types S06, S07, S08 - DO NOT receive shades.
Answer: See Exterior Window Shade Schedule on drawing A55-1 for openings to receive shades.
- Question 4: Does S04 get treated the same as S05? Note that there is an INSIDE corner to be dealt with.
Answer: See Exterior Window Shade Schedule on drawing A55-1 for openings to receive shades.

Question 5: Please confirm location is So Portland ME.

Answer: Yes.

Question 6: Multi-bay windows - one shade per bay or can some of these be combined i.e S01

Answer: See revision to drawings issued as part of this Addendum.

Question 7: Where are the Borrowed Lites located - do not see any on A10-1 where the interior sidelights are located - can only find Door 101B - is this the only one? Others?

Answer: See drawing A60-1 for frame types.

Question 8: The exterior wall configurations have multiple issues. Wall Types W01 and W02 - 2 x 6" Framing. Wall Types W11 and W12 - 2 x 8" Framing. All are drawn and described with 3-1/2" "Batt Insulation" in the cavities. If the cavities of exterior assemblies are insulated with "air permeable insulation", the cavity insulation should be in contact with all surfaces of the cavity and thus need to be a full cavity fill. Please advise.

1. The Thermal Insulation Specifications at 072100 include both Fiberglass and Mineral Wool Batts. Which type of Batt Insulation material is to be quoted for the Exterior Wall Cavities?

Answer: Item to be addressed in Addendum 2.

2. The Thermal Insulation Specifications at 072100 list a 6 Mil Poly Vapor Barrier. However, there is no Poly Vapor Barrier drawn or listed at the interior of the Exterior Wall assemblies. If intended to have a Vapor Retarder at the interior of the walls, it should be 4 Mil Poly or a Smart Vapor Retarder such as CertainTeed Membrain. This would prevent creating a double vapor barrier in conjunction with the Rigid Insulation and the Self-Adhered Air and Vapor Membrane which is drawn and listed at the exterior of the sheathing. Please advise.

Answer: See revision to specification issued as part of this Addendum.

3. Interior Partitions - All call for "Sound Attenuation Batts" As defined in the Gypsum Wall Board Specs at 092110 / 2.6 / 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. Which material is to be quoted for Sound

Attenuation Batts? Fiberglass or Mineral Wool? Please advise.

Answer: See revision to specification issued as part of this Addendum.

The following are questions submitted to the Maine Turnpike Authority at the Pre-Bid conference held on November 4, 2025. Answers to the questions are noted. Bidders shall utilize this information in preparing their bid.

Question 1: Please clarify the quantity of asphalt that is to be milled.

Answer: See revised Schedule of Bid Prices issued as part of this Addendum.

Question 2: Please clarify if this project will carry an Asphalt Escalator provision?

Answer: This project will not carry an Asphalt Escalator provision.

Question 3: Do the Record Drawings (As-Built) require a professional seal?

Answer: Record Drawings will not require a professional seal.

Question 4: Is there a published estimate for the cost of the work that can be provided?

Answer: An estimate is not being provided.

Question 5: Can you provide attendees with the sign-in sheet?

Answer: The sign-in sheet is included with this Addendum.

ATTACHMENTS

- (This document - Addendum #1 (5 pages))
- Pre-Bid Meeting Agenda (4 pages)
- Pre-Bid Meeting Attendance Form (1 page)
- Specification Section Schedule of Bid Prices (10 pages)
- Specification Section 633 – Propane Gas Utility (2 pages)
- Specification Section 014533a – Code Required Special Inspections and Procedures (7 pages)
- Specification Section 014533b – Statement of Special Inspections (26 pages)
- Specification Section 072100 – Building Insulation (8 pages)
- Specification Section 092110 – Gypsum Board Assemblies (12 pages)
- Specification Section 230900 – Instrumentation and Control for Mechanical Systems (39 pages)

Notes: The above items shall be considered as part of the bid submittal.

The total number of pages included in this addendum is one hundred fourteen (114) pages.

All bidders are requested to acknowledge the receipt of the Addendum No. 1 by signing below and email this sheet to Nathaniel Carll, Purchasing Department, Maine Turnpike Authority at ncarll@maineturnpike.com Bidders are also required to acknowledge receipt of this Addendum No. 1 on Page P-9 of the bid package.

Business Name

Print Name and Title

Signature

Date

Very truly

yours,

MAINE TURNPIKE AUTHORITY

Nathaniel Carll
Purchasing Department
Maine Turnpike
Authority

MAINE TURNPIKE AUTHORITY

PRE-BID CONFERENCE

CONTRACT 2026.07

CROSBY MAINTENANCE OFFICE

BUILDING

November 4, 2025, at 10:00 a.m.

At Maine Turnpike Authority

1) Location

- a) The general limits of work are as shown in the Contract Plans.

2) General Description

The work consists of the following:

- a) Construction of an approximate 6,000 square foot wood-framed building consisting of offices, a crew room with kitchenette, locker and toilet rooms.
- b) 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.
- c) Construction of reinforced concrete footings, piers, foundation walls, and slabs-on-grade including exterior concrete aprons and entry foundation/slab systems.
- d) Construction of the building proper, including all equipment and interior and exterior finishes
- e) Furnishing and installing plumbing, heating, and electrical, complete with all appurtenances and accessories
- f) Coordinating with the utility to provide transformers and connections
- g) 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

3) Bid

- a) Proposals will be opened December 9, 2025, at 11:00 A.M. at the office of the MTA at 2360 Congress Street, Portland.
- b) All bid and contractual questions shall be directed to Purchasing Department (207-482- 8115)
- c) All questions on plans and specifications shall be in writing and shall be directed to Nate Carll, Purchasing Manager, at (207-871-7739) or email ncarll@maineturnpike.com.

- d) All questions must be submitted by Noon on Tuesday December 2, 2025, to be considered.
- 4) Construction Schedule:
- a) MTA Board is scheduled to consider the Contract Award on or about December 18, 2025.
- b) Construction Schedule:
- i) Substantially complete date is November 20, 2026.
- ii) All work shall be complete on or before December 18, 2026.
- c) Substantial Completion — Section 107.1.1
- Substantially complete shall be defined by the Authority as the following:
- New Maintenance Office 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 all other utility systems operational.
- 5) 104.3.8 Wage Rates and Labor Laws
- a) Fair minimum hourly rates determined by Maine Department of Labor shall apply.
- 6) 104.4.6 Utility Coordination
- a) The Contractor shall contact Dig Safe before excavation.
- b) Aerial and Underground utilities exist throughout the project limits.
- c) The Contractor shall be responsible for and anticipate making multiple long lead time Utility Notifications for relocating aerial utilities.
- d) The Contractor shall review the extent of new underground utilities required of this Contract and their close proximity to existing utilities. All existing utilities, permanent and temporary, shall be maintained until such time that new utilities are brought on-line.
- 7) 105.8.2 Permit Requirements
- a) Construction is subject to Maine Stormwater Law Basic Standards through implementation of MaineDOT's Best Management Practices for Erosion and Sedimentation Control.
- b) Contractor is responsible to follow erosion and sedimentation control requirements outlined in this Contract.
- 8) 105.11 As-Built Plans
- a) 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.

- b) See also 105.11.1 and 105.11.2 for more details on As-Built Plan Submittals and Requirements.

9) 107.1.2 Limitations of Operations

- a) Construction of the Crosby Maintenance Office 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.
- b) 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.
- c) 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.

10) 108.2.1 Generation of Progress Payments

- a) 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.

11) 108.2.3 Mobilization Payment

- a) 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.

12) General Requirements

- a) The Specifications are divided into two parts: Part I, Supplemental Specifications and Part II, Special Provisions and Appendices (Division 02 thru 28). Review thoroughly.

13) Specific Contract Items

- a) 203 Excavation and Embankment — removal and disposal of all material unsuitable for re-use on the project, fill to raise grades as shown on plans.
- b) 403 Hot Mix Asphalt Pavement —Various pavement repair, rehabilitation, and replacements.
- c) 670 Septic System — this is for the designing, furnishing, and installing a subsurface sewage disposal system.
- d) 633 Propane Gas Utility — This is for the installation of a 1,000 gallon of propane tank adjacent to existing tanks.
- f) 655 Electrical Work — This includes Division 26 Electrical Specifications and other related Specifications — The Contractor shall coordinate closely with the Resident and MTA during the replacement and new electrical infrastructure throughout the project limits.
- g) 800 Crosby Maintenance Office Building — this includes Divisions 02 through 28. This is for the new building, including all appurtenances, utilities, and services as shown on the Plans and Drawings. Contractor shall thoroughly review these specifications in conjunction with the plans and drawings.
- h) Section 825 Water Service Supply Lines — This is for the new water service as shown on the plans.

14) Questions

PRE BID MEETING

Name	Company	Telephone	Email
Molly Grover	AH Grover, Inc.	233.1552	molly@gangrover.com
JASON RING	BENCHMARK		KRICE@BENCHMARKCONSTRUCTION
TIDE BOWEN	EASTERN FIRE	819-720-4891	tide.bowen@easternfiregroup.us
Matthew Glickman	C.L.DDEN EXAVING	(207)694-9592	matteglidenparvus.com
JULIE McLEAN	GREAT FALLS CONCRETE	207-839-2744	TROD@GREATFALLSINC.COM
MATT MASTERER	BLADE CASEY	207-622-5600	mymasterer@bladecasey.com
Amanda Denning	H E Callahan	201 571 7023	adenning@hecallahan.com
DANIEL MESSER	MTA	482-8172	d.messer@mair-tompkins.com
Steve Foster	MTA	207 831 5014	S.Foster@mairtompkins.com
Ralph Morwood	MTA	207-415-0917	r.morwood@mailexportservice
Nate Carl	MTA	207-482-8115	nccarl@maire-tompkins.com
BRIAN TARDIO	MTA	207-482-8247	btardio@mta.ny.gov

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				
403.305	MILLING BITUMINOUS PAVEMENT	Linear Foot	800				
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				

CARRIED FORWARD:

606.356	UNDERDRAIN DELINEATOR POST	Each	1				
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				

CARRIED FORWARD:

634.1943	4" SCHEDULE 80 PVC CONDUIT	Linear Foot	125				
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				

CARRIED FORWARD:

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				
825.4222	2 INCH GATE VALVE QITH BOX	Each	3				
825.4222	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)

-

SPECIAL PROVISION

SECTION 633

PROPANE GAS UTILITY

(Propane Service)

633.01 Description

This work shall include adding one additional 1000-gallon propane tank east of the two existing propane tanks, modifying the manifold piping between the propane tanks including the primary regulator, installation of new High Density Polyethylene (HDPE) service to the Crosby Maintenance Office Building, and system testing. The Contractor shall install modify the existing 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

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 **2021** 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 **2021** 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), **2021**.
- 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

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 2021 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

November 10, 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: 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

Design Professional Seal

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

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
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-21 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-21 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.

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
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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
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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

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Schedule of Special Inspections and Tests

SOILS AND FOUNDATION CONSTRUCTION

Test or Special Inspection	Y/N	Continuous	Periodic	Agent	Agent Qualification
Soils (ref: IBC-21 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-21 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 341-16, 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-21 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-21 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-21 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 2021 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 602-16/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'ac in accordance with TMS 602-16/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 TAI 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-21 Section 1705.2, AISC 360-16 Chapter N, AISC 341-16 Chapter J)					
Prior to Welding (AISC 360-16 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 360-16 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 341-16)	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 360-16 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 341-16)	N	-	X	TA1	AWS CWI/ AWS AISC-SSI
10. Backing removed, weld tabs removed and finished, and fillet welds added (if required) (ref: AISC 341-16)	N	-	X	TA1	AWS CWI/ AWS AISC-SSI
Nondestructive Testing (AISC 360-16 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 341-16 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 360-16 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 360-16 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 360-16 Table N5.6-3)					
Document acceptance or rejection of bolted connections	N	X	-	TA1	AWS AISC-SSI
Other Inspection Tasks (AISC 360-16 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 341-16)					
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 341-16)	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 341-16)	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-21 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-21 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 341-16 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 341-16 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 341-16 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-21 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-21 Section 1705.5)					
1. Inspection of the fabrication process of wood structural elements and assemblies in accordance with IBC-21 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:

- Wind Exposure Category B, where V exceeds 150 mph.
- Wind Exposure Category C or D, where V exceeds 140 mph.

VERIFICATION AND INSPECTION	Y/N	Continuous	Periodic	Agent	Agent Qualification
Structural Wood (ref: IBC-21 Section 1705.12.1) 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-21 Section 1705.12.2) 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-21 Section 1705.12.3)					
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-21 Section 1705.13.1) 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-21 Section 1705.13.2) 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-21 Section 1705.13.3) 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-21 Section 1705.13.4)	-				
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-21 Section 1705.13.5) 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-21 Section 1705.13.6)				-	
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-21 Section 1705.13.7)					
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-21 Section 1705.13.8)					
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-21 Section 1705.13.9)				-	
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-21 Section 1705.14)	-				
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-21 Section 1705.15)						
1. Perform inspections and tests of sprayed fire-resistant materials in accordance with IBC-21 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-21 Section 1705.16)						
1. Special inspections and tests for mastic and intumescent fire-resistant coatings applied to structural elements and decks shall be performed in accordance with AWC1 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-21 Section 1705.17)						
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-21 Section 1705.18)						
1. Perform inspections and tests in accordance with project specifications and IBC-21 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-21 Section 1705.19)						
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-21 Section 1705.1.1)	-					
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 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 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. Studeo 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: Column 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. **Sound Attenuating Batts, SAB: ASTM C 665, Type I (blankets without membrane facing) produced by combining thermosetting resins with mineral fibers manufactured from glass that is fire resistance in accordance with ASTM E 136 and sound control in accordance with ASTM E 423; designed to reduce airborne sound transmission; with maximum flame-spread and smoke- developed indices of 25 and 50, respectively; passing ASTM E 136 for combustion characteristics. Thermal fiberglass insulation not allowed.**
 - 1. **Fire-Resistance-Rated Assemblies: Comply with mineral-fiber requirements of assembly.**
 - 2. **Sound Attenuating Batts in Wall Assemblies: 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.**
 - a. **STC Rating for Interior Walls: As indicated.**
 - 3. **Products:**
 - a. **Johns Manville; Fiberglass Sound Control Batts.**
 - b. **Knauf Insulation; Quiet Therm Acoustical/Thermal Batt Insulation.**
 - c. **Owens Corning; Sound Attenuation Batt Insulation**
- 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 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. **Basix Automation with Schneider Controls**
 - 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, fintube 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

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