



**STATE OF CONNECTICUT
DEPARTMENT OF TRANSPORTATION**



**2800 BERLIN TURNPIKE, P.O. BOX 317546
NEWINGTON, CONNECTICUT 06131-7546**

Phone: 860-594-3128

October 10, 2014

Subject: Project No. 431-0006

F.A.P. No. CT-90-X523

Waterbury Bus Maintenance Facility Replacement in the Town of Watertown.

NOTICE TO CONTRACTORS:

This is to notify all concerned and especially the prospective bidders that the bid opening for the subject project is being postponed four (4) weeks from October 22, 2014 to November 19, 2014 at 2:00 P.M. in the Conference Room of the Department of Transportation Administration Building, 2800 Berlin Turnpike, Newington, Connecticut.

Addendum No. 3 is attached and can also be obtained on the Statewide Contracting Portal at http://www.biznet.ct.gov/scp_search/BidResults.aspx?groupid=64

This Addendum is necessary to revise a contract documents.

Pre-Bid Questions and Answers: Questions pertaining to DOT advertised construction projects must be presented through the CTDOT Pre-Bid Q and A Website. The Department cannot guarantee that all questions will be answered prior to the bid date. **PLEASE NOTE - at 12:01 am, the day before the bid, the subject project(s) being bid will be removed from the Q and A Website, Projects Advertised Section, at which time questions can no longer be submitted through the Q and A Website. At this time, the Q and A for those projects will be considered final, unless otherwise stated and/or the bid is postponed to a future date and time to allow for further questions and answers to be posted.**

Philip J. Melchionne

For: Gregory D. Straka

Contracts Manager

Division of Contracts Administration

OCTOBER 10, 2014
WATERBURY BUS MAINTENANCE FACILITY REPLACEMENT
FEDERAL AID PROJECT NO. CT-90-X523
STATE PROJECT NO. 431-006
TOWN OF WATERTOWN

ADDENDUM NO. 3

SPECIAL PROVISIONS

REVISED SPECIAL PROVISION

The following Special Provision is hereby deleted in its entirety and replaced with the attached like-named Special Provision:

- **NOTICE TO CONTRACTORS – CLOSEOUT DOCUMENTS**

CSI FORMATTED SPECIAL PROVISIONS

NEW CSI SECTIONS

The following CSI Specifications are hereby ADDED to the Contract:

- **DIVISION 10 – SECTION 102600 WALL AND DOOR PROTECTION**
- **DIVISION 26 – SECTION 262413 SWITCHBOARDS**

REVISED CSI SECTIONS

The following CSI Sections are hereby deleted in their entirety and replaced with the attached like-named CSI Sections:

- **DIVISION 04 – SECTION 042000 UNIT MASONRY**
- **DIVISION 06 – SECTION 064023 INTERIOR ARCHITECTURAL WOODWORK**
- **DIVISION 07 – SECTION 077100 ROOF SPECIALITIES**
- **DIVISION 07 – SECTION 077200 ROOF ACCESSORIES**
- **DIVISION 08 – SECTION 088000 GLAZING**
- **DIVISION 08 – SECTION 088853 SECURITY GLAZING**
- **DIVISION 09 – SECTION 092900 GYPSUM BOARD**
- **DIVISION 10 – SECTION 105113 METAL LOCKERS**
- **DIVISION 12 – SECTION 122413 ROLLER WINDOW SHADES**
- **DIVISION 12 – SECTION 129300 SITE FURNISHINGS**
- **DIVISION 14 – SECTION 142100 MACHINE ROOM-LESS ELECTRIC TRACTION ELEVATORS**

- DIVISION 23 – SECTION 230993 SEQUENCE OF OPERATIONS
- DIVISION 23 – SECTION 233300 DUCT ACCESSORIES
- DIVISION 23 – SECTION 237200 AIR-TO AIR ENERGY RECOVERY UNITS
- DIVISION 23 – SECTION 237523 ROOFTOP HEATING AND COOLING UNITS
- DIVISION 23 – SECTION 238316 HYDRONIC RADIANT FLOOR HEATING SYSTEM

PLANS

REVISED PLANS

The following Plan Sheets are hereby deleted and replaced with the like-numbered Plan Sheets:

<u>SHEET NO.</u>	<u>DRAWING NO.</u>	<u>DRAWING TITLE</u>
03.004.A3	C-101	PAY LIMITS PLAN
03.007.A3	C-104	SITE PREPARATION PLAN
03.008.A3	C-105	EROSION AND SEDIMENT CONTROL PLAN
03.009.A3	C-200	OVERALL LAYOUT & UTILITES PLAN
03.013.A3	C-204	MATERIALS & UTILITES PLAN
03.018.A3	C-209	LAYOUT PLAN
03.019.A3	C-210	STRIPING PLAN
03.021.A3	C-300	OVERALL GRADING & DRAINAGE PLAN
03.022.A3	C-301	GRADING & DRAINAGE PLAN
03.025.A3	C-304	GRADING & DRAINAGE PLAN
03.026.A3	C-305	RINGROAD PLAN AND PROFILE & MULTI-USE TRAIL PLAN
03.027.A3	C-310	WALL GRADING PLAN
03.028.A3	C-311	WALL GRADING ENLARGEMENTS
03.030.A3	C-313	SITE RETAINING WALL ELEVATIONS
06.002.A3	L-401	OVERALL LANDSCAPE PLAN
06.006.A3	L-405	LANDSCAPE PLAN
07.002.A3	A-002	SYMBOLS, ABB. & CODE INFO
07.005.A3	A-005	GROUND FLOOR CODE COMPLIANCE PLAN
07.006.A3	A-006	FIRST FLOOR CODE COMPLIANCE PLAN
07.007.A3	A-007	ENLARGED CODE COMPLIANCE PLAN – AREA D & G
07.008.A3	A-008	ENLARGED CODE COMPLIANCE PLAN – AREA E
07.009.A3	A-101	GROUND FLOOR PLAN
07.010.A3	A-102	FIRST FLOOR PLAN
07.011.A3	A-103	SECOND FLOOR PLAN

07.012.A3	A-104	ROOF PLAN
07.013.A3	A-105	GROUND FLOOR PLAN – AREA A
07.014.A3	A-106	GROUND FLOOR PLAN – AREA B
07.015.A3	A-107	GROUND FLOOR PLAN – AREA C
07.016.A3	A-108	GROUND FLOOR PLAN – AREA D&E
07.017.A3	A-109	FIRST FLOOR PLAN – AREA A
07.018.A3	A-110	FIRST FLOOR PLAN – AREA B
07.019.A3	A-111	FIRST FLOOR PLAN – AREA C
07.020.A3	A-112	FIRST FLOOR PLAN – AREA D
07.021.A3	A-113	FIRST FLOOR PLAN – AREA E
07.022.A3	A-114	FIRST FLOOR PLAN – AREA F
07.023.A3	A-115	SECOND FLOOR PLAN – AREA G
07.024.A3	A-116	CLERESTORY PLANS
07.025.A3	A-117	FIRST FLOOR BUS STRIPING PLAN
07.026.A3	A-152	ROOF PLAN – AREA A
07.027.A3	A-153	ROOF PLAN – AREA B
07.028.A3	A-154	ROOF PLAN – AREA C
07.029.A3	A-155	ROOF PLAN – AREA D
07.030.A3	A-156	ROOF PLAN – AREA E
07.031.A3	A-157	ROOF PLAN – AREA F
07.032.A3	A-201	ENLARGED TOILET ROOM PLANS
07.033.A3	A-202	ENLARGED PLANS
07.034.A3	A-203	ENLARGED PIT PLANS
07.035.A3	A-301	ELEVATIONS
07.036.A3	A-302	ELEVATIONS
07.037.A3	A-303	ELEVATIONS
07.038.A3	A-304	ELEVATIONS
07.039.A3	A-305	BUILDING SECTIONS/ELEVATIONS
07.040.A3	A-351	BUILDING SECTIONS
07.042.A3	A-353	BUILDING SECTIONS
07.043.A3	A-354	BUILDING SECTIONS
07.044.A3	A-355	BUILDING SECTIONS
07.046.A3	A-357	BUILDING SECTIONS
07.048.A3	A-401	EXTERIOR WALL TYPES
07.054.A3	A-407	WALL SECTIONS
07.055.A3	A-431	PLAN DETAILS
07.056.A3	A-432	PLAN DETAILS
07.058.A3	A-434	PLAN DETAILS
07.059.A3	A-435	PLAN DETAILS
07.060.A3	A-436	PLAN DETAILS
07.060-1.A3	A-438	PLAN DETAILS
07.062.A3	A-451	EXTERIOR DETAILS
07.063.A3	A-452	EXTERIOR DETAILS
07.064.A3	A-453	EXTERIOR DETAILS
07.065.A3	A-454	EXTERIOR DETAILS

07.066.A3	A-455	EXTERIOR DETAILS
07.071.A3	A-501	STAIR A-PLANS AND SECTIONS
07.073.A3	A-503	STAIR G & R – PLANS AND SECTIONS
07.075.A3	A-505	ELEVATOR DETAILS
07.076.A3	A-601	INTERIOR ELEVATIONS
07.077.A3	A-701	GROUND FLOOR REFLECTED CEILING PLAN- AREA A
07.080.A3	A-704	GROUND FLOOR REFLECTED CEILING PLAN- AREA D&E
07.081.A3	A-705	FIRST FLOOR REFLECTED CEILING PLAN- AREA A
07.082.A3	A-706	FIRST FLOOR REFLECTED CEILING PLAN- AREA B
07.083.A3	A-707	FIRST FLOOR REFLECTED CEILING PLAN- AREA C
07.084.A3	A-708	FIRST FLOOR REFLECTED CEILING PLAN- AREA D
07.085.A3	A-709	FIRST FLOOR REFLECTED CEILING PLAN- AREA E
07.086.A3	A-710	FIRST FLOOR REFLECTED CEILING PLAN- AREA F
07.087.A3	A-711	SECOND FLOOR REFLECTED CEILING PLAN- AREA G
07.088.A3	A-801	INTERIOR DETAILS
07.089.A3	A-802	INTERIOR DETAILS
07.090.A3	A-851	MILLWORK DETAILS
07.091.A3	A-881	CEILING DETAILS
07.092.A3	A-882	CEILING DETAILS
07.093.A3	A-901	ROOM FINISH SCHEDULE
07.094.A3	A-902	DOOR SCHEDULE AND TYPES
07.095.A3	A-903	VIEW WINDOW SCHEDULE
07.096.A3	A-904	WINDOW SCHEDULE
07.097.A3	A-905	WINDOW SCHEDULE
07.099.A3	A-908	WINDOW DETAILS
07.100.A3	A-909	WINDOW DETAILS
07.101.A3	A-910	WINDOW DETAILS
07.102.A3	A-911	TYPICAL INTERIOR PARTITION TYPES AND DETAILS
07.106.A3	AF-001	FUEL CANOPY PLANS, SECTIONS, ELEVATIONS, & SECTIONS
09.003.A3	S-101	GROUND FLOOR FOUNDATION PLAN- AREA A
09.004.A3	S-102	GROUND FLOOR FOUNDATION PLAN- AREA B
09.005.A3	S-103	GROUND FLOOR FOUNDATION PLAN- AREA C
09.006.A3	S-104	GROUND FLOOR FOUNDATION PLAN- AREA D&E

09.007.A3	S-105	FIRST FLOOR FRAMING PLAN- AREA A
09.008.A3	S-106	FIRST FLOOR FRAMING PLAN- AREA B
09.009.A3	S-107	FIRST FLOOR FRAMING PLAN- AREA C
09.010.A3	S-108	FIRST FLOOR FRAMING PLAN- AREA D
09.011.A3	S-109	FIRST FLOOR FRAMING PLAN- AREA B
09.012.A3	S-110	FIRST FLOOR FOUNDATION PLAN- AREA F
09.013.A3	S-111	SECOND FLOOR FRAMING PLAN- AREA G
09.014.A3	S-112	LOW ROOF FRAMING PLAN-AREA A
09.015.A3	S-113	LOW ROOF FRAMING PLAN-AREA B
09.016.A3	S-114	LOW ROOF FRAMING PLAN-AREA C
09.017.A3	S-115	ROOF FRAMING PLAN-AREA D
09.018.A3	S-116	LOW ROOF FRAMING PLAN-AREA G
09.019.A3	S-117	LOW ROOF FRAMING PLAN-AREA E&F
09.020.A3	S-118	ROOF FRAMING PLAN-AREA E
09.021.A3	S-119	ROOF FRAMING PLAN-AREA F
09.022.A3	S-120	HIGH ROOF FRAMING PLAN-AREA E&F
09.029.A3	S-301	TYPICAL DETAILS
09.031.A3	S-303	TYPICAL DETAILS
09.032.A3	S-304	TYPICAL DETAILS
09.034.A3	S-306	TYPICAL DETAILS
09.036.A3	S-308	TYPICAL DETAILS
09.039.A3	S-311	TYPICAL DETAILS
09.046.A3	S-407	SECTIONS
09.047.A3	S-408	SECTIONS
09.052.A3	S-413	SECTIONS
09.061.A3	S-601	BRACING DETAILS
09.062.A3	S-602	BRACING DETAILS
10.003.A3	P-101	PLUMBING GROUND FLOOR PLAN- AREA D&E
10.007.A3	P-105	PLUMBING FIRST FLOOR PLAN-AREA D
10.009.A3	P-107	PLUMBING FIRST FLOOR PLAN-AREA F
10.010.A3	P-108	PLUMBING SECOND FLOOR PLAN-AREA G
10.014.A3	P-112	SANITARY GROUND FLOOR PLAN-AREA D&E
10.018.A3	P-116	SANITARY FIRST FLOOR PLAN-AREA D
10.020.A3	P-118	SANITARY FIRST FLOOR PLAN-AREA F
10.021.A3	P-119	SANITARY SECOND FLOOR PLAN-AREA G
10.029.A3	P-802	PLUMBING DETAILS
10.030.A3	P-803	PLUMBING DETAILS
11.006.A3	FP-104	GROUND FLOOR REFLECTED CEILING PLAN- AREA D&E
11.010.A3	FP-108	FIRST FLOOR REFLECTED CEILING PLAN-AREA D
11.013.A3	FP-111	SECOND FLOOR REFLECTED CEILING PLAN- AREA G

12.003.A3	M-108	MECHANICAL GROUND FLOOR DUCTWORK PLAN- AREA D&E
12.004.A3	M-109	MECHANICAL FIRST FLOOR DUCTWORK PLAN- AREA A
12.005.A3	M-110	MECHANICAL FIRST FLOOR DUCTWORK PLAN- AREA B
12.006.A3	M-111	MECHANICAL FIRST FLOOR DUCTWORK PLAN- AREA C
12.007.A3	M-112	MECHANICAL FIRST FLOOR DUCTWORK PLAN- AREA D
12.010.A3	M-115	MECHANICAL SECOND FLOOR DUCTWORK PLAN- AREA G
12.015.A3	M-156	MECHANICAL ROOF DUCTWORK PLAN- AREA E
12.018.A3	M-208	MECHANICAL GROUND FLOOR PIPING PLAN- AREA D&E
12.022.A3	M-212	MECHANICAL FIRST FLOOR PIPING PLAN- AREA D
12.025.A3	M-215	MECHANICAL SECOND FLOOR PIPING PLAN- AREA G
12.033.A3	M-401	MECHANICAL FLOW DIAGRAMS
12.035.A3	M-601	MECHANICAL SCHEDULES
12.036.A3	M-602	MECHANICAL SCHEDULE
13.002.A3	E-001	ELECTRICAL ABBREVIATIONS, SYMBOLS & NOTES
13.003.A3	E-002	ELECTRICAL SITE PLAN
13.008.A3	E108	ELECTRICAL GROUND FLOOR POWER PLAN- AREA D&E
13.012.A3	E-112	ELECTRICAL FIRST FLOOR POWER PLAN-AREA D
13.014.A3	E-114	ELECTRICAL FIRST FLOOR POWER PLAN-AREA F
13.015.A3	E-115	ELECTRICAL SECOND FLOOR POWER PLAN-AREA G
13.018.A3	E-152	ELECTRICAL ROOF POWER PLAN-AREA A
13.019.A3	E-153	ELECTRICAL ROOF POWER PLAN-AREA B
13.020.A3	E-154	ELECTRICAL ROOF POWER PLAN-AREA C
13.021.A3	E-155	ELECTRICAL ROOF POWER PLAN-AREA D
13.022.A3	E-156	ELECTRICAL ROOF POWER PLAN-AREA E
13.023.A3	E-157	ELECTRICAL ROOF POWER PLAN-AREA F
13.027.A3	E-208	ELECTRICAL GROUND FLOOR LIGHTING PLAN- AREA D&E
13.028.A3	E-209	ELECTRICAL FIRST FLOOR LIGHTING PLAN-AREA A
13.029.A3	E-210	ELECTRICAL FIRST FLOOR LIGHTING PLAN-AREA B
13.030.A3	E-211	ELECTRICAL FIRST FLOOR LIGHTING PLAN-AREA C
13.031.A3	E-212	ELECTRICAL FIRST FLOOR LIGHTING PLAN-AREA D
13.032.A3	E-213	ELECTRICAL FIRST FLOOR LIGHTING PLAN-AREA E
13.033.A3	E-214	ELECTRICAL FIRST FLOOR LIGHTING PLAN-AREA F

13.034.A3	E-215	ELECTRICAL SECOND FLOOR LIGHTING PLAN- AREA G
13.038.A3	E-308	ELECTRICAL GROUND FLOOR SYSTEMS PLAN- AREA D&E
13.042.A3	E-312	ELECTRICAL FIRST FLOOR SYSTEMS PLAN- AREA D
13.045.A3	E-315	ELECTRICAL SECOND FLOOR SYSTEMS PLAN- AREA G
13.054.A3	E-409	ELECTRICAL ENLARGED PLAN- RADIO ROOM
13.055.A3	E-501	ELECTRICAL LIGHTING FIXTURE SCHEDULE
13.057.A3	E-503	ELECTRICAL EQUIPMENT SCHEDULE
13.058.A3	E-504	ELECTRICAL EQUIPMENT SCHEDULE
13.059.A3	E-505	ELECTRICAL EQUIPMENT SCHEDULE
13.061.A3	E-601	ELECTRICAL ONE-LINE DIAGRAM
13.063.A3	E-603	ELECTRICAL PANELBOARD SCHEDULES
13.064.A3	E-604	ELECTRICAL PANELBOARD SCHEDULES
13.065.A3	E-605	ELECTRICAL PANELBOARD SCHEDULES
13.068.A3	E-701	ELECTRICAL DETAILS
13.079.A3	EG-101	ELECTRICAL GUARD BOOTH PLAN
15.007.A3	D-105	PARTIAL FIRST FLOOR PIPING

The Bid Proposal Form is not affected by these changes.

There will be no change in the number of calendar days due to this Addendum.

The foregoing is hereby made a part of the contract.

NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS

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

This Table will be forwarded to Mr. Phillip T. Scarrozzo, Manager, Bureau of Public Transportation, for concurrence prior to the Semi-Final Inspection.

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

Operation and Maintenance Manuals: Submit 4 copies of each manual to the Designer. The Designer and Mr. Phillip T. Scarrozzo, Manager, Bureau of Public Transportation, will review the manuals for conformance to the Contract. The manuals will be processed in accordance with Form 816 Article 1.20-1.05.02, with 3 copies being forwarded to Mr. Phillip T. Scarrozzo, and one copy being sent to the Engineer.

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

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

Training: The Contractor shall provide training on products listed in the Table below. All training sessions shall be videotaped by the Contractor, with three (3) DVD copies forwarded to Mr. Phillip T. Scarrozzo, Manager, Bureau of Public Transportation, and one copy provided to the Engineer. The DVDs provided by the Contractor shall not be copy-protected in order to allow future copying and distribution by the Department as needed.

All training sessions required by the Contract Documents shall be coordinated and scheduled through the Commissioning Authority. Reference **NOTICE TO CONTRACTOR - COMMISSIONING** for a sample Training Form and Evaluation Form.

Training Instructors shall be a Manufacturer's Representative or Applications Engineer fully qualified in the operation, troubleshooting and maintenance procedures for the equipment or systems being covered. Sales Representatives or others possessing only general knowledge of the equipment or systems will not be acceptable.

The following format shall be used to schedule, perform, document and evaluate the required training sessions:

1. The Contractor shall submit a separate Training Form for each training session required by the Contract Documents to the Commissioning Authority. This form shall be submitted a minimum of fourteen (14) calendar days in advance of the proposed training session.
2. The Contractor shall complete the first section of the form including the proposed training session date, name of instructor(s), and proposed length (time) of the session(s). Also, attach an Agenda indicating the format of the training session and listing any handouts that will be provided.
3. The Commissioning Authority will then review the proposed training information with the Owner. If the submitted information is complete and the proposed dates meet the Owner's Operations Personnel schedule, the Commissioning Authority will respond to the Contractor to proceed with scheduling the subject training session.
4. During the training session, the Contractor shall have all in attendance sign in the third section of the Training Form. Attach additional pages if necessary. The Contractor shall then forward the Training Form to the Commissioning Authority.
5. After each Training Session is completed, the Cx Authority will issue an Evaluation Form to each of the Attendees. This feedback information will be provided to the Owner and Designer for review. If the session meets the objectives and intent of the Contract Documents, the Commissioning Authority will approve the training form and return to the Contractor for Project Records. If negative feedback is received, the Evaluation Forms will be reviewed with the Commissioning Team and if necessary, re-scheduling of the training may be required.

Training sessions shall cover the following items:

1. Review of Operations and Maintenance Manuals
2. Review of As-built Drawings
3. Overview of system components
4. System operation under normal conditions
5. System operation under abnormal conditions
6. Emergency procedures
7. Troubleshooting procedures
8. Maintenance and Repair procedures
9. Questions

The Contractor is responsible for all costs associated with travel to and from the Training Facility, lodging during the training session and tuition & materials.

Warranties: Submit 4 copies of written warranties, including special warranties to the Designer. The Designer and Mr. Phillip T. Scarozzo, Manager, Bureau of Public Transportation, will review the warranties for conformance to the Contract. The warranties will be processed in accordance with Form 816 Article 1.20-1.05.02, with 3 copies being forwarded to Mr. Phillip T. Scarozzo and one copy being sent to the Engineer.

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

TABLE

CSI-formatted Specifications	Warranties	Spare Parts	Training	Operation and Maintenance Manuals
CSI Section 071416, "Cold Fluid-Applied Waterproofing"	X			
CSI Section 074213, "Metal Wall Panels"	X			X
CSI Section 075423, "Thermoplastic Polyolefin (TPO) Roofing"	X			X
CSI Section 076200, "Sheet Metal Flashing and Trim"	X			
CSI Section 077100, "Roof Specialties"	X			X
CSI Section 077200, "Roof Accessories"	X			X
CSI Section 079200, "Joint Sealants"	X			
CSI Section 081216, "Aluminum Frames"				X
CSI Section 081416, "Flush Wood Doors"	X			
CSI Section 083313, "Coiling Counter Doors"				X
CSI Section 083323, "Overhead Coiling Doors"				X
CSI Section 083613, "Sectional Doors"	X			X
CSI Section 084113, "Aluminum-Framed Entrances and Storefronts"	X			X
CSI Section 084413, "Glazed Aluminum Curtainwalls"	X			X
CSI Section 085653, "Security Windows"	X			
CSI Section 086200, "Unit Skylights"	X			X
CSI Section 087100, "Door Hardware"	X		X	X
CSI Section 087650, "Assistive Window Actuator"	X		X	X
CSI Section 088000, "Glazing"	X			
CSI Section 088300, "Mirrors"	X			X
CSI Section 088853, "Security Glazing"	X			
CSI Section 093000, "Tiling"		X		
CSI Section 095113, "Acoustical Panel Ceilings"		X		

CSI-formatted Specifications	Warranties	Spare Parts	Training	Operation and Maintenance Manuals
CSI Section 096513, "Resilient Base and Accessories"		X		
CSI Section 096519, "Resilient Tile Flooring"		X		X
CSI Section 096536, "Static Control Resilient Flooring"		X		X
CSI Section 096566, "Resilient Athletic Flooring"		X		X
CSI Section 096613, "Portland Cement Terrazzo Flooring"				X
CSI Section 096623, "Resinous Matrix Terrazzo Flooring"				X
CSI Section 096813, "Tile Carpeting"	X	X		X
CSI Section 096900, "Access Flooring"		X		
CSI Section 099123, "Interior Painting"		X		
CSI Section 099600, "High Performance Coatings"		X		
CSI Section 101100, "Visual Display Units"	X			X
CSI Section 101400, "Signage"	X			X
CSI Section 102113, "Toilet Compartments"				X
CSI Section 102600, "Wall and Door Protection"	X	X		X
CSI Section 102800, "Toilet, Bath, and Laundry Accessories"	X			X
CSI Section 103000, "Doorway Spill Barrier"	X	X	X	X
CSI Section 104413, "Fire Protection Cabinets"				X
CSI Section 104416, "Fire Extinguishers"	X			X
CSI Section 105113, "Metal Lockers"	X			X
CSI Section 106700, "Storage Equipment"	X	X	X	X
CSI Section 109900, "Tactile Warning Surface"	X			
CSI Section 111400, "Fuel and Fluid Management System"	X		X	X
CSI Section 115100, "Shop Equipment"	X	X	X	X
CSI Section 115110, "Carbon Monoxide Exhaust Systems"	X	X	X	X
CSI Section 115213, "Projection Screens"				X
CSI Section 115400, "Fare Collection Equipment"	X		X	X
CSI Section 115500, "Vehicle Wash Equipment"	X	X	X	X
CSI Section 115600, "Fueling System Equipment"	X	X	X	X
CSI Section 115700, "Compressed Air Equipment"	X	X	X	X
CSI Section 115710, "Breathing Air System"	X	X	X	X
CSI Section 115800, "Fluid Lubrication Systems"	X	X	X	X
CSI Section 122113, "Horizontal Louver Blinds"		X		X

CSI-formatted Specifications	Warranties	Spare Parts	Training	Operation and Maintenance Manuals
CSI Section 122413, "Roller Window Shades"		X		X
CSI Section 124813, "Entrance Floor Mats and Frames"		X		X
CSI Section 131200, "Canopies"	X			X
CSI Section 142100, "Machine-Room-Less Electric Traction Elevators"	X		X	X
CSI Section 143000, "Cranes"	X	X	X	X
CSI Section 144500, "Vehicle Lifts"	X	X	X	X
CSI Section 211313, "Wet Pipe Sprinkler Systems"		X	X	X
CSI Section 211316, "Dry Pipe Srinkler Systems"			X	X
CSI Section 220553, "Identification for Plumbing Piping and Equipment"				X
CSI Section 221119, "Domestic Water Piping Specialties"				X
CSI Section 221325, "Oil-Water Separator"	X		X	X
CSI section 221345, "Facility Packaged Storm Water Pumping Stations"			X	X
CSI Section 223300, "Electric, Domestic Water Heaters"	X		X	X
CSI Section 224213.13, "Commercial Water Closets"		X		X
CSI Section 224213.16, "Commercial Urinals"		X		X
CSI Section 224216.13, "Commercial Lavatories"		X		X
CSI Section 224216.16, "Commercial Sinks"		X		X
CSI Section 224500, "Emergency Plumbing Fixtures"				X
CSI Section 224716, "Pressure Water Coolers"		X		X
CSI Section 230516, "Pipe Expansion Joints "	X			X
CSI Section 230519, "Meters and Gauges "	X			X
CSI Section 230593, "Testing, Adjusting, and Balancing "	X			
CSI Section 230900, "Instrumentation and Control for HVAC"	X	X	X	X
CSI Section 232113, "Hydronic Piping"				X
CSI Section 232119, "Glycol Injection System"	X			X
CSI Section 232123, "HVAC Pumps"	X			X
CSI Section 233300, "Duct Accessories"		X		
CSI Section 233400, "Fans"	X	X		X
CSI Section 233600, "Air Terminals"		X	X	X
CSI Section 235101, "Positive Pressure Venting System"	X			X

CSI-formatted Specifications	Warranties	Spare Parts	Training	Operation and Maintenance Manuals
CSI Section 235216, "Condensing Boilers"	X		X	X
CSI Section 237200, "Air-To-Air Energy Recovery Units"	X	X	X	X
CSI Section 238126, "Ductless Split System Air Conditioners"	X		X	X
CSI Section 238200, "Terminal Units"	X			X
CSI Section 238316, "Hydronic Radiant Floor Heating Systems"	X		X	X
CSI Section 260519, "Building Wire and Cable"				X
CSI Section 260526, "Grounding and Bonding for Electrical Systems"				X
CSI Section 260529, "Hangers and Supports for Electrical Systems"				X
CSI Section 260533, "Raceways and Boxes for Electrical Systems"				X
CSI Section 260536, "Cable Trays for Electrical Systems"				X
CSI Section 260553, "Electrical Identification"				X
CSI Section 260573.13, "Overcurrent Protective Device Coordination Study"			X	X
CSI Section 260573.16, "Overcurrent Protective Device Short-Circuit Study"			X	X
CSI Section 260573.19-1, "Overcurrent Protective Device Arc-Flash Study"			X	X
CSI Section 260923, "Lighting Control Equipment"			X	X
CSI Section 262100, "Electrical Service – Utility"				X
CSI Section 262200, "Dry Type Transformers"				X
CSI Section 262300, "Switchgear"		X	X	X
CSI Section 262416, "Panelboards and Circuit Breakers"				X
CSI Section 262713, "Electricity Metering"				X
CSI Section 262726, "Wiring Devices"				X
CSI Section 262813, "Fuses"		X		X
CSI Section 262816, "Safety Switches"				X
CSI Section 262900, "Motor Controllers"		X	X	X
CSI Section 263213, "Engine Generator Systems"	X	X	X	X
CSI Section 263600, "Transfer Switches"			X	X
CSI Section 264113, "Lightning Protection Systems"				X
CSI Section 265100, "Interior Lighting Fixtures"	X	X		X
CSI Section 265110, "Lamps and Ballasts"		X		X

CSI-formatted Specifications	Warranties	Spare Parts	Training	Operation and Maintenance Manuals
CSI Section 265600, "Exterior Lighting"	X	X		X
CSI Section 271500, "Communications Horizontal cabling"		X	X	X
CSI Section 273000, "Telephone Systems"			X	X
CSI Section 275116, "Public Address and Mass Notification Systems"			X	X
CSI Section 281300, "Access Control"		X	X	X
CSI Section 282304, "Indoor and Outdoor Surveillance CCTV System"		X	X	X
CSI Section 283100, "Addressable Fire Alarm Detection System"	X	X	X	X
CSI Section 283300, "Wireless Clock System"			X	X
CSI Section 333213.13 A.4 "Above Ground Wet Well Mounted Quad -Plex Pump Station , Pump Station 2		X		X
CSI Section 333213.13 B.2 "Recessed Wet Well Mounted Duplex Pump Station , Pump Station 1		X		X

SECTION 042000 - UNIT MASONRY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Concrete masonry units.
2. Decorative concrete masonry units.
3. Precast architectural concrete trim units.
4. Mortar and grout.
5. Steel reinforcing bars.
6. Masonry joint reinforcement.
7. Ties and anchors.
8. Embedded flashing.
9. Miscellaneous masonry accessories.

B. Related Sections:

1. Division 01, High Performance Buildings Requirements Section for credit 16a-38-4(d)11 and 16a-38-4(b)4.
 - a. The above listed HPB credit is related to this section. Other HPB credits may apply and shall be reviewed for their potential applicability and conformed with as though listed.
2. Section 051200 "Structural Steel Framing" for installing anchor sections of adjustable masonry anchors for connecting to structural steel frame.
3. Section 055000 "Metal Fabrications" for furnishing steel lintels and shelf angles for unit masonry.
4. Section 076200 "Sheet Metal Flashing and Trim" for exposed sheet metal flashing and for furnishing manufactured reglets installed in masonry joints.

1.3 DEFINITIONS

- A. CMU(s): Concrete masonry unit(s).
- B. Reinforced Masonry: Masonry containing reinforcing steel in grouted cells.

1.4 PERFORMANCE REQUIREMENTS

- A. Provide unit masonry that develops indicated net-area compressive strengths at 28 days.
1. Determine net-area compressive strength of masonry from average net-area compressive strengths of masonry units and mortar types (unit-strength method) according to Tables 1 and 2 in ACI 530.1/ASCE 6/TMS 602.
 2. Determine net-area compressive strength of masonry by testing masonry prisms according to ASTM C 1314.
 - a. For Concrete Unit Masonry: $f'_m = 1900$ psi
- B. Delegated Design: Engage a qualified professional engineer, to design precast architectural concrete trim units.
- C. Design Standards: Comply with ACI 318 (ACI 318M) and design recommendations of PCI MNL 120, "PCI Design Handbook - Precast and Prestressed Concrete," applicable to types of architectural precast concrete units indicated.

1.5 PRECONSTRUCTION TESTING

- A. Preconstruction Testing Service: Owner will engage a qualified independent testing agency to perform preconstruction testing indicated below. Retesting of materials that fail to comply with specified requirements shall be done at Contractor's expense.
1. Concrete Masonry Unit Test: For each type of unit required, according to ASTM C 140 for compressive strength.
 2. Mortar Test (Property Specification): For each mix required, according to ASTM C 780 for compressive strength.
 3. Grout Test (Compressive Strength): For each mix required, according to ASTM C 1019.

1.6 ACTION SUBMITTALS

- A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.
- B. Product Data: For each type of product indicated.
- C. Design Mixtures: For each precast architectural concrete trim unit mixture. Include compressive strength and water-absorption tests.
- D. Shop Drawings: For the following:
1. Reinforcing Steel: Detail bending and placement of unit masonry reinforcing bars. Comply with ACI 315, "Details and Detailing of Concrete Reinforcement." Show elevations of reinforced walls.
 2. Control Joints: Show locations, detail joint conditions and locations of special conditions. Refer to architectural drawings typical locations and spacing.
 3. Fabricated Flashing: Detail corner units, end-dam units, and other special applications.
 4. Precast architectural concrete trim units:

- a. Detail fabrication and installation of architectural precast concrete units.
- b. Indicate locations, plans, elevations, dimensions, shapes, and cross sections of each unit.
- c. Indicate joints, reveals, drips, chamfers, and extent and location of each surface finish.
- d. Indicate details at building corners.

E. Samples for Initial Selection:

- 1. Precast architectural concrete trim units.
- 2. Colored mortar.
- 3. Weep holes/vents.

F. Samples for Verification: For each type and color of the following:

- 1. Decorative CMUs.
- 2. Color mortar. Make Samples using same sand and mortar ingredients to be used on Project.
- 3. Weep holes and vents.
- 4. Accessories embedded in masonry.
- 5. Precast architectural concrete trim units: Design reference samples for initial verification of design intent, for each type of finish indicated on exposed surfaces of architectural precast concrete units, in sets of three, representative of finish, color, and texture variations expected; approximately 12 by 12 by 2 inches (300 by 300 by 50 mm).

1.7 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

B. Material Certificates: For each type and size of the following:

- 1. Masonry units.
 - a. Include material test reports substantiating compliance with requirements.
 - b. For masonry units, include data and calculations establishing average net-area compressive strength of units.
- 2. Cementitious materials. Include brand, type, and name of manufacturer.
- 3. Preblended, dry mortar mixes. Include description of type and proportions of ingredients.
- 4. Grout mixes. Include description of type and proportions of ingredients.
- 5. Reinforcing bars.
- 6. Joint reinforcement.
- 7. Anchors, ties, and metal accessories.
- 8. Precast architectural concrete trim units:
 - a. Include material test reports substantiating compliance with requirements for aggregates.

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

- 1. Include test reports, according to ASTM C 1019, for grout mixes required to comply with compressive strength requirement.

- D. Statement of Compressive Strength of Masonry: For each combination of masonry unit type and mortar type, provide statement of average net-area compressive strength of masonry units, mortar type, and resulting net-area compressive strength of masonry determined according to Tables 1 and 2 in ACI 530.1/ASCE 6/TMS 602.
- E. Cold-Weather and Hot-Weather Procedures: Detailed description of methods, materials, and equipment to be used to comply with requirements.

1.8 QUALITY ASSURANCE (UNIT MASONRY)

- A. Testing Agency Qualifications: Qualified according to ASTM C 1093 for testing indicated.
- B. Source Limitations for Masonry Units: Obtain exposed masonry units of a uniform texture and color, or a uniform blend within the ranges accepted for these characteristics, from single source from single manufacturer for each product required.
- C. Source Limitations for Mortar Materials: Obtain mortar ingredients of a uniform quality, including color for exposed masonry, from single manufacturer for each cementitious component and from single source or producer for each aggregate.
- D. Masonry Standard: Comply with ACI 530.1/ASCE 6/TMS 602 unless modified by requirements in the Contract Documents.
- E. Sample Panel: Build sample panels to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
 - 1. Build sample panel of wall area as shown on drawings, including face and backup wythes and accessories.
 - a. Include a sealant-filled joint at least 16 inches (400 mm) long in exterior face.
 - b. Include lower corner of window opening at upper corner of exterior wall mockup. Make opening approximately 12 inches (300 mm) wide by 16 inches (400 mm) high.
 - c. Include through-wall flashing installed for a 24-inch (600-mm) length in corner of exterior wall mockup approximately 16 inches (400 mm) down from top of mockup, with a 12-inch (300-mm) length of flashing left exposed to view (omit masonry above half of flashing).
 - d. Include air barrier, veneer anchors, flashing, cavity drainage material, and weep holes in exterior masonry-veneer wall mockup.
 - 2. Clean one-half of exposed faces of mockups with masonry cleaner as indicated.
 - 3. Protect accepted mockups from the elements with weather-resistant membrane.
 - 4. Approval of mockups is for color, texture, and blending of masonry units; relationship of mortar and sealant colors to masonry unit colors; tooling of joints; and aesthetic qualities of workmanship.
 - a. Approval of mockups is also for other material and construction qualities specifically approved by Architect in writing.
 - b. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless such deviations are specifically approved by Architect in writing.

5. Remove mock-ups in its entirety when directed by the architect.

F. Preinstallation Conference: Conduct conference at Project site.

1.9 QUALITY ASSURANCE (PRECAST ARCHITECTURAL CONCRETE TRIM UNITS)

A. Fabricator Qualifications: A firm that assumes responsibility for engineering architectural precast concrete units to comply with performance requirements. This responsibility includes preparation of Shop Drawings and comprehensive engineering analysis by a qualified professional engineer.

1. Designated as a PCI-certified plant or designated as an APA-certified plant for production of architectural precast concrete products.
2. Fabricator is located within 500 miles (800 km) of Project site.

B. Quality-Control Standard: For manufacturing procedures and testing requirements, quality-control recommendations, and dimensional tolerances for types of units required, comply with PCI MNL 117, "Manual for Quality Control for Plants and Production of Architectural Precast Concrete Products."

1.10 DELIVERY, STORAGE, AND HANDLING

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

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

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

D. Deliver preblended, dry mortar mix in moisture-resistant containers designed for use with dispensing silos. Store preblended, dry mortar mix in delivery containers on elevated platforms, under cover, and in a dry location or in covered weatherproof dispensing silos.

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

1.11 PROJECT CONDITIONS

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

1. Extend cover a minimum of 24 inches (600 mm) down both sides of walls and hold cover securely in place.

2. Where one wythe of multi-wythe masonry walls is completed in advance of other wythes, secure cover a minimum of 24 inches (600 mm) down face next to unconstructed wythe and hold cover in place.
- B. Do not apply uniform floor or roof loads for at least 12 hours and concentrated loads for at least three days after building masonry walls or columns.
 - C. Stain Prevention: Prevent grout, mortar, and soil from staining the face of masonry to be left exposed or painted. Immediately remove grout, mortar, and soil that come in contact with such masonry.
 1. Protect base of walls from rain-splashed mud and from mortar splatter by spreading coverings on ground and over wall surface.
 2. Protect sills, ledges, and projections from mortar droppings.
 3. Protect surfaces of window and door frames, as well as similar products with painted and integral finishes, from mortar droppings.
 4. Turn scaffold boards near the wall on edge at the end of each day to prevent rain from splashing mortar and dirt onto completed masonry.
 - D. Cold-Weather Requirements: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen substrates. Remove and replace unit masonry damaged by frost or by freezing conditions. Comply with cold-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.
 1. Cold-Weather Cleaning: Use liquid cleaning methods only when air temperature is 40 deg F (4 deg C) and higher and will remain so until masonry has dried, but not less than seven days after completing cleaning.
 - E. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in ACI 530.1/ASCE 6/TMS 602.

PART 2 - PRODUCTS

2.1 MASONRY UNITS, GENERAL

- A. Defective Units: Referenced masonry unit standards may allow a certain percentage of units to contain chips, cracks, or other defects exceeding limits stated in the standard. Do not use units where such defects will be exposed in the completed Work.
- B. Fire-Resistance Ratings: Where indicated, provide units that comply with requirements for fire-resistance ratings indicated as determined by testing according to ASTM E 119, by equivalent masonry thickness, or by other means, as acceptable to authorities having jurisdiction.

2.2 CONCRETE MASONRY UNITS

- A. Shapes: Provide shapes indicated and as follows, with exposed surfaces matching exposed faces of adjacent units unless otherwise indicated.

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

B. Integral Water Repellent: Provide units made with integral water repellent for exposed units .

1. Integral Water Repellent: Liquid polymeric, integral water-repellent admixture that does not reduce flexural bond strength. Units made with integral water repellent, when tested according to ASTM E 514 as a wall assembly made with mortar containing integral water-repellent manufacturer's mortar additive, with test period extended to 24 hours, shall show no visible water or leaks on the back of test specimen.

a. Products: Subject to compliance with requirements, provide one of the following:

- 1) ACM Chemistries; RainBloc.
- 2) BASF Aktiengesellschaft; Rheopel Plus.
- 3) Grace Construction Products, W. R. Grace & Co. - Conn.; Dry-Block.

C. CMUs: ASTM C 90.

1. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 1900 psi .
2. Density Classification: Medium weight unless otherwise indicated.
3. Size : Manufactured to dimensions 3/8 inch less than nominal dimensions.
 - a. Nominal Dimensions: Unless otherwise noted, provide 8 inch high x 16 inches wide x depth indicated on the drawings.

D. Decorative CMUs: ASTM C 90.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Ravenstone, Trendstone Ground Face Masonry Units; Trenwyth Industries, Inc.
2. Unit Compressive Strength: Provide units with minimum average net-area compressive strength of 2150 psi (14.8 MPa).
3. Density Classification: Normal weight.
4. Size (Width): Manufactured to dimensions specified in "CMUs" Paragraph.
5. Pattern and Texture:
 - a. Standard pattern, ground-face finish.
6. Colors: As selected by Architect from manufacturer's full range.

2.3 MASONRY LINTELS

A. General: Provide one of the following:

B. Masonry Lintels: Prefabricated or built-in-place masonry lintels made from bond beam CMUs with reinforcing bars placed as indicated and filled with coarse grout. Cure precast lintels before handling and installing. Temporarily support built-in-place lintels until cured.

2.4 PRECAST ARCHITECTURAL CONCRETE TRIM UNITS

- A. Portland Cement: ASTM C 150/C 150M, Type I or Type III, gray, unless otherwise indicated.
 - 1. For surfaces exposed to view in finished structure, use gray or white cement, of same type, brand, and mill source.
- B. Supplementary Cementitious Materials:
 - 1. Fly Ash: ASTM C 618, Class C or F, with maximum loss on ignition of 3 percent.
 - 2. Metakaolin: ASTM C 618, Class N.
 - 3. Silica Fume: ASTM C 1240, with optional chemical and physical requirement.
 - 4. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.
- C. Normal-Weight Aggregates: Except as modified by PCI MNL 117, ASTM C 33/C 33M, with coarse aggregates complying with Class 5S. Stockpile fine and coarse aggregates for each type of exposed finish from a single source (pit or quarry) for Project.
 - 1. Face-Mixture-Fine Aggregates: Selected, natural or manufactured sand compatible with coarse aggregate; to match approved finish sample.
- D. Coloring Admixture: ASTM C 979/C 979M, synthetic or natural mineral-oxide pigments or colored water-reducing admixtures, temperature stable, and nonfading.
- E. Water: Potable; free from deleterious material that may affect color stability, setting, or strength of concrete and complying with chemical limits of PCI MNL 117.
- F. Air-Entraining Admixture: ASTM C 260, certified by manufacturer to be compatible with other required admixtures.
- G. Finish:
 - 1. Acid-Etched Finish: Use acid and hot-water solution, equipment, application techniques, and cleaning procedures to expose aggregate and surrounding matrix surfaces. Protect hardware, connections, and insulation from acid attack.
 - 2. Finish exposed surfaces of architectural precast concrete units to match face-surface finish.
- H. Color: As selected by Architect from manufacturer's full range.
 - 1. Chemical Admixtures: Certified by manufacturer to be compatible with other admixtures and to not contain calcium chloride, or more than 0.15 percent chloride ions or other salts by weight of admixture.

2.5 MORTAR AND GROUT MATERIALS

- A. Portland Cement: ASTM C 150, Type I or II, except Type III may be used for cold-weather construction. Provide natural color or white cement as required to produce mortar color indicated.
- B. Hydrated Lime: ASTM C 207, Type S.

- C. Portland Cement-Lime Mix: Packaged blend of portland cement and hydrated lime containing no other ingredients.
- D. Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes and complying with ASTM C 979. Use only pigments with a record of satisfactory performance in masonry mortar.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Davis Colors; True Tone Mortar Colors.
 - b. Lanxess Corporation; Bayferrox Iron Oxide Pigments.
 - c. Solomon Colors, Inc.; SGS Mortar Colors.
- E. Colored Cement Product: Packaged blend made from portland cement and hydrated lime and mortar pigments, all complying with specified requirements, and containing no other ingredients.
1. Colored Portland Cement-Lime Mix:
 - a. Products: Subject to compliance with requirements, provide one of the following:
 - 1) Capital Materials Corporation; Riverton Portland Cement Lime Custom Color.
 - 2) Lafarge North America Inc.; Eaglebond Portland & Lime.
 - 3) Lehigh Cement Company; Lehigh Custom Color Portland/Lime Cement.
 2. Formulate blend as required to produce color indicated or, if not indicated, as selected from manufacturer's standard colors.
 3. Pigments shall not exceed 10 percent of portland cement by weight.
- F. Aggregate for Mortar: ASTM C 144.
1. For mortar that is exposed to view, use washed aggregate consisting of natural sand or crushed stone.
 2. For joints less than 1/4 inch (6 mm) thick, use aggregate graded with 100 percent passing the No. 16 (1.18-mm) sieve.
 3. White-Mortar Aggregates: Natural white sand or crushed white stone.
 4. Colored-Mortar Aggregates: Natural sand or crushed stone of color necessary to produce required mortar color.
- G. Aggregate for Grout: ASTM C 404.
- H. Water-Repellent Admixture: Liquid water-repellent mortar admixture intended for use with CMUs containing integral water repellent by same manufacturer.
1. Products: Subject to compliance with requirements, provide one of the following:
 - a. ACM Chemistries; RainBloc for Mortar.
 - b. BASF Aktiengesellschaft; Rheopel Mortar Admixture.
 - c. Grace Construction Products, W. R. Grace & Co. - Conn.; Dry-Block Mortar Admixture.

- I. Water: Potable.

2.6 REINFORCEMENT (UNIT MASONRY)

- A. Uncoated Steel Reinforcing Bars: ASTM A 615/A 615M or ASTM A 996/A 996M, Grade 60 (Grade 420).
- B. Masonry Joint Reinforcement, General: ASTM A 951/A 951M.
 - 1. Interior Walls: Mill- galvanized, carbon steel.
 - 2. Exterior Walls: Hot-dip galvanized, carbon steel.
 - 3. Exterior and Interior Walls in Rooms S102, S103, S104, S105, S106, S107, S108, S108A, S109, S110, S111, S112, S114, Stair R: Stainless steel.
 - 4. Wire Size for Side Rods: 0.148-inch (3.77-mm) diameter.
 - 5. Wire Size for Cross Rods: 0.148-inch (3.77-mm) diameter.
 - 6. Wire Size for Veneer Ties: 0.148-inch (3.77-mm) diameter.
 - 7. Spacing of Cross Rods, Tabs, and Cross Ties: Not more than 16 inches (407 mm) o.c.
 - 8. Provide in lengths of not less than 10 feet (3 m), with prefabricated corner and tee units.
- C. Masonry Joint Reinforcement for Single-Wythe Masonry: Either ladder or truss type with single pair of side rods.
- D. Masonry Joint Reinforcement for Multiwythe Masonry:
 - 1. Adjustable (two-piece) type, either ladder or truss design, with one side rod at each face shell of backing wythe and with separate adjustable ties with pintle-and-eye connections having a maximum adjustment of 1-1/4 inches (32 mm). Size ties to extend at least halfway through facing wythe but with at least 5/8-inch (16-mm) cover on outside face. Ties have hooks or clips to engage a continuous horizontal wire in the facing wythe.
- E. Masonry Joint Reinforcement for Veneers Anchored with Seismic Masonry-Veneer Anchors: Single 0.187-inch- (4.76-mm-) diameter, hot-dip galvanized, carbon-steel continuous wire.

2.7 REINFORCING MATERIALS (PRECAST ARCHITECTURAL CONCRETE TRIM UNITS)

- A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), deformed.
- B. Low-Alloy-Steel Reinforcing Bars: ASTM A 706/A 706M, deformed.
- C. Plain-Steel Welded Wire Reinforcement: ASTM A 185/A 185M, fabricated from as-drawn steel wire into flat sheets.
- D. Deformed-Steel Welded Wire Reinforcement: ASTM A 497/A 497M, flat sheet.
- E. Supports: Suspend reinforcement from back of mold or use bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place according to PCI MNL 117.

2.8 TIES AND ANCHORS

- A. Materials: Provide ties and anchors specified in this article that are made from materials that comply with the following unless otherwise indicated.
1. Mill-Galvanized, Carbon-Steel Wire: ASTM A 82/A 82M; with ASTM A 641/A 641M, Class 1 coating.
 2. Hot-Dip Galvanized, Carbon-Steel Wire: ASTM A 82/A 82M; with ASTM A 153/A 153M, Class B-2 coating.
- B. Wire Ties, General: Unless otherwise indicated, size wire ties to extend at least halfway through veneer but with at least 5/8-inch (16-mm) cover on outside face. Outer ends of wires are bent 90 degrees and extend 2 inches (50 mm) parallel to face of veneer.
- C. Individual Wire Ties: Rectangular units with closed ends and not less than 4 inches (100 mm) wide.
1. Z-shaped ties with ends bent 90 degrees to provide hooks not less than 2 inches (50 mm) long may be used for masonry constructed from solid units.
 2. Where wythes do not align or are of different materials, use adjustable ties with pintle-and-eye connections having a maximum adjustment of 1-1/4 inches (32 mm).
 3. Wire: Fabricate from 3/16-inch- (4.76-mm-), hot-dip galvanized steel wire. Mill-galvanized wire ties may be used in interior walls unless otherwise indicated.
- D. Adjustable Anchors for Connecting to Structural Steel Framing: Provide anchors that allow vertical or horizontal adjustment but resist tension and compression forces perpendicular to plane of wall.
1. Anchor Section for Welding to Steel Frame: Crimped 1/4-inch- (6.35-mm-) diameter, hot-dip galvanized steel-wire. Mill-galvanized wire may be used at interior walls unless otherwise indicated.
 2. Tie Section: Triangular-shaped wire tie, sized to extend within 1 inch (25 mm) of masonry face, made from 0.187-inch- (4.76-mm-) diameter, hot-dip galvanized steel wire. Mill-galvanized wire may be used at interior walls unless otherwise indicated.
- E. Adjustable Masonry-Veneer Anchors:
1. General: Provide anchors that allow vertical adjustment but resist tension and compression forces perpendicular to plane of wall, for attachment over sheathing to wood or metal studs, and as follows:
 - a. Structural Performance Characteristics: Capable of withstanding a 100-lbf (445-N) load in both tension and compression without deforming or developing play in excess of 0.05 inch (1.3 mm).
 2. Fabricate sheet metal anchor sections and other sheet metal parts from 0.075-inch- (1.90-mm-) thick steel sheet, galvanized after fabrication.
 3. Wire Ties: Triangular-, rectangular-, or T-shaped wire ties fabricated from 0.187-inch- (4.76-mm-) diameter, hot-dip galvanized-steel wire unless otherwise indicated.
 4. Contractor's Option: Unless otherwise indicated, provide any of the following types of anchors:

5. Screw-Attached, Masonry-Veneer Anchors: Units consisting of a wire tie and a metal anchor section.
 - a. Products: Subject to compliance with requirements, provide one of the following:
 - 1) Dayton Superior Corporation, Dur-O-Wal Division; D/A 213.
 - 2) Wire-Bond; RJ-711.
 - b. Anchor Section: Rib-stiffened, sheet metal plate with screw holes top and bottom, 2-3/4 inches (70 mm) wide by 3 inches (76 mm) high; with projecting tabs having slotted holes for inserting vertical legs of wire tie specially formed to fit anchor section.
6. Polymer-Coated, Steel Drill Screws for Steel Studs: ASTM C 954 except manufactured with hex washer head and neoprene or EPDM washer, No. 10 (4.83-mm) diameter by length required to penetrate steel stud flange with not less than three exposed threads, and with organic polymer coating with salt-spray resistance to red rust of more than 800 hours per ASTM B 117.
7. Stainless-Steel Drill Screws for Steel Studs: Proprietary fastener consisting of carbon-steel drill point and 300 Series stainless-steel shank, complying with ASTM C 954 except manufactured with hex washer head and neoprene or EPDM washer, No. 10 (4.83-mm) diameter by length required to penetrate steel stud flange with not less than three exposed threads.

2.9 MISCELLANEOUS ANCHORS

- A. Unit Type Inserts in Concrete: Cast-iron or malleable-iron wedge-type inserts.
- B. Anchor Bolts: Headed or L-shaped steel bolts complying with ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6); with ASTM A 563 (ASTM A 563M) hex nuts and, where indicated, flat washers; hot-dip galvanized to comply with ASTM A 153/A 153M, Class C; of dimensions indicated.
- C. Post-installed Anchors: Torque-controlled expansion anchors or chemical anchors.
 1. Load Capacity: Capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488, conducted by a qualified independent testing agency.
 2. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B 633 or ASTM F 1941 (ASTM F 1941M), Class Fe/Zn 5 unless otherwise indicated.
 3. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy Group 1 (A1) stainless-steel bolts, ASTM F 593 (ASTM F 738M), and nuts, ASTM F 594 (ASTM F 836M).

2.10 EMBEDDED FLASHING MATERIALS

- A. Metal Flashing: Provide metal flashing complying with SMACNA's "Architectural Sheet Metal Manual" and as follows:
1. Stainless Steel: ASTM A 240/A 240M, Type 304, 0.016 inch (0.40 mm) thick.
 2. Fabricate continuous flashings in sections 96 inches (2400 mm) long minimum, but not exceeding 12 feet (3.7 m). Provide matching splice plates at joints
 3. Metal Drip Edge: Fabricate from stainless steel. Extend at least 3 inches (76 mm) into wall and 1/2 inch (13 mm) out from wall, with outer edge bent down 30 degrees and hemmed.
- B. Flexible Flashing: Use one of the following unless otherwise indicated:
1. Copper-Laminated Flashing: 5-oz./sq. ft. (1.5-kg/sq. m) copper sheet bonded between 2 layers of glass-fiber cloth. Use only where flashing is fully concealed in masonry.
 - a. Products: Subject to compliance with requirements, provide one of the following:
 - 1) Dayton Superior Corporation, Dur-O-Wal Division; Copper Fabric Thru-Wall Flashing.
 - 2) Hohmann & Barnard, Inc.; H & B C-Fab Flashing.
 - 3) York Manufacturing, Inc.; Multi-Flash 500.
 2. Rubberized-Asphalt Flashing: Composite flashing product consisting of a pliable, adhesive rubberized-asphalt compound, bonded to a high-density, cross-laminated polyethylene film to produce an overall thickness of not less than 0.040 inch (1.02 mm).
 - a. Products: Subject to compliance with requirements, provide one of the following:
 - 1) Grace Construction Products, W. R. Grace & Co. - Conn.; Perm-A-Barrier Wall Flashing.
 - 2) Heckmann Building Products Inc.; No. 82 Rubberized-Asphalt Thru-Wall Flashing.
 - 3) Hohmann & Barnard, Inc.; Textroflash.
 - b. Accessories: Provide preformed corners, end dams, other special shapes, and seaming materials produced by flashing manufacturer.
- C. Application: Unless otherwise indicated, use the following:
1. Where flashing is indicated to receive counterflashing, use metal flashing.
 2. Where flashing is indicated to be turned down at or beyond the wall face, use metal flashing.
 3. Where flashing is partly exposed and is indicated to terminate at the wall face, use flexible flashing with stainless steel metal drip edge.
 4. Where flashing is fully concealed, use flexible flashing.
- D. Solder and Sealants for Sheet Metal Flashings
1. Solder for Stainless Steel: ASTM B 32, Grade Sn60, with acid flux of type recommended by stainless-steel sheet manufacturer.
 2. Elastomeric Sealant: ASTM C 920, as specified in Division 7 Section "Joint Sealants."

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

2.11 MISCELLANEOUS MASONRY ACCESSORIES

- A. Compressible Filler: Premolded filler strips complying with ASTM D 1056, Grade 2A1; compressible up to 35 percent; of width and thickness indicated; formulated from neoprene or urethane.
- B. Preformed Control-Joint Gaskets: Made from styrene-butadiene-rubber compound, complying with ASTM D 2000, Designation M2AA-805 and designed to fit standard sash block and to maintain lateral stability in masonry wall; size and configuration as indicated.
- C. Bond-Breaker Strips: Asphalt-saturated, organic roofing felt complying with ASTM D 226, Type I (No. 15 asphalt felt).
- D. Weep/Vent Products: Use one of the following unless otherwise indicated:
 - 1. Cellular Plastic Weep/Vent: One-piece, flexible extrusion made from UV-resistant polypropylene copolymer, full height and width of head joint and depth 1/8 inch (3 mm) less than depth of outer wythe, in color selected from manufacturer's standard.
 - a. Products: Subject to compliance with requirements, provide one of the following:
 - 1) Dayton Superior Corporation, Dur-O-Wal Division; Cell Vents.
 - 2) Heckmann Building Products Inc.; No. 85 Cell Vent.
 - 3) Hohmann & Barnard, Inc.; Quadro-Vent.
- E. Cavity Drainage Material: Free-draining mesh, made from polymer strands that will not degrade within the wall cavity.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Advanced Building Products Inc.; Mortar Break.
 - b. Dayton Superior Corporation, Dur-O-Wal Division; Polytite MortarStop.
 - c. Mortar Net USA, Ltd.; Mortar Net.
 - 2. Provide one of the following configurations:
 - a. Strips, full-depth of cavity and 10 inches (250 mm) high, with dovetail shaped notches 7 inches (175 mm) deep that prevent clogging with mortar droppings.
- F. Reinforcing Bar Positioners: Wire units designed to fit into mortar bed joints spanning masonry unit cells and hold reinforcing bars in center of cells. Units are formed from 0.148-inch (3.77-mm) steel wire, hot-dip galvanized after fabrication. Provide units designed for number of bars indicated.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Dayton Superior Corporation, Dur-O-Wal Division; D/A 810, D/A 812 or D/A 817.

- b. Heckmann Building Products Inc.; No. 376 Rebar Positioner.
- c. Hohmann & Barnard, Inc.; #RB or #RB-Twin Rebar Positioner.

2.12 CAVITY-WALL INSULATION

- A. Refer to Division 07 Section "Thermal Insulation".

2.13 MASONRY CLEANERS

- A. Proprietary Acidic Cleaner: Manufacturer's standard-strength cleaner designed for removing mortar/grout stains, efflorescence, and other new construction stains from new masonry without discoloring or damaging masonry surfaces. Use product expressly approved for intended use by cleaner manufacturer and manufacturer of masonry units being cleaned.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Diedrich Technologies, Inc.
 - b. EaCo Chem, Inc.
 - c. ProSoCo, Inc.

2.14 MORTAR AND GROUT MIXES

- A. General: Do not use admixtures, including pigments, air-entraining agents, accelerators, retarders, water-repellent agents, antifreeze compounds, or other admixtures, unless otherwise indicated.
 - 1. Do not use calcium chloride in mortar or grout.
 - 2. Use portland cement-lime mortar unless otherwise indicated.
- B. Preblended, Dry Mortar Mix: Furnish dry mortar ingredients in form of a preblended mix. Measure quantities by weight to ensure accurate proportions, and thoroughly blend ingredients before delivering to Project site.
- C. Mortar for Unit Masonry: Comply with ASTM C 270, Proportion Specification. Provide the following types of mortar for applications stated unless another type is indicated or needed to provide required compressive strength of masonry.
 - 1. For masonry below grade or in contact with earth, use Type M.
 - 2. For reinforced and loadbearing masonry, use Type S.
 - 3. For exterior, above-grade, non-load-bearing walls and parapet walls; for interior non-load-bearing partitions; and for other applications where another type is not indicated, use Type N.
- D. Pigmented Mortar: Use colored cement product or select and proportion pigments with other ingredients to produce color required. Do not add pigments to colored cement products.
 - 1. Pigments shall not exceed 10 percent of portland cement by weight.
 - 2. Mix to match Architect's sample.

3. Application: Use pigmented mortar for exposed mortar joints with the following units:
 - a. Decorative CMUs.
- E. Colored-Aggregate Mortar: Produce required mortar color by using colored aggregates and natural color or white cement as necessary to produce required mortar color.
 1. Application: Use colored aggregate mortar for exposed mortar joints with the following units:
 - a. Decorative CMUs.
- F. Grout for Unit Masonry: Comply with ASTM C 476.
 1. Use grout of type indicated or, if not otherwise indicated, of type (fine or coarse) that will comply with Table 1.15.1 in ACI 530.1/ASCE 6/TMS 602 for dimensions of grout spaces and pour height.
 2. Proportion grout in accordance with ASTM C 476, Table 1 or paragraph 4.2.2 for specified 28-day compressive strength indicated, but not less than 2500 psi.
 3. Provide grout with a slump of 8 to 11 inches (203 to 279 mm) as measured according to ASTM C 143/C 143M.

2.15 FABRICATION (PRECAST ARCHITECTURAL CONCRETE TRIM UNITS)

- A. Furnish loose hardware items including steel plates, clip angles, seat angles, anchors, dowels, cramps, hangers, and other hardware shapes for securing architectural precast concrete units to supporting and adjacent construction.
- B. Cast-in reglets, slots, holes, and other accessories in architectural precast concrete units as indicated on the Contract Drawings.
- C. Reinforcement: Comply with recommendations in PCI MNL 117 for fabricating, placing, and supporting reinforcement.
- D. Reinforce architectural precast concrete units to resist handling, transportation, and erection stresses and specified in-place loads.
- E. Comply with requirements in PCI MNL 117 and requirements in this Section for measuring, mixing, transporting, and placing concrete. After concrete batching, no additional water may be added.
- F. Place face mixture to a minimum thickness after consolidation of the greater of 1 inch (25 mm) or 1.5 times the maximum aggregate size, but not less than the minimum reinforcing cover specified.
- G. Place concrete in a continuous operation to prevent cold joints or planes of weakness from forming in precast concrete units.
- H. Thoroughly consolidate placed concrete by internal and external vibration without dislocating or damaging reinforcement and built-in items, and minimize pour lines, honeycombing, or entrapped air voids on surfaces. Use equipment and procedures complying with PCI MNL 117.

1. Place self-consolidating concrete without vibration according to PCI TR-6, "Interim Guidelines for the Use of Self-Consolidating Concrete in Precast/Prestressed Concrete Institute Member Plants." Ensure adequate bond between face and backup concrete, if used.
 - I. Comply with PCI MNL 117 for hot- and cold-weather concrete placement.
 - J. Cure concrete, according to requirements in PCI MNL 117, by moisture retention without heat or by accelerated heat curing using low-pressure live steam or radiant heat and moisture. Cure units until compressive strength is high enough to ensure that stripping does not have an effect on performance or appearance of final product.
 - K. Discard and replace architectural precast concrete units that do not comply with requirements, including structural, manufacturing tolerance, and appearance, unless repairs meet requirements in PCI MNL 117 and Architect's approval.
- 2.16 FABRICATION TOLERANCES (PRECAST ARCHITECTURAL CONCRETE TRIM UNITS)
- A. Fabricate architectural precast concrete units to shapes, lines, and dimensions indicated so each finished unit complies with PCI MNL 117 product tolerances as well as position tolerances for cast-in items.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
 1. For the record, prepare written report, endorsed by Installer, listing conditions detrimental to performance of work.
 2. Verify that foundations are within tolerances specified.
 3. Verify that reinforcing dowels are properly placed.
- B. Before installation, examine rough-in and built-in construction for piping systems to verify actual locations of piping connections.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

- A. Thickness: Build cavity and composite walls and other masonry construction to full thickness shown. Build single-wythe walls to actual widths of masonry units, using units of widths indicated.
- B. Build chases and recesses to accommodate items specified in this and other Sections.

- C. Leave openings for equipment to be installed before completing masonry. After installing equipment, complete masonry to match the construction immediately adjacent to opening.
- D. Use full-size units without cutting if possible. If cutting is required to provide a continuous pattern or to fit adjoining construction, cut units with motor-driven saws; provide clean, sharp, unchipped edges. Allow units to dry before laying unless wetting of units is specified. Install cut units with cut surfaces and, where possible, cut edges concealed.
- E. Select and arrange units for exposed unit masonry to produce a uniform blend of colors and textures.
 - 1. Mix units from several pallets or cubes as they are placed.

3.3 TOLERANCES

A. Dimensions and Locations of Elements:

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

B. Lines and Levels:

- 1. For bed joints and top surfaces of bearing walls do not vary from level by more than 1/4 inch in 10 feet (6 mm in 3 m), or 1/2 inch (12 mm) maximum.
- 2. For conspicuous horizontal lines, such as lintels, sills, parapets, and reveals, do not vary from level by more than 1/8 inch in 10 feet (3 mm in 3 m), 1/4 inch in 20 feet (6 mm in 6 m), or 1/2 inch (12 mm) maximum.
- 3. For vertical lines and surfaces do not vary from plumb by more than 1/4 inch in 10 feet (6 mm in 3 m), 3/8 inch in 20 feet (9 mm in 6 m), or 1/2 inch (12 mm) maximum.
- 4. For conspicuous vertical lines, such as external corners, door jambs, reveals, and expansion and control joints, do not vary from plumb by more than 1/8 inch in 10 feet (3 mm in 3 m), 1/4 inch in 20 feet (6 mm in 6 m), or 1/2 inch (12 mm) maximum.
- 5. For lines and surfaces do not vary from straight by more than 1/4 inch in 10 feet (6 mm in 3 m), 3/8 inch in 20 feet (9 mm in 6 m), or 1/2 inch (12 mm) maximum.
- 6. For vertical alignment of exposed head joints, do not vary from plumb by more than 1/4 inch in 10 feet (6 mm in 3 m), or 1/2 inch (12 mm) maximum.
- 7. For faces of adjacent exposed masonry units, do not vary from flush alignment by more than 1/16 inch (1.5 mm) except due to warpage of masonry units within tolerances specified for warpage of units.

C. Joints:

- 1. For bed joints, do not vary from thickness indicated by more than plus or minus 1/8 inch (3 mm), with a maximum thickness limited to 1/2 inch (12 mm).
- 2. For exposed bed joints, do not vary from bed-joint thickness of adjacent courses by more than 1/8 inch (3 mm).

3. For head and collar joints, do not vary from thickness indicated by more than plus 3/8 inch (9 mm) or minus 1/4 inch (6 mm).
4. For exposed head joints, do not vary from thickness indicated by more than plus or minus 1/8 inch (3 mm). Do not vary from adjacent bed-joint and head-joint thicknesses by more than 1/8 inch (3 mm).
5. For exposed bed joints and head joints of stacked bond, do not vary from a straight line by more than 1/16 inch (1.5 mm) from one masonry unit to the next.

3.4 LAYING MASONRY WALLS

- A. Lay out walls in advance for accurate spacing of surface bond patterns with uniform joint thicknesses and for accurate location of openings, movement-type joints, returns, and offsets. Avoid using less-than-half-size units, particularly at corners, jambs, and, where possible, at other locations.
- B. Bond Pattern for Exposed Masonry: Unless otherwise indicated, lay exposed masonry in running bond; do not use units with less than nominal 4-inch (100-mm) horizontal face dimensions at corners or jambs.
- C. Lay concealed masonry with all units in a wythe in running bond or bonded by lapping not less than 4-inches (100-mm). Bond and interlock each course of each wythe at corners. Do not use units with less than nominal 4-inch (100-mm) horizontal face dimensions at corners or jambs.
- D. Stopping and Resuming Work: Stop work by racking back units in each course from those in course below; do not tooth. When resuming work, clean masonry surfaces that are to receive mortar, remove loose masonry units and mortar, and wet brick if required before laying fresh masonry.
- E. Built-in Work: As construction progresses, build in items specified in this and other Sections. Fill in solidly with masonry around built-in items.
- F. Fill space between steel frames and masonry solidly with mortar unless otherwise indicated.
- G. Where built-in items are to be embedded in cores of hollow masonry units, place a layer of metal lath, wire mesh, or plastic mesh in the joint below and rod mortar or grout into core.
- H. Fill cores in hollow CMUs with grout 24 inches (600 mm) under bearing plates, beams, lintels, posts, and similar items unless otherwise indicated.
- I. Build non-load-bearing interior partitions full height of story to underside of solid floor or roof structure above unless otherwise indicated.
 1. Install compressible filler in joint between top of partition and underside of structure above.
 2. Fasten partition top anchors to structure above and build into top of partition. Grout cells of CMUs solidly around plastic tubes of anchors and push tubes down into grout to provide 1/2-inch (13-mm) clearance between end of anchor rod and end of tube. Space anchors 48 inches (1200 mm) o.c. unless otherwise indicated.
 3. At fire-rated partitions, treat joint between top of partition and underside of structure above to comply with Section 078446 "Fire-Resistive Joint Systems."

3.5 MORTAR BEDDING AND JOINTING

- A. Lay hollow CMUs as follows:
1. With face shells fully bedded in mortar and with head joints of depth equal to bed joints.
 2. With webs fully bedded in mortar in all courses of piers, columns, and pilasters.
 3. With webs fully bedded in mortar in grouted masonry, including starting course on footings.
 4. With entire units, including areas under cells, fully bedded in mortar at starting course on footings where cells are not grouted.
 5. Unless otherwise indicated, provide 3/8 inch high joints.
- B. Lay solid masonry units with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not deeply furrow bed joints or slush head joints.
- C. Tool exposed joints slightly concave when thumbprint hard, using a jointer larger than joint thickness unless otherwise indicated.
- D. Cut joints flush for masonry walls to receive direct-applied finishes (other than paint) unless otherwise indicated.

3.6 CAVITY WALLS

- A. Bond wythes of cavity walls together using the following method:
1. Masonry Joint Reinforcement: Installed in horizontal mortar joints.
 - a. Use adjustable (two-piece) type reinforcement with continuous horizontal wire in facing wythe attached to ties to allow for differential movement regardless of whether bed joints align.
- B. Keep cavities clean of mortar droppings and other materials during construction. Bevel beds away from cavity, to minimize mortar protrusions into cavity. Do not attempt to trowel or remove mortar fins protruding into cavity.

3.7 MASONRY JOINT REINFORCEMENT

- A. General: Install entire length of longitudinal side rods in mortar with a minimum cover of 5/8 inch (16 mm) on exterior side of walls, 1/2 inch (13 mm) elsewhere. Lap reinforcement a minimum of 6 inches (150 mm).
1. Space reinforcement not more than 16 inches (406 mm) o.c.
 2. Provide reinforcement not more than 8 inches (203 mm) above and below wall openings and extending 12 inches (305 mm) beyond openings in addition to continuous reinforcement.
- B. Interrupt joint reinforcement at control and expansion joints unless otherwise indicated.
- C. Provide continuity at wall intersections by using prefabricated T-shaped units.

- D. Provide continuity at corners by using prefabricated L-shaped units.
- E. Cut and bend reinforcing units as directed by manufacturer for continuity at returns, offsets, column fireproofing, pipe enclosures, and other special conditions.

3.8 ANCHORING MASONRY TO STRUCTURAL STEEL AND CONCRETE

- A. Anchor masonry to structural steel and concrete where masonry abuts or faces structural steel or concrete to comply with the following:
 1. Provide an open space not less than 1 inch (25 mm) wide between masonry and structural steel or concrete unless otherwise indicated. Keep open space free of mortar and other rigid materials.
 2. Anchor masonry with anchors embedded in masonry joints and attached to structure.
 3. Space anchors as indicated, but not more than 24 inches (610 mm) o.c. vertically and 36 inches (915 mm) o.c. horizontally.

3.9 ANCHORING MASONRY VENEERS

- A. Anchor masonry veneers to wall framing and concrete and masonry backup with masonry-veneer anchors to comply with the following requirements:
 1. Fasten screw-attached anchors through sheathing to wall framing and to concrete and masonry backup with metal fasteners of type indicated. Use two fasteners unless anchor design only uses one fastener.
 2. Insert slip-in anchors in metal studs as sheathing is installed. Provide one anchor at each stud in each horizontal joint between sheathing boards.
 3. Embed tie sections in masonry joints. Provide not less than 2 inches (50 mm) of air space between back of masonry veneer and face of sheathing.
 4. Locate anchor sections to allow maximum vertical differential movement of ties up and down.
 5. Space anchors as indicated, but not more than 16 inches (406 mm) o.c. vertically and 24 inches (610 mm) o.c. horizontally with not less than 1 anchor for each 2.67 sq. ft. (0.25 sq. m) of wall area. Install additional anchors within 12 inches (305 mm) of openings and at intervals, not exceeding 36 inches (914 mm), around perimeter.

3.10 CONTROL AND EXPANSION JOINTS

- A. General: Install control and expansion joint materials in unit masonry as masonry progresses. Do not allow materials to span control and expansion joints without provision to allow for in-plane wall or partition movement.
- B. Form control joints in concrete masonry as follows:
 1. Install preformed control-joint gaskets designed to fit standard sash block as indicated on the architectural drawings.

3.11 LINTELS

- A. Install steel lintels where indicated.
- B. Provide masonry lintels where shown and where openings of more than 12 inches (305 mm) for brick-size units and 24 inches (610 mm) for block-size units are shown without structural steel or other supporting lintels.
- C. Provide minimum bearing of 8 inches (200 mm) at each jamb unless otherwise indicated.

3.12 FLASHING, WEEP HOLES, CAVITY DRAINAGE, AND VENTS

- A. General: Install embedded flashing and weep holes in masonry at shelf angles, lintels, ledges, other obstructions to downward flow of water in wall, and where indicated. Install vents at shelf angles, ledges, and other obstructions to upward flow of air in cavities, and where indicated.
- B. Install flashing as follows unless otherwise indicated:
 - 1. Prepare masonry surfaces so they are smooth and free from projections that could puncture flashing. Where flashing is within mortar joint, place through-wall flashing on sloping bed of mortar and cover with mortar. Before covering with mortar, seal penetrations in flashing with adhesive, sealant, or tape as recommended by flashing manufacturer.
 - 2. At multiwythe masonry walls, including cavity walls, extend flashing through outer wythe, turned up a minimum of 4 inches (100 mm), and 1-1/2 inches (38 mm) into the inner wythe..
 - 3. At masonry-veneer walls, extend flashing through veneer, across air space behind veneer, and up face of sheathing at least 8 inches (200 mm); with upper edge tucked under building paper or building wrap, lapping at least 4 inches (100 mm).
 - 4. At lintels and shelf angles, extend flashing a minimum of 6 inches (150 mm) into masonry at each end. At heads and sills, extend flashing 6 inches (150 mm) at ends and turn up not less than 2 inches (50 mm) to form end dams.
 - 5. Install metal drip edges beneath flexible flashing at exterior face of wall. Stop flexible flashing 1/2 inch (13 mm) back from outside face of wall and adhere flexible flashing to top of metal drip edge.
- C. Install reglets and nailers for flashing and other related construction where they are shown to be built into masonry.
- D. Install weep holes in head joints in exterior wythes of first course of masonry immediately above embedded flashing and as follows:
 - 1. Use specified weep/vent products to form weep holes.
 - 2. Space weep holes 32 inches o.c. unless otherwise indicated.
- E. Place cavity drainage material in cavities to comply with configuration requirements for cavity drainage material in "Miscellaneous Masonry Accessories" Article.

- F. Install vents in head joints in exterior wythes at spacing indicated. Use specified weep/vent products to form vents.

3.13 REINFORCED UNIT MASONRY INSTALLATION

- A. Temporary Formwork and Shores: Construct formwork and shores as needed to support reinforced masonry elements during construction.
 - 1. Construct formwork to provide shape, line, and dimensions of completed masonry as indicated. Make forms sufficiently tight to prevent leakage of mortar and grout. Brace, tie, and support forms to maintain position and shape during construction and curing of reinforced masonry.
 - 2. Do not remove forms and shores until reinforced masonry members have hardened sufficiently to carry their own weight and other loads that may be placed on them during construction.
- B. Placing Reinforcement: Comply with requirements in ACI 530.1/ASCE 6/TMS 602.
- C. Grouting: Do not place grout until entire height of masonry to be grouted has attained enough strength to resist grout pressure.
 - 1. Comply with requirements in ACI 530.1/ASCE 6/TMS 602 for cleanouts and for grout placement, including minimum grout space and maximum pour height.
 - 2. Limit height of vertical grout pours to not more than 60 inches (1520 mm).

3.14 PRECAST ARCHITECTURAL CONCRETE TRIM UNIT INSTALLATION

- A. Install clips, hangers, bearing pads, and other accessories required for connecting architectural precast concrete units to supporting members and backup materials.
- B. Set architectural precast concrete level, plumb, and square within specified allowable tolerances. Provide temporary supports and bracing as required to maintain position, stability, and alignment of units until permanent connections are completed.
 - 1. Maintain horizontal and vertical uniform joint width as erection progresses.
 - 2. Unless otherwise indicated, maintain uniform joint widths of 3/8 inch.
- C. Connect architectural precast concrete units in position by grouting, or as otherwise indicated on Shop Drawings. Remove temporary shims, wedges, and spacers as soon as practical after connecting and grouting are completed.
- D. Grouting or Dry-Packing Connections and Joints: Grout connections where required or indicated. Retain flowable grout in place until hard enough to support itself. Alternatively, pack spaces with stiff dry-pack grout material, tamping until voids are completely filled. Place grout and finish smooth, level, and plumb with adjacent concrete surfaces. Promptly remove grout material from exposed surfaces before it affects finishes or hardens. Keep grouted joints damp for not less than 24 hours after initial set.

- E. Erect architectural precast concrete units level, plumb, square, and in alignment without exceeding the noncumulative erection tolerances of PCI MNL 117, Appendix I.

3.15 FIELD QUALITY CONTROL

- A. Testing and Inspecting: Owner will engage special inspectors to perform tests and inspections and prepare reports. Allow inspectors access to scaffolding and work areas, as needed to perform tests and inspections. Retesting of materials that fail to comply with specified requirements shall be done at Contractor's expense.
- B. Inspections: Level 2 special inspections according to the "2005 Connecticut Supplement with 2009 Amendment – State Building Code."
 - 1. Begin masonry construction only after inspectors have verified proportions of site-prepared mortar.
 - 2. Place grout only after inspectors have verified compliance of grout spaces and of grades, sizes, and locations of reinforcement.
 - 3. Place grout only after inspectors have verified proportions of site-prepared grout.
- C. Testing Prior to Construction: One set of tests.
- D. Testing Frequency for Vertically Reinforced Masonry: One set of tests for each 1500 sq. ft. (140 sq. m) of wall area or portion thereof, with a minimum of one test per day.
- E. Testing Frequency for Non-loadbearing Masonry: One set of tests for each 5000 sq. ft. (460 sq. m) of wall area or portion thereof.
- F. Concrete Masonry Unit Test: For each type of unit provided, according to ASTM C 140 for compressive strength.
- G. Mortar Test (Compressive Strength): For each mix provided, according to ASTM C 780.
- H. Grout Test (Compressive Strength): For each mix provided, according to ASTM C 1019.

3.16 REPAIRING, POINTING, AND CLEANING (UNIT MASONRY)

- A. Remove and replace masonry units that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Install new units to match adjoining units; install in fresh mortar, pointed to eliminate evidence of replacement.
- B. Pointing: During the tooling of joints, enlarge voids and holes, except weep holes, and completely fill with mortar. Point up joints, including corners, openings, and adjacent construction, to provide a neat, uniform appearance. Prepare joints for sealant application, where indicated.
- C. In-Progress Cleaning: Clean unit masonry as work progresses by dry brushing to remove mortar fins and smears before tooling joints.
- D. Final Cleaning: After mortar is thoroughly set and cured, clean exposed masonry as follows:

1. Remove large mortar particles by hand with wooden paddles and nonmetallic scrape hoes or chisels.
2. Test cleaning methods on sample wall panel; leave one-half of panel uncleaned for comparison purposes. Obtain Architect's approval of sample cleaning before proceeding with cleaning of masonry.
3. Protect adjacent surfaces from contact with cleaner by covering them with liquid strippable masking agent or polyethylene film and waterproof masking tape.
4. Wet wall surfaces with water before applying cleaners; remove cleaners promptly by rinsing surfaces thoroughly with clear water.
5. Clean masonry with a proprietary acidic cleaner applied according to manufacturer's written instructions.
6. Clean concrete masonry by cleaning method indicated in NCMA TEK 8-2A applicable to type of stain on exposed surfaces.

3.17 REPAIRS (PRECAST ARCHITECTURAL CONCRETE TRIM UNITS)

- A. Repair architectural precast concrete units if permitted by Architect. Architect reserves the right to reject repaired units that do not comply with requirements.
- B. Mix patching materials and repair units so cured patches blend with color, texture, and uniformity of adjacent exposed surfaces and show no apparent line of demarcation between original and repaired work, when viewed in typical daylight illumination from a distance of 20 feet (6 m).
- C. Remove and replace damaged architectural precast concrete units when repairs do not comply with requirements.

3.18 CLEANING (PRECAST ARCHITECTURAL CONCRETE TRIM UNITS)

- A. Clean surfaces of precast concrete units exposed to view.
- B. Clean mortar and other deleterious material from concrete surfaces and adjacent materials immediately.
- C. Clean exposed surfaces of precast concrete units after erection and completion of joint treatment to remove markings, dirt, and stains.
 1. Perform cleaning procedures, if necessary, according to precast concrete fabricator's recommendations. Protect other work from staining or damage due to cleaning operations.
 2. Do not use cleaning materials or processes that could change the appearance of exposed concrete finishes or damage adjacent materials.

3.19 MASONRY WASTE DISPOSAL

- A. Salvageable Materials: Refer to Section 017419 "Construction Waste Management and Disposal".

- B. Excess Masonry Waste: Remove excess clean masonry waste that cannot be used as fill, as described above, and other masonry waste, and legally dispose of off Owner's property.

END OF SECTION 042000

SECTION 064023 - INTERIOR ARCHITECTURAL WOODWORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:

1. Interior standing and running trim.
2. Wood cabinet doors.
3. Plastic-laminate cabinets.
4. Plastic-laminate countertops.
5. Plastic-laminate pass-through sorter

- B. Related Sections include the following:

1. Division 01, High Performance Buildings Requirements Section for credits 16a-38k-4(b)4, 16a-38k-4(b)5, 16a-38k-4(d)13 and 16a-38k-4(b)7.
 - a. The above listed HPB credits are related to this section. Other HPB credits may apply and shall be reviewed for their potential applicability and conformed with as though listed.
2. Division 06 Section "Interior Finish Carpentry" for interior carpentry exposed to view that is not specified in this Section.
3. Division 12 Section "Simulated Stone Countertops for solid surfacing material countertops."

1.3 DEFINITIONS

- A. Interior architectural woodwork includes wood furring, blocking, shims, and hanging strips for installing woodwork items unless concealed within other construction before woodwork installation.

1.4 ACTION SUBMITTALS

- A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.
- B. Product Data: For each type of product indicated, including high-pressure decorative laminate, cabinet hardware and accessories and finishing materials and processes.

- C. Shop Drawings: Show location of each item, dimensioned plans and elevations, large-scale details, attachment devices, and other components.
 - 1. Show locations and sizes of furring, blocking, and hanging strips, including concealed blocking and reinforcement specified in other Sections.
 - 2. Show locations and sizes of cutouts and holes for plumbing fixtures, faucets, soap dispensers and other items installed in architectural woodwork.
- D. Samples for Initial Selection:
 - 1. Shop-applied transparent finishes.
 - 2. Shop-applied opaque finishes.
 - 3. Plastic laminates.
 - 4. PVC edge material.
- E. Samples for Verification:
 - 1. Lumber with or for transparent finish, not less than 5 inches (125 mm) wide by 24 inches (600 mm) long, for each species and cut, finished on 1 side and 1 edge.
 - 2. Lumber and panel products with shop-applied opaque finish, 12 inch long for each finish system and color.
 - 3. Plastic laminates, 8 by 10 inches (200 by 250 mm), for each type, color, pattern, and surface finish, with 1 sample applied to core material and specified edge material applied to 1 edge.
 - 4. Exposed cabinet hardware and accessories, one unit for each type and finish.

1.5 INFORMATIONAL SUBMITTALS

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

1.6 QUALITY ASSURANCE

- A. Fabricator Qualifications: Shop that employs skilled workers who custom-fabricate products similar to those required for this Project and whose products have a record of successful in-service performance. Shop is a certified participant in AWI's Quality Certification Program.
- B. Installer Qualifications: Certified participant in AWI's Quality Certification Program.
- C. Quality Standard: Unless otherwise indicated, comply with AWI's "Architectural Woodwork Quality Standards" for grades of interior architectural woodwork indicated for construction, finishes, installation, and other requirements.
 - 1. Provide AWI Quality Certification Program certificates indicating that woodwork, including installation, complies with requirements of grades specified.
- D. Preinstallation Conference: Conduct conference at Project .

1.7 DELIVERY, STORAGE, AND HANDLING

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

1.8 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install woodwork until building is enclosed, wet work is complete, and HVAC system is operating and maintaining temperature and relative humidity at occupancy levels during the remainder of the construction period.
- B. Field Measurements: Where woodwork is indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication, and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
 - 1. Locate concealed framing, blocking, and reinforcements that support woodwork by field measurements before being enclosed, and indicate measurements on Shop Drawings.

1.9 COORDINATION

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

PART 2 - PRODUCTS

2.1 MATERIALS

- A. General: Provide materials that comply with requirements of AWI's quality standard for each type of woodwork and quality grade specified, unless otherwise indicated.
- B. Wood Species and Cut for Transparent Finish: White Maple, plain sawn or sliced.
- C. Wood Species for Opaque Finish: Any closed-grain hardwood.
- D. Wood Products: Comply with the following:
 - 1. Hardboard: AHA A135.4.
 - 2. Medium-Density Fiberboard: ANSI A208.2, Grade MD, made with binder containing no urea formaldehyde.
 - 3. Particleboard: ANSI A208.1, Grade M-2, made with binder containing no urea formaldehyde.
- E. High-Pressure Decorative Laminate: NEMA LD 3, grades as indicated or, if not indicated, as required by woodwork quality standard.

1. Manufacturer: Subject to compliance with requirements, provide high-pressure decorative laminates by one of the following:
 - a. Formica Corporation.
 - b. Nevamar Company, LLC; Decorative Products Div.
 - c. Wilsonart International; Div. of Premark International, Inc.

2.2 CABINET HARDWARE AND ACCESSORIES

- A. General: Provide cabinet hardware and accessory materials associated with architectural cabinets.
- B. Frameless Concealed Hinges (European Type): BHMA A156.9, B01602, [100] [135] [170] degrees of opening.
- C. Back-Mounted Pulls: BHMA A156.9, B02011.
- D. Wire Pulls: Back mounted, solid metal, 4 inches (100 mm) long, 5/16 inch (8 mm) in diameter.
- E. Catches: Magnetic catches, BHMA A156.9, B03141 and Roller catches, BHMA A156.9, B03071, where indicated..
- F. Adjustable Shelf Standards and Supports: BHMA A156.9, B04071; with shelf rests, B04081.
- G. Drawer Slides: BHMA A156.9, B05091.
 1. Heavy Duty (Grade 1HD-100 and Grade 1HD-200): Side mounted; full-extension type; zinc-plated steel ball-bearing slides.
 2. Box Drawer Slides: Grade 1HD-100; for drawers not more than 6 inches (150 mm) high and 24 inches (600 mm) wide.
 3. File Drawer Slides: Grade 1HD-100; for drawers more than 6 inches (150 mm) high or 24 inches (600 mm) wide.
 4. Pencil Drawer Slides: Grade 2; for drawers not more than 3 inches (75 mm) high and 24 inches (600 mm) wide.
 5. Keyboard Slides: Grade 1HD-100; for computer keyboard shelves.
 6. Trash Bin Slides: Grade 1HD-100; for trash bins not more than 20 inches (500 mm) high and 16 inches (400 mm) wide.
- H. Door Locks: BHMA A156.11, E07121.
- I. Drawer Locks: BHMA A156.11, E07041.
- J. Grommets for Cable Passage through Countertops: 2-inch (51-mm) black, molded-plastic grommets and matching plastic caps with slot for wire passage.
 1. Product: Subject to compliance with requirements, provide "SG series" by Doug Mockett & Company, Inc.
- K. Exposed Hardware Finishes: For exposed hardware, provide finish that complies with BHMA A156.18 for BHMA finish number indicated.

1. Satin Stainless Steel: BHMA 630.
- L. For concealed hardware, provide manufacturer's standard finish that complies with product class requirements in BHMA A156.9.
- M. Flush Mount Aluminum Support Angle
1. Basis-of-Design Product: Subject to compliance with requirements, provide EH Series, Countertop Support Bracket; Rakks/ Rangine Corp.
 2. Thickness: 1/4 inch, min.
 3. Material: Aluminum.
 4. Finish: Clear anodized.
 5. Bracket Width: 2 inches min.
 6. Size: See drawings for bracket support sizes.

2.3 MISCELLANEOUS MATERIALS

- A. Furring, Blocking, Shims, and Hanging Strips: Softwood or hardwood lumber, kiln dried to less than 15 percent moisture content.
- B. Anchors: Select material, type, size, and finish required for each substrate for secure anchorage. Provide nonferrous-metal or hot-dip galvanized anchors and inserts on inside face of exterior walls and elsewhere as required for corrosion resistance. Provide toothed-steel or lead expansion sleeves for drilled-in-place anchors.
- C. Adhesives, General: Adhesives shall not contain urea formaldehyde.
- D. Adhesive for Bonding Plastic Laminate: Contact cement .
1. Adhesive for Bonding Edges: Hot-melt adhesive or adhesive specified above for faces.

2.4 FABRICATION, GENERAL

- A. Interior Woodwork Grade: Unless otherwise indicated, provide Custom-grade interior woodwork complying with referenced quality standard.
- B. Wood Moisture Content: Comply with requirements of referenced quality standard for wood moisture content in relation to ambient relative humidity during fabrication and in installation areas.
- C. Complete fabrication, including assembly, finishing, and hardware application, to maximum extent possible before shipment to Project site. Disassemble components only as necessary for shipment and installation. Where necessary for fitting at site, provide ample allowance for scribing, trimming, and fitting.
1. Trial fit assemblies at fabrication shop that cannot be shipped completely assembled. Install dowels, screws, bolted connectors, and other fastening devices that can be removed after trial fitting. Verify that various parts fit as intended and check measurements of assemblies against field measurements indicated on Shop Drawings before disassembling for shipment.

- D. Shop-cut openings to maximum extent possible to receive hardware, appliances, plumbing fixtures, electrical work, and similar items. Locate openings accurately and use templates or roughing-in diagrams to produce accurately sized and shaped openings. Sand edges of cutouts to remove splinters and burrs.
 - 1. Seal edges of openings in countertops with a coat of varnish.

2.5 INTERIOR STANDING AND RUNNING TRIM FOR OPAQUE FINISH

- A. Grade: Custom.
- B. Wood Species: Any closed-grain hardwood.
- C. Backout or groove backs of flat trim members and kerf backs of other wide, flat members, except for members with ends exposed in finished work.
- D. Field assemble trim in the field.

2.6 WOOD CABINETS FOR TRANSPARENT FINISH

- A. Grade: Custom.
- B. AWI Type of Cabinet Construction: Flush overlay.
- C. Reveal Dimension: 1/2 inch (13 mm).
- D. Wood Species and Cut for Exposed Surfaces: White Maple, plain sawn or sliced.
 - 1. Grain Direction: Horizontally for drawer fronts, doors, and fixed panels.
 - 2. Matching of Veneer Leaves: Book match.
 - 3. Vertical Matching of Veneer Leaves: End match.
 - 4. Veneer Matching within Panel Face: Balance match.
 - 5. Veneer Matching within Room: Provide cabinet veneers in each room or other space from a single flitch with doors, drawer fronts, and other surfaces matched in a sequenced set with continuous match where veneers are interrupted perpendicular to the grain.
 - 6. Comply with veneer and other matching requirements indicated for blueprint-matched paneling.
- E. Semiexposed Surfaces: Provide surface materials indicated below:
 - 1. Surfaces Other Than Drawer Bodies: Same species and cut indicated for exposed surfaces.
 - 2. Drawer Sides and Backs: Solid-hardwood lumber, stained to match species indicated for exposed surfaces.
 - 3. Drawer Bottoms: Hardwood plywood.

2.7 PLASTIC-LAMINATE CABINETS

- A. Grade: Premium.

- B. AWI Type of Cabinet Construction: Flush overlay.
- C. Laminate Cladding for Exposed Surfaces: High-pressure decorative laminate complying with the following requirements:
 - 1. Horizontal Surfaces Other Than Tops: Grade HGS.
 - 2. Vertical Surfaces: Grade VGS.
 - 3. Edges: PVC edge banding, 0.12 inch (3 mm) thick, matching laminate in color, pattern, and finish.
- D. Materials for Semiexposed Surfaces:
 - 1. Surfaces Other Than Drawer Bodies: High-pressure decorative laminate, Grade CLS.
 - a. Edges of Plastic-Laminate Shelves: PVC edge banding, 0.12 inch (3 mm) thick, matching laminate in color, pattern, and finish.
 - 2. Drawer Sides and Backs: Solid-hardwood lumber.
 - 3. Drawer Bottoms: Hardwood plywood.
- E. Colors, Patterns, and Finishes: Provide materials and products that result in colors and textures of exposed laminate surfaces complying with the following requirements:
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide 6206-43 Planked Deluxe Pear, Formica Corporation.
- F. Provide dust panels of 1/4-inch (6.4-mm) plywood or tempered hardboard above compartments and drawers, unless located directly under tops.

2.8 PLASTIC-LAMINATE COUNTERTOPS

- A. Grade: Custom.
- B. High-Pressure Decorative Laminate Grade: HGS for flat countertops, HGP for postformed countertops..
- C. Colors, Patterns, and Finishes: Provide materials and products that result in colors and textures of exposed laminate surfaces complying with the following requirements:
 - 1. Match laminate cabinet color.
- D. Edge Treatment: Same as laminate cladding on horizontal surfaces.
- E. Core Material: Particleboard or medium-density fiberboard.
- F. Core Material at Sinks: Particleboard made with exterior glue or medium-density fiberboard made with exterior glue.
- G. Paper Backing: Provide paper backing on underside of countertop substrate.

2.9 PLASTIC-LAMINATE PASS-THROUGH SORTER

- A. Grade: Premium.
- B. Laminate Cladding for Exposed Surfaces: High-pressure decorative laminate complying with the following requirements:
 - 1. Horizontal Surfaces Other Than Tops: Grade HGS.
 - 2. Vertical Surfaces: Grade VGS.
 - 3. Edges: PVC edge banding, 0.12 inch (3 mm) thick, matching laminate in color, pattern, and finish.
- C. Colors, Patterns, and Finishes: Provide materials and products that result in colors and textures of exposed laminate surfaces complying with the following requirements:
- D. Dimensions:
 - 1. Clear Height: 5 inches.
 - 2. Clear Width: 2 ½" inches.
 - 3. Clear Depth: 12 inches.
 - 4. Number of Slots: 80.
- E. Panels: ¾ inch thick particleboard.

2.10 CLOSET AND UTILITY SHELVING

- A. Grade: Custom.
- B. Shelf Material: ¾-inch (19-mm) medium-density fiberboard with high-pressure decorative laminate Grade (HGS).

Edge Treatment: Same as laminate cladding on horizontal surfaces.
- C. Clothes Rods: 1-5/16-inch- (33-mm-) diameter, chrome-plated-steel telescoping tubes with end brackets for mounting on shelf cleats.

2.11 SHOP FINISHING

- A. Grade: Provide finishes of same grades as items to be finished.
- B. General: Finish architectural woodwork at fabrication shop as specified in this Section. Defer only final touchup, cleaning, and polishing until after installation.
- C. General: Shop finish transparent-finished interior architectural woodwork at fabrication shop as specified in this Section. Refer to Division 09 painting Sections for finishing opaque-finished architectural woodwork.
- D. Preparation for Finishing: Comply with referenced quality standard for sanding, filling countersunk fasteners, sealing concealed surfaces, and similar preparations for finishing architectural woodwork, as applicable to each unit of work.

1. Backpriming: Apply one coat of sealer or primer, compatible with finish coats, to concealed surfaces of woodwork. Apply two coats to back of paneling and to end-grain surfaces. Concealed surfaces of plastic-laminate-clad woodwork do not require backpriming when surfaced with plastic laminate, backing paper, or thermoset decorative panels.
- E. Transparent Finish:
1. Grade: Custom.
 2. AWI Finish System: Conversion varnish or Catalyzed polyurethane.
 3. Staining: Match approved sample for color.
 4. Wash Coat for Stained Finish: Apply wash-coat sealer to woodwork made from closed-grain wood before staining and finishing.
 5. Open Finish for Open-Grain Woods: Do not apply filler to open-grain woods.
 6. Sheen: Satin, 31-45 or Semigloss, 46-60 gloss units measured on 60-degree gloss meter per ASTM D 523.
- F. Opaque Finish:
1. Grade: Custom.
 2. AWI Finish System: Conversion varnish Catalyzed polyurethane.
 3. Color: As selected by Architect from manufacturer's full range.
 4. Sheen: Satin, 31-45 or Semigloss, 46-60 gloss units measured on 60-degree gloss meter per ASTM D 523.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Before installation, condition woodwork to average prevailing humidity conditions in installation areas.
- B. Before installing architectural woodwork, examine shop-fabricated work for completion and complete work as required, including removal of packing and backpriming.

3.2 INSTALLATION

- A. Grade: Install woodwork to comply with requirements for the same grade specified in Part 2 for fabrication of type of woodwork involved.
- B. Assemble woodwork and complete fabrication at Project site to comply with requirements for fabrication in Part 2, to extent that it was not completed in the shop.
- C. Install woodwork level, plumb, true, and straight. Shim as required with concealed shims. Install level and plumb (including tops) to a tolerance of 1/8 inch in 96 inches (3 mm in 2400 mm).
- D. Scribe and cut woodwork to fit adjoining work, refinish cut surfaces, and repair damaged finish at cuts.

- E. Anchor woodwork to anchors or blocking built in or directly attached to substrates. Secure with countersunk, concealed fasteners and blind nailing as required for complete installation. Use fine finishing nails for exposed fastening, countersunk and filled flush with woodwork.
- F. Standing and Running Trim: Install with minimum number of joints possible, using full-length pieces (from maximum length of lumber available) to greatest extent possible. Do not use pieces less than 60 inches (1500 mm) long, except where shorter single-length pieces are necessary. Scarf running joints and stagger in adjacent and related members.
 - 1. Install standing and running trim with no more variation from a straight line than 1/8 inch in 96 inches (3 mm in 2400 mm).
- G. Cabinets: Install without distortion so doors and drawers fit openings properly and are accurately aligned. Adjust hardware to center doors and drawers in openings and to provide unencumbered operation. Complete installation of hardware and accessory items as indicated.
 - 1. Install cabinets with no more than 1/8 inch in 96-inch (3 mm in 2400-mm) sag, bow, or other variation from a straight line.
 - 2. Maintain veneer sequence matching of cabinets with transparent finish.
 - 3. Fasten wall cabinets through back, near top and bottom, at ends and not more than 16 inches (400 mm) o.c. with No. 10 wafer-head sheet metal screws through metal backing or metal framing behind wall finish.
- H. Countertops: Anchor securely by screwing through corner blocks of base cabinets or other supports into underside of countertop.
 - 1. Install countertops with no more than 1/8 inch in 96-inch (3 mm in 2400-mm) sag, bow, or other variation from a straight line.
- I. Touch up finishing work specified in this Section after installation of woodwork.

3.3 ADJUSTING AND CLEANING

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

END OF SECTION 064023

SECTION 077100 - ROOF SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

- 1. Roof-edge specialties.
- 2. Roof-edge drainage systems.

B. Related Requirements:

- 1. Division 01, High Performance Buildings Requirements Section for credits 6a-38k-4(d)9
 - a. The above listed HPB credits are related to this section. Other HPB credits may apply and shall be reviewed for their potential applicability and conformed with as though listed.
- 2. Section 061053 "Miscellaneous Rough Carpentry" for wood nailers, curbs, and blocking.
- 3. Section 076200 "Sheet Metal Flashing and Trim" for custom- and site-fabricated sheet metal flashing and trim.
- 4. Section 077200 "Roof Accessories" for set-on-type curbs, equipment supports, roof hatches, and other manufactured roof accessory units.
- 5. Section 079200 "Joint Sealants" for field-applied sealants between roof specialties and adjacent materials.
- 6. Section 079500 "Expansion Control" for manufactured sheet metal expansion-joint covers.

C. Preinstallation Conference: Conduct conference at Project site.

- 1. Conference to be held concurrently with preinstallation roofing conference. Refer to Section 075423 "Thermoplastic Polyolefin (TPO) Roofing" for requirements.
- 2. Meet with Owner, Architect, Owner's insurer if applicable, roofing-system testing and inspecting agency representative, roofing Installer, roofing-system manufacturer's representative, Installer, structural-support Installer, and installers whose work interfaces with or affects roof specialties, including installers of roofing materials and accessories.
- 3. Examine substrate conditions for compliance with requirements, including flatness and attachment to structural members.
- 4. Review special roof details, roof drainage, and condition of other construction that will affect roof specialties.

1.3 ACTION SUBMITTALS

- A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.
- B. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.
- C. Shop Drawings: For roof specialties.
 - 1. Include plans, elevations, expansion-joint locations, keyed details, and attachments to other work. Distinguish between plant- and field-assembled work.
 - 2. Include details for expansion and contraction; locations of expansion joints, including direction of expansion and contraction.
 - 3. Indicate profile and pattern of seams and layout of fasteners, cleats, clips, and other attachments.
 - 4. Detail termination points and assemblies, including fixed points.
 - 5. Include details of special conditions.
- D. Samples for Initial Selection: For each type of roof specialty indicated with factory-applied color finishes.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For manufacturer.
- B. Product Certificates: For each type of roof specialty.
- C. Product Test Reports: For roof-edge flashings, for tests performed by a qualified testing agency.
- D. Sample Warranty: For manufacturer's special warranty.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For Roof Specialties to include in emergency, operation, and maintenance manuals specified in Form 816 Article 1.20-1.08.14 subsection 2 and described in NOTICE TO CONTRACTOR - CLOSEOUT DOCUMENTS.
- B. Warranty: For Roof Specialties specified in Form 816 Article 1.20-1.06.08 and described in NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS.

1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A qualified manufacturer offering products meeting requirements that are FM Approvals listed for specified class.

- B. Source Limitations: Obtain roof specialties approved by manufacturer providing roofing-system warranty specified in Section 075423 “Thermoplastic Polyolefin (TPO) Roofing.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Do not store roof specialties in contact with other materials that might cause staining, denting, or other surface damage. Store roof specialties away from uncured concrete and masonry.
- B. Protect strippable protective covering on roof specialties from exposure to sunlight and high humidity, except to extent necessary for the period of roof-specialty installation.

1.8 FIELD CONDITIONS

- A. Field Measurements: Verify profiles and tolerances of roof-specialty substrates by field measurements before fabrication, and indicate measurements on Shop Drawings.
- B. Coordination: Coordinate roof specialties with flashing, trim, and construction of parapets, roof deck, roof and wall panels, and other adjoining work to provide a leakproof, secure, and noncorrosive installation.

1.9 WARRANTY

- A. Roofing-System Warranty: Roof specialties are included in warranty provisions in Section 075423 “Thermoplastic Polyolefin (TPO) Roofing.
- B. Special Warranty on Painted Finishes: Manufacturer agrees to repair finish or replace roof specialties that show evidence of deterioration of factory-applied finishes within specified warranty period.
 - 1. Fluoropolymer Finish: Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
 - b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
 - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
 - 2. Finish Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. General Performance: Roof specialties shall withstand exposure to weather and resist thermally induced movement without failure, rattling, leaking, or fastener disengagement due to defective manufacture, fabrication, installation, or other defects in construction.

- B. FM Approvals' Listing: Manufacture and install roof-edge specialties that are listed in FM Approvals' "RoofNav" and FM Global Loss Prevention Data Sheet 1-49 and approved for windstorm classification, Class 1-60. Identify materials with FM Approvals' markings.
- C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes to prevent buckling, opening of joints, hole elongation, overstressing of components, failure of joint sealants, failure of connections, and other detrimental effects. Provide clips that resist rotation and avoid shear stress as a result of thermal movements. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
 - 1. Temperature Change (Range): 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

2.2 ROOF-EDGE SPECIALTIES

- A. Roof-Edge Fascia: Manufactured, two-piece, roof-edge fascia consisting of snap-on metal fascia cover in section lengths not exceeding 12 feet (3.6 m) and a continuous formed galvanized-steel cleat, 0.028 inch (0.71 mm) thick, minimum, with extended vertical leg terminating in a drip-edge cleat. Provide matching corner units.
 - 1. Basis-of-Design Product: Subject to compliance with requirements, provide Edge Systems One Gravel Stop; Metal Era, Inc.
 - 2. Extruded-Aluminum Fascia Covers: Extruded aluminum, Min. 0.080 inch (2.03 mm) thick.
 - a. Finish: Two-coat fluoropolymer.
 - b. Color: Custom color, as selected by Architect..
 - 3. Corners: Factory mitered and continuously welded.
 - 4. Splice Plates: Concealed, of same material, finish, and shape as fascia cover.
 - 5. Height: 6 ½ inches.

2.3 ROOF-EDGE DRAINAGE SYSTEMS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Hickman Company, W. P.
 - 2. Metal-Era, Inc.
 - 3. Perimeter Systems; a division of Southern Aluminum Finishing Company, Inc.
- B. Gutters: Manufactured in uniform section lengths not exceeding 12 feet (3.6 m), with matching corner units, ends, outlet tubes, and other accessories. Elevate back edge at least 1 inch (25 mm) above front edge. Furnish flat-stock gutter straps, gutter brackets, expansion joints, and expansion-joint covers fabricated from same metal as gutters.
 - 1. Aluminum Sheet: 0.050 inch (1.27 mm) thick.
 - 2. Gutter Profile: Style A according to SMACNA's "Architectural Sheet Metal Manual."

3. Corners: Factory mitered and continuously welded.
 4. Gutter Supports: Straps with finish matching the gutters.
- C. Downspouts: Plain rectangular complete with mitered elbows, manufactured from the following exposed metal. Furnish with metal hangers, from same material as downspouts, and anchors.
1. Formed Aluminum: 0.050 inch (1.27 mm) thick.
- D. Aluminum Finish: Two-coat fluoropolymer.
1. Color: Custom color, as selected by Architect..

2.4 REGLETS AND COUNTERFLASHINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Fry Reglet Corporation.
 2. Hickman Company, W. P.
 3. Metal-Era, Inc.
- B. Reglets: Manufactured units formed to provide secure interlocking of separate reglet and counterflashing pieces, from the following exposed metal:
1. Formed Aluminum: 0.050 inch (1.27 mm) thick.
 2. Corners: Factory mitered and continuously welded.
 3. Surface-Mounted Type: Provide reglets with slotted holes for fastening to substrate, with neoprene or other suitable weatherproofing washers, and with channel for sealant at top edge.
 4. Stucco Type, Embedded: Provide reglets with upturned fastening flange and extension leg of length to match thickness of applied finish materials.
 5. Concrete Type, Embedded: Provide temporary closure tape to keep reglet free of concrete materials, special fasteners for attaching reglet to concrete forms, and guides to ensure alignment of reglet section ends.
 6. Masonry Type, Embedded: Provide reglets with offset top flange for embedment in masonry mortar joint.
- C. Counterflashings: Manufactured units of heights to overlap top edges of base flashings by 4 inches (100 mm) and in lengths not exceeding 12 feet (3.6 m) designed to snap into reglets or through-wall-flashing receiver and compress against base flashings with joints lapped, from the following exposed metal:
1. Formed Aluminum: 0.032 inch (0.81 mm) thick.
- D. Accessories:
1. Flexible-Flashing Retainer: Provide resilient plastic or rubber accessory to secure flexible flashing in reglet where clearance does not permit use of standard metal counterflashing or where reglet is provided separate from metal counterflashing.

2. Counterflashing Wind-Restraint Clips: Provide clips to be installed before counterflashing to prevent wind uplift of counterflashing lower edge.

2.5 MATERIALS

- A. Zinc-Coated (Galvanized) Steel Sheet: ASTM A 653/A 653M, G90 (Z275) coating designation.
- B. Aluminum Sheet: ASTM B 209 (ASTM B 209M), alloy as standard with manufacturer for finish required, with temper to suit forming operations and performance required.
- C. Aluminum Extrusions: ASTM B 221 (ASTM B 221M), alloy and temper recommended by manufacturer for type of use and finish indicated, finished as follows:

2.6 UNDERLAYMENT MATERIALS

- A. Self-Adhering, High-Temperature Sheet: Minimum 30 to 40 mils (0.76 to 1.0 mm) thick, consisting of slip-resisting polyethylene-film top surface laminated to layer of butyl or SBS-modified asphalt adhesive, with release-paper backing; cold applied. Provide primer when recommended by underlayment manufacturer.
 1. Thermal Stability: ASTM D 1970/D 1970M; stable after testing at 240 deg F (116 deg C).
 2. Low-Temperature Flexibility: ASTM D 1970/D 1970M; passes after testing at minus 20 deg F (29 deg C).
 3. Products: Subject to compliance with requirements, provide one of the following:
 - a. Carlisle Coatings & Waterproofing; CCW WIP 300HT.
 - b. Henry Company; Blueskin PE200 HT.
 - c. Owens Corning; WeatherLock Metal High Temperature Underlayment.
- B. Felt: ASTM D 226/D 226M, Type II (No. 30), asphalt-saturated organic felt, nonperforated.
- C. Slip Sheet: Rosin-sized building paper, 3-lb/100 sq. ft. (0.16-kg/sq. m) minimum.

2.7 MISCELLANEOUS MATERIALS

- A. Fasteners: Manufacturer's recommended fasteners, suitable for application and designed to meet performance requirements. Furnish the following unless otherwise indicated:
 1. Exposed Penetrating Fasteners: Gasketed screws with hex washer heads matching color of sheet metal.
 2. Fasteners for Aluminum: Aluminum or Series 300 stainless steel.
 3. Fasteners for Zinc-Coated (Galvanized) Steel Sheet: Series 300 stainless steel or hot-dip zinc-coated steel according to ASTM A 153/A 153M or ASTM F 2329.
- B. Elastomeric Sealant: ASTM C 920, elastomeric silicone polymer sealant of type, grade, class, and use classifications required by roofing-specialty manufacturer for each application.

- C. Butyl Sealant: ASTM C 1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for hooked-type joints with limited movement.
- D. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D 1187/D 1187M.
- E. Asphalt Roofing Cement: ASTM D 4586, asbestos free, of consistency required for application.

2.8 FINISHES

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Protect mechanical and painted finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- C. Appearance of Finished Work: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.
- D. Coil-Coated Aluminum Sheet Finishes:
 - 1. High-Performance Organic Finish: Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 - a. Two-Coat Fluoropolymer: AAMA 2605. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 - b. Concealed Surface Finish: Apply pretreatment and manufacturer's standard acrylic or polyester backer finish consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil (0.013 mm).
- E. Aluminum Extrusion Finishes:
 - 1. High-Performance Organic Finish: Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 - a. Two-Coat Fluoropolymer: AAMA 2605. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 - b. Concealed Surface Finish: Apply pretreatment and manufacturer's standard acrylic or polyester backer finish consisting of prime coat and wash coat with a minimum total dry film thickness of 0.5 mil (0.013 mm).

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions, and other conditions affecting performance of the Work.
- B. Examine walls, roof edges, and parapets for suitable conditions for roof specialties.
- C. Verify that substrate is sound, dry, smooth, clean, sloped for drainage where applicable, and securely anchored.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 UNDERLAYMENT INSTALLATION

- A. Self-Adhering Sheet Underlayment: Apply primer if required by manufacturer. Comply with temperature restrictions of underlayment manufacturer for installation. Apply wrinkle free, in shingle fashion to shed water, and with end laps of not less than 6 inches (152 mm) staggered 24 inches (610 mm) between courses. Overlap side edges not less than 3-1/2 inches (90 mm). Roll laps with roller. Cover underlayment within 14 days.
 - 1. Apply continuously under roof-edge specialties and reglets and counterflashings.
 - 2. Coordinate application of self-adhering sheet underlayment under roof specialties with requirements for continuity with adjacent air barrier materials.
- B. Felt Underlayment: Install with adhesive for temporary anchorage to minimize use of mechanical fasteners under roof specialties. Apply in shingle fashion to shed water, with lapped joints of not less than 2 inches (50 mm).
- C. Slip Sheet: Install with tape or adhesive for temporary anchorage to minimize use of mechanical fasteners under roof specialties. Apply in shingle fashion to shed water, with lapped joints of not less than 2 inches (50 mm).

3.3 INSTALLATION, GENERAL

- A. General: Install roof specialties according to manufacturer's written instructions. Anchor roof specialties securely in place, with provisions for thermal and structural movement. Use fasteners, protective coatings, separators, underlayments, sealants, and other miscellaneous items as required to complete roof-specialty systems.
 - 1. Install roof specialties level, plumb, true to line and elevation; with limited oil-canning and without warping, jogs in alignment, buckling, or tool marks.
 - 2. Provide uniform, neat seams with minimum exposure of solder and sealant.
 - 3. Install roof specialties to fit substrates and to result in weathertight performance. Verify shapes and dimensions of surfaces to be covered before manufacture.
 - 4. Torch cutting of roof specialties is not permitted.
 - 5. Do not use graphite pencils to mark metal surfaces.
- B. Metal Protection: Protect metals against galvanic action by separating dissimilar metals from contact with each other or with corrosive substrates by painting contact surfaces with bituminous coating or by other permanent separation as recommended by manufacturer.

1. Coat concealed side of uncoated aluminum roof specialties with bituminous coating where in contact with wood, ferrous metal, or cementitious construction.
 2. Bed flanges in thick coat of asphalt roofing cement where required by manufacturers of roof specialties for waterproof performance.
- C. Expansion Provisions: Allow for thermal expansion of exposed roof specialties.
1. Space movement joints at a maximum of 12 feet (3.6 m) with no joints within 18 inches (450 mm) of corners or intersections unless otherwise indicated on Drawings.
 2. When ambient temperature at time of installation is between 40 and 70 deg F (4 and 21 deg C), set joint members for 50 percent movement each way. Adjust setting proportionately for installation at higher ambient temperatures.
- D. Fastener Sizes: Use fasteners of sizes that penetrate substrate not less than recommended by fastener manufacturer to achieve maximum pull-out resistance.
- E. Seal concealed joints with butyl sealant as required by roofing-specialty manufacturer.
- F. Seal joints as required for weathertight construction. Place sealant to be completely concealed in joint. Do not install sealants at temperatures below 40 deg F (4 deg C).

3.4 ROOF-EDGE SPECIALITIES INSTALLATION

- A. Install cleats, cants, and other anchoring and attachment accessories and devices with concealed fasteners.
- B. Anchor roof edgings with manufacturer's required devices, fasteners, and fastener spacing to meet performance requirements.

3.5 ROOF-EDGE DRAINAGE-SYSTEM INSTALLATION

- A. General: Install components to produce a complete roof-edge drainage system according to manufacturer's written instructions. Coordinate installation of roof perimeter flashing with installation of roof-edge drainage system.
- B. Gutters: Join and seal gutter lengths. Allow for thermal expansion. Attach gutters to firmly anchored gutter supports spaced not more than 24 inches (610 mm) apart. Attach ends with rivets and seal with sealant to make watertight. Slope to downspouts.
 1. Install gutter with expansion joints at locations indicated but not exceeding 50 feet (15.2 m) apart. Install expansion-joint caps.
 2. Install continuous leaf guards on gutters with noncorrosive fasteners, hinged to swing open for cleaning gutters.
- C. Downspouts: Join sections with manufacturer's standard telescoping joints. Provide hangers with fasteners designed to hold downspouts securely to walls and 1 inch (25 mm) away from walls; locate fasteners at top and bottom and at approximately 30 inches (750 mm) o.c.
 1. Provide elbows at base of downspouts at grade to direct water away from building.

3.6 CLEANING AND PROTECTION

- A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.
- B. Clean and neutralize flux materials. Clean off excess solder and sealants.
- C. Remove temporary protective coverings and strippable films as roof specialties are installed. On completion of installation, clean finished surfaces, including removing unused fasteners, metal filings, pop rivet stems, and pieces of flashing. Maintain roof specialties in a clean condition during construction.
- D. Replace roof specialties that have been damaged or that cannot be successfully repaired by finish touchup or similar minor repair procedures.

END OF SECTION 077100

SECTION 077200 - ROOF ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Equipment supports.
2. Roof hatches.
3. Pipe supports.
4. Preformed flashing sleeves.
5. Precast concrete splashblock.

B. Related Sections:

1. Division 01, High Performance Buildings Requirements Section for credits 16a-38k-4(b)4.
 - a. The above listed HPB credits are related to this section. Other HPB credits may apply and shall be reviewed for their potential applicability and conformed with as though listed.
2. Section 055100 "Metal Stairs" for stairs for access to roof hatches.
3. Section 076200 "Sheet Metal Flashing and Trim" for shop- and field-formed metal flashing, roof-drainage systems, and miscellaneous sheet metal trim and accessories.
4. Section 077100 "Roof Specialties" for manufactured fasciae, copings, gravel stops, and counterflashing.
5. Section 086200 "Unit Skylights" for skylights mounted on site erected curbs.

1.3 PERFORMANCE REQUIREMENTS

- A. General Performance: Roof accessories shall withstand exposure to weather and resist thermally induced movement without failure, rattling, leaking, or fastener disengagement due to defective manufacture, fabrication, installation, or other defects in construction.

1.4 ACTION SUBMITTALS

- A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.
- B. Product Data: For each type of roof accessory indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

- C. Shop Drawings: For roof accessories. Include plans, elevations, keyed details, and attachments to other work. Indicate dimensions, loadings, and special conditions. Distinguish between plant- and field-assembled work.
- D. Samples: For each exposed product and for each color and texture specified, prepared on Samples of size to adequately show color.

1.5 INFORMATIONAL SUBMITTALS

- A. Warranty: Sample of special warranty.

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For Roof Accessories to include in emergency, operation, and maintenance manuals specified in Form 816 Article 1.20-1.08.14 subsection 2 and described in NOTICE TO CONTRACTOR - CLOSEOUT DOCUMENTS.
- B. Warranty: For Roof Accessories specified in Form 816 Article 1.20-1.06.08 and described in NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS.

1.7 QUALITY ASSURANCE SUBMITTALS

- A. Manufacturers Certification Letter in accordance with NOTICE TO CONTRACTOR – POTENTIAL FOR ASBESTOS CONTAINING MATERIALS.

1.8 COORDINATION

- A. Coordinate layout and installation of roof accessories with roofing membrane and base flashing and interfacing and adjoining construction to provide a leak-proof, weather-tight, secure, and noncorrosive installation.
- B. Coordinate dimensions with rough-in information or Shop Drawings of equipment to be supported.

1.9 WARRANTY

- A. Special Warranty on Painted Finishes: Manufacturer's standard form in which manufacturer agrees to repair finishes or replace roof accessories that show evidence of deterioration of factory-applied finishes within specified warranty period.
 - 1. Fluoropolymer Finish: Deterioration includes, but is not limited to, the following:
 - a. Color fading more than 5 Hunter units when tested according to ASTM D 2244.
 - b. Chalking in excess of a No. 8 rating when tested according to ASTM D 4214.
 - c. Cracking, checking, peeling, or failure of paint to adhere to bare metal.
 - 2. Finish Warranty Period: 20 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 METAL MATERIALS

- A. Aluminum Sheet: ASTM B 209 (ASTM B 209M), manufacturer's standard alloy for finish required, with temper to suit forming operations and performance required.
 - 1. Exposed Coil-Coated Finish: Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
 - a. Two-Coat Fluoropolymer Finish: AAMA 620. System consisting of primer and fluoropolymer color topcoat containing not less than 70 percent PVDF resin by weight.
 - 2. Concealed Finish: Pretreat with manufacturer's standard white or light-colored acrylic or polyester-backer finish consisting of prime coat and wash coat, with a minimum total dry film thickness of 0.5 mil (0.013 mm).
- B. Aluminum Extrusions and Tubes: ASTM B 221 (ASTM B 221M), manufacturer's standard alloy and temper for type of use, finished to match assembly where used, otherwise mill finished.
- C. Stainless-Steel Sheet and Shapes: ASTM A 240/A 240M or ASTM A 666, Type 304.
- D. Steel Shapes: ASTM A 36/A 36M, hot-dip galvanized according to ASTM A 123/A 123M unless otherwise indicated.
- E. Steel Tube: ASTM A 500, round tube.
- F. Galvanized-Steel Tube: ASTM A 500, round tube, hot-dip galvanized according to ASTM A 123/A 123M.
- G. Steel Pipe: ASTM A 53/A 53M, galvanized.

2.2 MISCELLANEOUS MATERIALS

- A. General: Provide materials and types of fasteners, protective coatings, sealants, and other miscellaneous items required by manufacturer for a complete installation.
- B. Glass-Fiber Board Insulation: ASTM C 726, thickness as indicated.
- C. Wood Nailers: Softwood lumber, pressure treated with waterborne preservatives for aboveground use, acceptable to authorities having jurisdiction, containing no arsenic or chromium, and complying with AWPA C2; not less than 1-1/2 inches (38 mm) thick.
- D. Bituminous Coating: Cold-applied asphalt emulsion complying with ASTM D 1187.
- E. Fasteners: Roof accessory manufacturer's recommended fasteners suitable for application and metals being fastened. Match finish of exposed fasteners with finish of material being fastened. Provide nonremovable fastener heads to exterior exposed fasteners. Furnish the following unless otherwise indicated:

1. Fasteners for Zinc-Coated or Aluminum-Zinc Alloy-Coated Steel: Series 300 stainless steel or hot-dip zinc-coated steel according to ASTM A 153/A 153M or ASTM F 2329.
 2. Fasteners for Aluminum Sheet: Aluminum or Series 300 stainless steel.
 3. Fasteners for Copper Sheet: Copper, hardware bronze, or passivated Series 300 stainless steel.
 4. Fasteners for Stainless-Steel Sheet: Series 300 stainless steel.
- F. Gaskets: Manufacturer's standard tubular or fingered design of neoprene, EPDM, PVC, or silicone or a flat design of foam rubber, sponge neoprene, or cork.
- G. Elastomeric Sealant: ASTM C 920, elastomeric polyurethane or silicone polymer sealant as recommended by roof accessory manufacturer for installation indicated; low modulus; of type, grade, class, and use classifications required to seal joints and remain watertight.
- H. Butyl Sealant: ASTM C 1311, single-component, solvent-release butyl rubber sealant; polyisobutylene plasticized; heavy bodied for expansion joints with limited movement.
- I. Asphalt Roofing Cement: ASTM D 4586, asbestos free, of consistency required for application.

2.3 EQUIPMENT SUPPORTS

- A. Equipment Supports: Internally reinforced metal equipment supports capable of supporting superimposed live and dead loads, including equipment loads and other construction indicated on Drawings; with welded or mechanically fastened and sealed corner joints, integral metal cant, and stepped integral metal cant raised the thickness of roof insulation, and integrally formed deck-mounting flange at perimeter bottom.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Greenheck Fan Corporation.
 - b. LM Curbs.
 - c. Milcor Inc.; Commercial Products Group of Hart & Cooley, Inc.
- B. Size: Coordinate dimensions with roughing-in information or Shop Drawings of equipment to be supported.
- C. Loads: Refer to drawings.
- D. Material: Aluminum sheet, 0.090 inch (2.28 mm) thick.
1. Finish: Two-coat fluoropolymer .
 2. Color: As selected by Architect from manufacturer's full range.
- E. Construction:
1. Insulation: Factory insulated with 1-1/2-inch- (38-mm-) thick glass-fiber board insulation.
 2. Liner: Same material as equipment support, of manufacturer's standard thickness and finish.

3. Factory-installed continuous wood nailers 3-1/2 inches (90 mm) wide at tops of equipment supports.
4. Metal Counterflashing: Manufacturer's standard, removable, fabricated of same metal and finish as equipment support.
5. On ribbed or fluted metal roofs, form deck-mounting flange at perimeter bottom to conform to roof profile.
6. Fabricate equipment supports to minimum height of 12 inches (300 mm) unless otherwise indicated.
7. Sloping Roofs: Where roof slope exceeds 1:48, fabricate each support with height to accommodate roof slope so that tops of supports are level with each other. Equip supports with water diverters or crickets on sides that obstruct water flow.

2.4 ROOF HATCH

- A. Roof Hatches: Metal roof-hatch units with lids and insulated double-walled curbs, welded or mechanically fastened and sealed corner joints, continuous lid-to-curb counterflashing and weathertight perimeter gasketing, integral metal cant, stepped integral metal cant raised the thickness of roof insulation, and integrally formed deck-mounting flange at perimeter bottom.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Babcock-Davis.
 - b. Bilco Company (The).
 - c. Nystrom.
- B. Type and Size: Single-leaf lid, 36 by 96 inches (900 by 2440 mm).
- C. Loads: Minimum 40-lbf/sq. ft. (1.9-kPa) external live load and 20-lbf/sq. ft. (0.95-kPa) internal uplift load.
- D. Hatch Material: Aluminum sheet, 0.090 inch (2.28 mm) thick.
 1. Finish: Two-coat fluoropolymer.
 2. Color: As selected by Architect from manufacturer's full range.
- E. Construction:
 1. Insulation: Glass-fiber board.
 2. Hatch Lid: Opaque, insulated, and double walled, with manufacturer's standard metal liner of same material and finish as outer metal lid.
 3. Curb Liner: Manufacturer's standard, of same material and finish as metal curb.
 4. On ribbed or fluted metal roofs, form flange at perimeter bottom to conform to roof profile.
 5. Fabricate curbs to minimum height of 12 inches (300 mm) unless otherwise indicated.
- F. Hardware: Galvanized-steel spring latch with turn handles, butt- or pintle-type hinge system, and padlock hasps inside and outside.
 1. Provide two-point latch on lids larger than 84 inches (2130 mm).

2.5 PIPE SUPPORTS

- A. Pipe Supports: Adjustable-height, extruded-aluminum tube, filled with urethane insulation; 2 inches (50 mm) in diameter; with aluminum baseplate, EPDM base seal, manufacturer's recommended hardware for mounting to structure or structural roof deck as indicated, and extruded-aluminum carrier assemblies; suitable for quantity of pipe runs and sizes.
1. Basis-of-Design Manufacturers: Subject to compliance with requirements, provide products by Thaler Metal USA Inc.
 2. Pipe Support Height: As indicated on Drawings.
 3. Roller Assembly: With stainless-steel roller, sized for supported pipes.
 4. Pipe Support Flashing: Manufacturer's standard insulated sleeve flashing with integral base flange; aluminum sheet, 0.063 inch (1.60 mm) thick.
 5. Finish: Manufacturer's standard.
- B. Light-Duty Pipe Supports: Extruded-aluminum base assembly and Type 304 stainless-steel roller assembly for pipe sizes indicated, including manufacturer's recommended load-distributing baseplate.
1. Basis-of-Design Manufacturers: Subject to compliance with requirements, provide products by Thaler Metal USA Inc.
 2. Finish: Manufacturer's standard

2.6 PRECAST CONCRETE SPLASHBLOCK

- A. Precast Concrete Splash Block: Manufacturers standard profile and the following:
- a. Basis-of-Design Manufacturers: Subject to compliance with requirements, provide products by Modern Precast Inc.
 2. Size: 30 inches long by 12 inches wide by 1 1/8 inches thick (3 inches at deepest)
 - Cement: Portland cement, Type 1 or 2 conforming to ASTM C 150.
 3. Aggregates: Course and fine conforming to ASTM C 33.
 4. Admixtures: ASTM C 494.
 5. Water: Potable.
 6. Pigments: Bayferrox inorganic, synthetic iron oxide pigments, lime proof and non-fading conforming to ASTM C 979.
 7. Reinforcing Steel: Conform to ASTM 615 and deformation to ASTM M 305.
 8. Compressive Strength: Min. 4000 psi
 9. Color: As selected by Architect from manufacturer's full range.

2.7 PREFORMED FLASHING SLEEVES

- A. Exhaust Vent Flashing: Double-walled metal flashing sleeve or boot, insulation filled, with integral deck flange, 12 inches (300 mm) high, with removable metal hood and slotted metal collar.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Custom Solution Roof and Metal Products.
 - b. Milcor Inc.; Commercial Products Group of Hart & Cooley, Inc.
 - c. Thaler Metal USA Inc.
- 2. Metal: Aluminum sheet, 0.063 inch (1.60 mm) thick.
 - 3. Diameter: As indicated.
 - 4. Finish: Manufacturer's standard.
- B. Vent Stack Flashing: Metal flashing sleeve, uninsulated, with integral deck flange.
- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Custom Solution Roof and Metal Products.
 - b. Milcor Inc.; Commercial Products Group of Hart & Cooley, Inc.
 - c. Thaler Metal USA Inc.
 - 2. Metal: Aluminum sheet, 0.063 inch (1.60 mm) thick.
 - 3. Height: 13 inches (330 mm).
 - 4. Diameter: As indicated.
 - 5. Finish: Manufacturer's standard.

2.8 GENERAL FINISH REQUIREMENTS

- A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
- B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, to verify actual locations, dimensions, and other conditions affecting performance of the Work.
- B. Verify that substrate is sound, dry, smooth, clean, sloped for drainage, and securely anchored.
- C. Verify dimensions of roof openings for roof accessories.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. General: Install roof accessories according to manufacturer's written instructions.

1. Install roof accessories level, plumb, true to line and elevation, and without warping, jogs in alignment, excessive oil canning, buckling, or tool marks.
 2. Anchor roof accessories securely in place so they are capable of resisting indicated loads.
 3. Use fasteners, separators, sealants, and other miscellaneous items as required to complete installation of roof accessories and fit them to substrates.
 4. Install roof accessories to resist exposure to weather without failing, rattling, leaking, or loosening of fasteners and seals.
- B. Metal Protection: Protect metals against galvanic action by separating dissimilar metals from contact with each other or with corrosive substrates by painting contact surfaces with bituminous coating or by other permanent separation as recommended by manufacturer.
1. Coat concealed side of uncoated aluminum and stainless-steel roof accessories with bituminous coating where in contact with wood, ferrous metal, or cementitious construction.
 2. Bed flanges in thick coat of asphalt roofing cement where required by manufacturers of roof accessories for waterproof performance.
- C. Equipment Support Installation: Install equipment supports so top surfaces are level with each other.
- D. Roof-Hatch Installation:
1. Install roof hatch so top surface of hatch curb is level.
 2. Verify that roof hatch operates properly. Clean, lubricate, and adjust operating mechanism and hardware.
 3. Attach safety railing system to roof-hatch curb.
 4. Attach ladder-assist post according to manufacturer's written instructions.
- E. Pipe Support Installation: Install pipe supports so top surfaces are in contact with and provide equally distributed support along length of supported item.
- F. Preformed Flashing-Sleeve Installation: Secure flashing sleeve to roof membrane according to flashing-sleeve manufacturer's written instructions.
- G. Seal joints with elastomeric or butyl sealant as required by roof accessory manufacturer.
- 3.3 REPAIR AND CLEANING
- A. Clean exposed surfaces according to manufacturer's written instructions.
 - B. Clean off excess sealants.
 - C. Replace roof accessories that have been damaged or that cannot be successfully repaired by finish touchup or similar minor repair procedures.

END OF SECTION 077200

SECTION 088000 - GLAZING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes glazing for the following products and applications, including those specified in other Sections where glazing requirements are specified by reference to this Section:

1. Windows.
2. Doors.
3. Glazed curtain walls.
4. Storefront framing.
5. Glazed entrances.
6. Interior borrowed lites.
7. Vacuum Insulation Panel.

- B. Related Sections:

1. Division 01, High Performance Buildings Requirements Section for credits 16a-38k-4(b)4 and 16a-38k-4(b)5
 - a. The above listed HPB credits are related to this section. Other HPB credits may apply and shall be reviewed for their potential applicability and conformed with as though listed.
2. Section 086200 "Unit Skylights" for glazing in unit skylights
3. Section 088300 "Mirrors."
4. Section 088853 "Security Glazing" for glazing units resistant to ballistic attacks.

1.3 DEFINITIONS

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

1.4 PERFORMANCE REQUIREMENTS

- A. General: Installed glazing systems shall withstand normal thermal movement and wind and impact loads (where applicable) without failure, including loss or glass breakage attributable to the following: defective manufacture, fabrication, or installation; failure of sealants or gaskets to remain watertight and airtight; deterioration of glazing materials; or other defects in construction.
- B. Delegated Design: Design glass, including comprehensive engineering analysis according to ASTM E 1300 by a qualified professional engineer, licensed in the State of Connecticut, using the following design criteria:
 - 1. Design Wind Pressures: As indicated on Structural Drawings.
 - 2. Design Snow Loads: As indicated on Structural Drawings.
 - 3. Vertical Glazing: For glass surfaces sloped 15 degrees or less from vertical, design glass to resist design wind pressure based on glass type factors for short-duration load.
 - 4. Glass Type Factors for Acid Etched Glass:
 - a. Short-Duration Glass Type Factor for Acid Etched: 0.5.
 - 5. Maximum Lateral Deflection: For glass supported on all four edges, limit center-of-glass deflection at design wind pressure to not more than 1/50 times the short-side length or 1 inch (25 mm), whichever is less.
 - 6. Differential Shading: Design glass to resist thermal stresses induced by differential shading within individual glass lites.
- C. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on glass framing members and glazing components.
 - 1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

1.5 ACTION SUBMITTALS

- A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.
- B. Product Data: For each glass product and glazing material indicated.
- C. Glass Samples: For each type of glass product other than clear monolithic vision glass; 12 inches (300 mm) square.
- D. Glazing Accessory Samples: For gaskets, sealants and colored spacers, in 12-inch (300-mm) lengths. Install sealant Samples between two strips of material representative in color of the adjoining framing system.
- E. Glazing Schedule: List glass types and thicknesses for each size opening and location. Use same designations indicated on Drawings.

- F. Delegated-Design Submittal: For glass indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer, licensed in the State of Connecticut, responsible for their preparation.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For installers manufacturers of insulating-glass units with sputter-coated, low-e coatings, glass testing agency and] sealant testing agency.
- B. Product Certificates: For glass and glazing products, from manufacturer.
- C. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for coated glass, insulating glass, glazing sealants and glazing gaskets.
 - 1. For glazing sealants, provide test reports based on testing current sealant formulations within previous 36-month period.
- D. Preconstruction adhesion and compatibility test report.
- E. Warranties: Sample of special warranties.

1.7 QUALITY ASSURANCE SUBMITTALS

- A. Manufacturers Certification Letter in accordance with NOTICE TO CONTRACTOR – POTENTIAL FOR ASBESTOS CONTAINING MATERIALS.

1.8 CLOSEOUT SUBMITTALS

- A. Warranty: For Glazing specified in Form 816 Article 1.20-1.06.08 and described in NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS.

1.9 QUALITY ASSURANCE

- A. Manufacturer Qualifications for Insulating-Glass Units with Sputter-Coated, Low-E Coatings: A qualified insulating-glass manufacturer who is approved and certified by coated-glass manufacturer.
- B. Installer Qualifications: A qualified installer who employs glass installers for this Project who are certified under the National Glass Association's Certified Glass Installer Program.
- C. Glass Testing Agency Qualifications: A qualified independent testing agency accredited according to the NFRC CAP 1 Certification Agency Program.
- D. Sealant Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 to conduct the testing indicated.
- E. Source Limitations for Glass: Obtain coated float glass, laminated glass and insulating glass from single source from single manufacturer for each glass type.

- F. Source Limitations for Glazing Accessories: Obtain from single source from single manufacturer for each product and installation method.
 - G. Glazing Publications: Comply with published recommendations of glass product manufacturers and organizations below, unless more stringent requirements are indicated. Refer to these publications for glazing terms not otherwise defined in this Section or in referenced standards.
 - 1. GANA Publications: GANA's "Laminated Glazing Reference Manual" and GANA's "Glazing Manual."
 - 2. IGMA Publication for Insulating Glass: SIGMA TM-3000, "North American Glazing Guidelines for Sealed Insulating Glass Units for Commercial and Residential Use."
 - H. Safety Glazing Labeling: Where safety glazing labeling is indicated, permanently mark glazing with certification label of the manufacturer. Label shall indicate manufacturer's name, type of glass, thickness, and safety glazing standard with which glass complies.
 - I. Fire-Protection-Rated Glazing Labeling: Permanently mark fire-protection-rated glazing with certification label of a testing agency acceptable to authorities having jurisdiction. Label shall indicate manufacturer's name, test standard, whether glazing is for use in fire doors or other openings, whether or not glazing passes hose-stream test, whether or not glazing has a temperature rise rating of 450 deg F (250 deg C), and the fire-resistance rating in minutes.
 - J. Insulating-Glass Certification Program: Permanently marked either on spacers or on at least one component lite of units with appropriate certification label of IGCC.
 - K. Mockups: Build mockups to verify selections made under sample submittals and to demonstrate aesthetic effects and set quality standards for materials and execution.
 - 1. Install glazing in mockups specified in Section 084113 "Aluminum-Framed Entrances and Storefronts" and Section 084413 "Glazed Aluminum Curtain Walls" to match glazing systems required for Project, including glazing methods.
 - 2. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
 - L. Preinstallation Conference: Conduct conference at Project site.
 - 1. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
 - 2. Review temporary protection requirements for glazing during and after installation.
- 1.10 DELIVERY, STORAGE, AND HANDLING
- A. Protect glazing materials according to manufacturer's written instructions. Prevent damage to glass and glazing materials from condensation, temperature changes, direct exposure to sun, or other causes.
 - B. Comply with insulating-glass manufacturer's written recommendations for venting and sealing units to avoid hermetic seal ruptures due to altitude change.

1.11 PROJECT CONDITIONS

- A. Environmental Limitations: Do not proceed with glazing when ambient and substrate temperature conditions are outside limits permitted by glazing material manufacturers and when glazing channel substrates are wet from rain, frost, condensation, or other causes.
 - 1. Do not install glazing sealants when ambient and substrate temperature conditions are outside limits permitted by sealant manufacturer or below 40 deg F (4.4 deg C).

1.12 WARRANTY

- A. Manufacturer's Special Warranty for Coated-Glass Products: Manufacturer's standard form in which coated-glass manufacturer agrees to replace coated-glass units that deteriorate within specified warranty period. Deterioration of coated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning coated glass contrary to manufacturer's written instructions. Defects include peeling, cracking, and other indications of deterioration in coating.
 - 1. Warranty Period: 10 years from date of Substantial Completion.
- B. Manufacturer's Special Warranty on Laminated Glass: Manufacturer's standard form in which laminated-glass manufacturer agrees to replace laminated-glass units that deteriorate within specified warranty period. Deterioration of laminated glass is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning laminated glass contrary to manufacturer's written instructions. Defects include edge separation, delamination materially obstructing vision through glass, and blemishes exceeding those allowed by referenced laminated-glass standard.
 - 1. Warranty Period: Five years from date of Substantial Completion.
- C. Manufacturer's Special Warranty on Insulating Glass: Manufacturer's standard form in which insulating-glass manufacturer agrees to replace insulating-glass units that deteriorate within specified warranty period. Deterioration of insulating glass is defined as failure of hermetic seal under normal use that is not attributed to glass breakage or to maintaining and cleaning insulating glass contrary to manufacturer's written instructions. Evidence of failure is the obstruction of vision by dust, moisture, or film on interior surfaces of glass.
 - 1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GLASS PRODUCTS, GENERAL

- A. Thickness: Where glass thickness is indicated, it is a minimum. Provide glass lites in thicknesses as needed to comply with requirements indicated.
 - 1. Minimum Glass Thickness for Exterior Lites: Not less than 6.0 mm.

- B. Strength: Where float glass is indicated, provide annealed float glass, Kind HS heat-treated float glass, or Kind FT heat-treated float glass as needed to comply with "Performance Requirements" Article. Where heat-strengthened glass is indicated, provide Kind HS heat-treated float glass or Kind FT heat-treated float glass as needed to comply with "Performance Requirements" Article. Where fully tempered glass is indicated, provide Kind FT heat-treated float glass.
- C. Thermal and Optical Performance Properties: Provide glass with performance properties specified, as indicated in manufacturer's published test data, based on procedures indicated below:
1. For monolithic-glass lites, properties are based on units with lites 6.0 mm thick.
 2. For laminated-glass lites, properties are based on products of construction indicated.
 3. For insulating-glass units, properties are based on units of thickness indicated for overall unit and for each lite.
 4. U-Factors: Center-of-glazing values, according to NFRC 100 and based on LBL's WINDOW 5.2 computer program, expressed as Btu/sq. ft. x h x deg F (W/sq. m x K).
 5. Solar Heat-Gain Coefficient and Visible Transmittance: Center-of-glazing values, according to NFRC 200 and based on LBL's WINDOW 5.2 computer program.
 6. Visible Reflectance: Center-of-glazing values, according to NFRC 300.

2.2 GLASS PRODUCTS

- A. Float Glass: ASTM C 1036, Type I, Quality-Q3, Class I (clear) unless otherwise indicated.
- B. Heat-Treated Float Glass: ASTM C 1048; Type I; Quality-Q3; Class I (clear) unless otherwise indicated; of kind and condition indicated.
1. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed unless otherwise indicated.
 2. For uncoated glass, comply with requirements for Condition A.
 3. For coated vision glass, comply with requirements for Condition C (other coated glass).
- A. Pyrolytic-Coated Float Glass: ASTM C 1376, float glass with metallic-oxide coating applied by pyrolytic deposition process during initial manufacture, and complying with other requirements specified.
- B. Sputter-Coated Float Glass: ASTM C 1376, float glass with metallic-oxide or -nitride coating deposited by vacuum deposition process after manufacture and heat treatment (if any), and complying with other requirements specified.
- C. Ceramic-Coated Spandrel Glass: ASTM C 1048, Condition B, Type I, Quality-Q3, and complying with other requirements specified.
1. Glass: Clear float.
Ceramic Coating Color: As selected by Architect from manufacturer's full range.
- D. Tempered Acid Etched Glass: ASTM C 1048 Kind FT (fully tempered) , Type II, Class 1 (clear), Form 3; Quality-Q6, Finish F2 (etched both sides), [Pattern P3 (random)].

2.3 LAMINATED GLASS

- A. Laminated Glass: ASTM C 1172, and complying with testing requirements in 16 CFR 1201 for Category II materials, and with other requirements specified. Use materials that have a proven record of no tendency to bubble, discolor, or lose physical and mechanical properties after fabrication and installation.
 - 1. Construction: Laminate glass with polyvinyl butyral interlayer to comply with interlayer manufacturer's written recommendations.
 - 2. Interlayer Thickness: Provide thickness not less than that indicated and as needed to comply with requirements.
 - 3. Interlayer Color: Clear unless otherwise indicated.
- B. Glass: Comply with applicable requirements in "Glass Products" Article as indicated by designations in "Laminated-Glass Types" Article.

2.4 INSULATING GLASS

- 1. Basis-of-Design Product: Subject to compliance with requirements, provide Solarban z75; PPG Industries, Inc.
- B. Insulating-Glass Units: Factory-assembled units consisting of sealed lites of glass separated by a dehydrated interspace, qualified according to ASTM E 2190, and complying with other requirements specified.
 - 1. Sealing System: Dual seal, with polyisobutylene and silicone primary and secondary.
 - 2. Spacer: Box type, desiccant filled, perforated aluminum in color selected by Architect. Use of "U" shaped spaces (in cross section) is not permitted..
 - 3. Desiccant: Molecular sieve or silica gel, or blend of both.
- C. Glass: Comply with applicable requirements in "Glass Products" Article and in "Laminated Glass" Article as indicated by designations in "Insulating-Glass Types" Article and in "Insulating-Laminated-Glass Types" Article.

2.5 FIRE-PROTECTION-RATED GLAZING

- A. Fire-Protection-Rated Glazing, General: Listed and labeled by a testing agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on testing according to NFPA 252 for door assemblies and NFPA 257 for window assemblies.
- B. Film-Faced Ceramic Glazing: Clear, ceramic flat glass; 3/16-inch (5-mm) nominal thickness; faced on one surface with a clear glazing film; complying with testing requirements in 16 CFR 1201 for Category II materials.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Nippon Electric Glass Co., Ltd. (distributed by Technical Glass Products); FireLite NT.
 - b. Safti First; SuperLite C/SP.

- c. Schott North America, Inc.; Filmed Pyran Star or Filmed Pyran Crystal.

2.6 GLAZING GASKETS

- A. Dense Compression Gaskets: Molded or extruded gaskets of profile and hardness required to maintain watertight seal, made from one of the following:
 1. Neoprene complying with ASTM C 864.
 2. EPDM complying with ASTM C 864.
 3. Silicone complying with ASTM C 1115.
 4. Thermoplastic polyolefin rubber complying with ASTM C 1115.
- B. Soft Compression Gaskets: Extruded or molded, closed-cell, integral-skinned neoprene, EPDM, silicone or thermoplastic polyolefin rubber gaskets complying with ASTM C 509, Type II, black; of profile and hardness required to maintain watertight seal.
 1. Application: Use where soft compression gaskets will be compressed by inserting dense compression gaskets on opposite side of glazing or pressure applied by means of pressure-glazing stops on opposite side of glazing.

2.7 GLAZING SEALANTS

- A. General:
 1. Compatibility: Provide glazing sealants that are compatible with one another and with other materials they will contact, including glass products, seals of insulating-glass units, and glazing channel substrates, under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.
 2. Suitability: Comply with sealant and glass manufacturers' written instructions for selecting glazing sealants suitable for applications indicated and for conditions existing at time of installation.
 3. Sealants used inside the weatherproofing system, shall have a VOC content of not more than 250 g/L when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 4. Colors of Exposed Glazing Sealants: As selected by Architect from manufacturer's full range.
- B. Glazing Sealant: Neutral-curing silicone glazing sealant complying with ASTM C 920, Type S, Grade NS, Class 100/50, Use NT.
 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. GE Advanced Materials - Silicones; SilPruf LM SCS2700.
 - b. Pecora Corporation; 890.
 - c. Sika Corporation, Construction Products Division; SikaSil-C990.
 2. Applications: Exterior glazing where recommended by glazed product manufacturer.
- C. Glazing Sealant: Neutral-curing silicone glazing sealant complying with ASTM C 920, Type S, Grade NS, Class 50, Use NT.

1. Products: Subject to compliance with requirements, provide one of the following:
 - a. GE Advanced Materials - Silicones; SilGlaze II SCS2800 or SilPruf NB SCS9000 or SilPruf SCS2000 or UltraPruf II SCS2900.
 - b. Pecora Corporation; 864 or 895 or 898].
 - c. Sika Corporation, Construction Products Division; SikaSil-C995.
 2. Applications: Exterior glazing where recommended by glazed product manufacturer.
- D. Glazing Sealants for Fire-Rated Glazing Products: Products that are approved by testing agencies that listed and labeled fire-resistant glazing products with which they are used for applications and fire-protection ratings indicated.

2.8 GLAZING TAPES

- A. Back-Bedding Mastic Glazing Tapes: Preformed, butyl-based, 100 percent solids elastomeric tape; nonstaining and nonmigrating in contact with nonporous surfaces; with or without spacer rod as recommended in writing by tape and glass manufacturers for application indicated; and complying with ASTM C 1281 and AAMA 800 for products indicated below:
1. AAMA 804.3 tape, where indicated.
 2. AAMA 806.3 tape, for glazing applications in which tape is subject to continuous pressure.
 3. AAMA 807.3 tape, for glazing applications in which tape is not subject to continuous pressure.
- B. Expanded Cellular Glazing Tapes: Closed-cell, PVC foam tapes; factory coated with adhesive on both surfaces; and complying with AAMA 800 for the following types:
1. AAMA 810.1, Type 1, for glazing applications in which tape acts as the primary sealant.
 2. AAMA 810.1, Type 2, for glazing applications in which tape is used in combination with a full bead of liquid sealant.

2.9 MISCELLANEOUS GLAZING MATERIALS

- A. General: Provide products of material, size, and shape complying with referenced glazing standard, requirements of manufacturers of glass and other glazing materials for application indicated, and with a proven record of compatibility with surfaces contacted in installation.
- B. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.
- C. Setting Blocks: Elastomeric material with a Shore, Type A durometer hardness of 85, plus or minus 5.
- D. Spacers: Elastomeric blocks or continuous extrusions of hardness required by glass manufacturer to maintain glass lites in place for installation indicated.
- E. Edge Blocks: Elastomeric material of hardness needed to limit glass lateral movement (side walking).

- F. Cylindrical Glazing Sealant Backing: ASTM C 1330, Type O (open-cell material), of size and density to control glazing sealant depth and otherwise produce optimum glazing sealant performance.
- G. Perimeter Insulation for Fire-Resistive Glazing: Product that is approved by testing agency that listed and labeled fire-resistant glazing product with which it is used for application and fire-protection rating indicated.
- H. Vacuum Insulation Panel: High efficiency insulation made of high performance inorganic fumed silica core material with aluminized multilayer barrier with thermal welded seams
 - 1. Basis-of-Design Product: Vacuum Insulation Panel; Dow Corning.
 - a. Thickness: ½ inch.
 - b. R-Value: 39 per inch thickness.
 - c. Flamespread Index: 25 or less.
 - d. Smoke Developed Index: 20 or less.

2.10 FABRICATION OF GLAZING UNITS

- A. Fabricate glazing units in sizes required to fit openings indicated for Project, with edge and face clearances, edge and surface conditions, and bite complying with written instructions of product manufacturer and referenced glazing publications, to comply with system performance requirements.
- B. Clean-cut or flat-grind vertical edges of butt-glazed monolithic lites to produce square edges with slight chamfers at junctions of edges and faces.
- C. Grind smooth and polish exposed glass edges and corners.

2.11 LAMINATED-GLASS TYPES

- A. Glass Type G5 and G7: Clear laminated glass with two plies of float glass.
 - a. Annealed or Kind HS (heat strengthened), if required, Kind FT (fully tempered), where indicated.
 - 2. Thickness of Each Glass Ply: 3.0 mm.
 - 3. Interlayer Thickness: 0.060 inch (1.52 mm).
 - 4. One glass ply to be acid etched at glass type G5.
 - 5. Provide safety glazing labeling.

2.12 INSULATING-GLASS TYPES

- A. Glass Type G1: 1" insulated clear vision glass. Low-e-coated.
 - 1. Overall Unit Thickness: 1 inch (25 mm).
 - 2. Thickness of Each Glass Lite: 6.0 mm.
 - 3. Outdoor Lite: Float glass.

- a. Annealed or Kind HS (heat strengthened), if required, Kind FT (fully tempered), where indicated.
4. Interspace Content: Air or Argon.
 5. Indoor Lite: Float glass.
 - a. Annealed or Kind HS (heat strengthened), if required, Kind FT (fully tempered), where indicated.
 6. Low-E Coating: Pyrolytic or sputtered on second surface.
 7. Visible Light Transmittance Outside: 8 percent minimum.
 8. Visible Light Transmittance Inside: 11 percent minimum.
 9. Winter Nighttime U-Factor: .29 maximum.
 10. Summer Daytime U-Factor: .27 maximum.
 11. Solar Heat Gain Coefficient: .25 maximum.
 12. Provide safety glazing labeling.
- B. Glass Type G2: 1" insulated spandrel glass. Ceramic-coated, low-e. laminated glass.
1. Overall Unit Thickness: 1 inch (25 mm).
 2. Thickness of Each Glass Lite: 6.0 mm.
 3. Outdoor Lite: Float glass.
 - a. Annealed or Kind HS (heat strengthened), if required, Kind FT (fully tempered), where indicated.
 4. Interspace Content: Vacuum Insulation Panel.
 5. Indoor Lite: Clear laminated glass with two plies of float glass.
 - a. Annealed or Kind HS (heat strengthened), if required, Kind FT (fully tempered), where indicated.
 6. Low-E Coating: Pyrolytic or sputtered on second surface.
 7. Opaque Coating Location: Second and third surface.
 8. Winter Nighttime U-Factor: .29 maximum.
 9. Summer Daytime U-Factor: .27 maximum.
- C. Glass Type G12: 1" insulated clear vision glass.
1. Overall Unit Thickness: 1 inch (25 mm).
 2. Thickness of Each Glass Lite: 6.0 mm.
 3. Outdoor Lite: Float glass.
 - a. Annealed or Kind HS (heat strengthened), if required, Kind FT (fully tempered), where indicated.
 4. Interspace Content: Air or Argon.
 5. Indoor Lite: Float glass.
 - a. Annealed or Kind HS (heat strengthened), if required, Kind FT (fully tempered), where indicated.
 6. Visible Light Transmittance Outside: 8 percent minimum.
 7. Visible Light Transmittance Inside: 11 percent minimum.
 8. Winter Nighttime U-Factor: .29 maximum.
 9. Summer Daytime U-Factor: .27 maximum.
 10. Solar Heat Gain Coefficient: .25 maximum.
 11. Provide safety glazing labeling.

2.13 INSULATING-LAMINATED-GLASS TYPES

A. Glass Type G4: 1 inch insulated safety glass. Low-e-coated, laminated glass.

1. Overall Unit Thickness: 1 inch (25 mm).
2. Thickness of Outdoor Lite: 6.0 mm.
 - a. Outdoor Lite: Float Glass.
 - 1) Kind HS (heat strengthened), if required, Kind FT (fully tempered), where indicated.
3. Interspace Content: Air or Argon.
4. Indoor Lite: Clear laminated glass with two plies of float glass.
 - a. Kind HS (heat strengthened), if required, Kind FT (fully tempered), where indicated.
 - b. Thickness of Each Glass Ply: 3.0 mm.
 - c. Interlayer Thickness: 0.060 inch (1.52 mm).
5. Low-E Coating: Pyrolytic or sputtered on second surface.
6. Visible Light Transmittance Outside: 8 percent minimum.
7. Visible Light Transmittance Inside: 11 percent minimum.
8. Winter Nighttime U-Factor: .29 maximum.
9. Summer Daytime U-Factor: .27 maximum.
10. Solar Heat Gain Coefficient: .25 maximum.
11. Provide safety glazing labeling.

B. Glass Type G13: 1 inch insulated safety glass. Laminated glass.

1. Overall Unit Thickness: 1 inch (25 mm).
2. Thickness of Outdoor Lite: 6.0 mm.
 - a. Outdoor Lite: Float Glass.
 - 1) Kind HS (heat strengthened), if required, Kind FT (fully tempered), where indicated.
3. Interspace Content: Air or Argon.
4. Indoor Lite: Clear laminated glass with two plies of float glass.
 - a. Kind HS (heat strengthened), if required, Kind FT (fully tempered), where indicated.
 - b. Thickness of Each Glass Ply: 3.0 mm.
 - c. Interlayer Thickness: 0.060 inch (1.52 mm).
5. Visible Light Transmittance Outside: 8 percent minimum.
6. Visible Light Transmittance Inside: 11 percent minimum.
7. Winter Nighttime U-Factor: .29 maximum.
8. Summer Daytime U-Factor: .27 maximum.
9. Solar Heat Gain Coefficient: .25 maximum.
10. Provide safety glazing labeling.

2.14 FIRE-PROTECTION-RATED GLAZING TYPES

A. Glass Type G6: 120-minute fire-rated glazing; film-faced ceramic glazing.

1. Provide safety glazing labeling.

2.15 FIRE PROTECTION-RATED INSULATING-GLASS TYPES

A. Glass Type G8: 1" insulated fire protection rated glass. Low-e-coated.

1. Overall Unit Thickness: 1 inch (25 mm).
2. Thickness of Each Glass Lite: 6.0 mm.
3. Outdoor Lite: 60 minute fire rated glazing; film faced.
 - a. Annealed or Kind HS (heat strengthened), if required, Kind FT (fully tempered), where indicated.
4. Interspace Content: Air or Argon.
5. Indoor Lite: 60 minute fire rated glazing; film faced.
 - a. Annealed or Kind HS (heat strengthened), if required, Kind FT (fully tempered), where indicated.
6. Low-E Coating: Pyrolytic or sputtered on second surface.
7. Visible Light Transmittance Outside: 8 percent minimum.
8. Visible Light Transmittance Inside: 11 percent minimum.
9. Winter Nighttime U-Factor: .29 maximum.
10. Summer Daytime U-Factor: .27 maximum.
11. Solar Heat Gain Coefficient: .25 maximum.
12. Provide safety glazing labeling.

B. Glass Type G9: 1" insulated fire protection rated spandrel glass. Ceramic-coated, low-e.

1. Overall Unit Thickness: 1 inch (25 mm).
2. Thickness of Each Glass Lite: 6.0 mm.
3. Outdoor Lite: 60 minute fire rated glazing; film faced.
 - a. Annealed or Kind HS (heat strengthened), if required, Kind FT (fully tempered), where indicated.
4. Interspace Content: Vacuum Insulation Panel.
5. Indoor Lite: 60 minute fire rated glazing; film faced.
 - a. Annealed or Kind HS (heat strengthened), if required, Kind FT (fully tempered), where indicated.
6. Low-E Coating: Pyrolytic or sputtered on second surface.
7. Opaque Coating Location: Fourth surface.
8. Winter Nighttime U-Factor: .29 maximum.
9. Summer Daytime U-Factor: .27 maximum.

C. Glass Type G14: 1" insulated fire protection rated glass. Low-e-coated, laminated glass.

1. Overall Unit Thickness: 1 inch (25 mm).
2. Thickness of Each Glass Lite: 6.0 mm.

3. Outdoor Lite: 60 minute fire rated glazing; film faced.
 - a. Annealed or Kind HS (heat strengthened), if required, Kind FT (fully tempered), where indicated.
 4. Interspace Content: Air or Argon.
 5. Indoor Lite: Clear laminated with two plies of 60 minute fire rated glazing; film faced.
 - a. Annealed or Kind HS (heat strengthened), if required, Kind FT (fully tempered), where indicated.
 6. Low-E Coating: Pyrolytic or sputtered on second surface.
 7. Visible Light Transmittance Outside: 8 percent minimum.
 8. Visible Light Transmittance Inside: 11 percent minimum.
 9. Winter Nighttime U-Factor: .29 maximum.
 10. Summer Daytime U-Factor: .27 maximum.
 11. Solar Heat Gain Coefficient: .25 maximum.
 12. Provide safety glazing labeling.
- D. Glass Type G15: 1" insulated fire protection rated spandrel glass. Ceramic-coated, low-e, laminated glass.
1. Overall Unit Thickness: 1 inch (25 mm).
 2. Thickness of Each Glass Lite: 6.0 mm.
 3. Outdoor Lite: 60 minute fire rated glazing; film faced.
 - a. Annealed or Kind HS (heat strengthened), if required, Kind FT (fully tempered), where indicated.
 4. Interspace Content: Vacuum Insulation Panel.
 5. Indoor Lite: Clear laminated with two plies of 60 minute fire rated glazing; film faced.
 - a. Annealed or Kind HS (heat strengthened), if required, Kind FT (fully tempered), where indicated.
 6. Low-E Coating: Pyrolytic or sputtered on second surface.
 7. Opaque Coating Location: Second and third surface.
 8. Winter Nighttime U-Factor: .29 maximum.
 9. Summer Daytime U-Factor: .27 maximum.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine framing, glazing channels, and stops, with Installer present, for compliance with the following:
 1. Manufacturing and installation tolerances, including those for size, squareness, and offsets at corners.

2. Presence and functioning of weep systems.
 3. Minimum required face and edge clearances.
 4. Effective sealing between joints of glass-framing members.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

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

3.3 GLAZING, GENERAL

- A. Comply with combined written instructions of manufacturers of glass, sealants, gaskets, and other glazing materials, unless more stringent requirements are indicated, including those in referenced glazing publications.
- B. Adjust glazing channel dimensions as required by Project conditions during installation to provide necessary bite on glass, minimum edge and face clearances, and adequate sealant thicknesses, with reasonable tolerances.
- C. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass is glass with edge damage or other imperfections that, when installed, could weaken glass and impair performance and appearance.
- D. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction testing.
- E. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications, unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.
- F. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.
- G. Provide spacers for glass lites where length plus width is larger than 50 inches (1270 mm).
 1. Locate spacers directly opposite each other on both inside and outside faces of glass. Install correct size and spacing to preserve required face clearances, unless gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances and to comply with system performance requirements.
 2. Provide 1/8-inch (3-mm) minimum bite of spacers on glass and use thickness equal to sealant width. With glazing tape, use thickness slightly less than final compressed thickness of tape.

- H. Provide edge blocking where indicated or needed to prevent glass lites from moving sideways in glazing channel, as recommended in writing by glass manufacturer and according to requirements in referenced glazing publications.
- I. Set glass lites in each series with uniform pattern, draw, bow, and similar characteristics.
- J. Set glass lites with proper orientation so that coatings face exterior or interior as specified.
- K. Where wedge-shaped gaskets are driven into one side of channel to pressurize sealant or gasket on opposite side, provide adequate anchorage so gasket cannot walk out when installation is subjected to movement.
- L. Square cut wedge-shaped gaskets at corners and install gaskets in a manner recommended by gasket manufacturer to prevent corners from pulling away; seal corner joints and butt joints with sealant recommended by gasket manufacturer.

3.4 TAPE GLAZING

- A. Position tapes on fixed stops so that, when compressed by glass, their exposed edges are flush with or protrude slightly above sightline of stops.
- B. Install tapes continuously, but not necessarily in one continuous length. Do not stretch tapes to make them fit opening.
- C. Cover vertical framing joints by applying tapes to heads and sills first and then to jambs. Cover horizontal framing joints by applying tapes to jambs and then to heads and sills.
- D. Place joints in tapes at corners of opening with adjoining lengths butted together, not lapped. Seal joints in tapes with compatible sealant approved by tape manufacturer.
- E. Do not remove release paper from tape until right before each glazing unit is installed.
- F. Apply heel bead of elastomeric sealant.
- G. Center glass lites in openings on setting blocks and press firmly against tape by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings.
- H. Apply cap bead of elastomeric sealant over exposed edge of tape.

3.5 GASKET GLAZING (DRY)

- A. Cut compression gaskets to lengths recommended by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.
- B. Insert soft compression gasket between glass and frame or fixed stop so it is securely in place with joints miter cut and bonded together at corners.
- C. Installation with Drive-in Wedge Gaskets: Center glass lites in openings on setting blocks and press firmly against soft compression gasket by inserting dense compression gaskets formed and

installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.

- D. Installation with Pressure-Glazing Stops: Center glass lites in openings on setting blocks and press firmly against soft compression gasket. Install dense compression gaskets and pressure-glazing stops, applying pressure uniformly to compression gaskets. Compress gaskets to produce a weathertight seal without developing bending stresses in glass. Seal gasket joints with sealant recommended by gasket manufacturer.
- E. Install gaskets so they protrude past face of glazing stops.

3.6 SEALANT GLAZING (WET)

- A. Install continuous spacers, or spacers combined with cylindrical sealant backing, between glass lites and glazing stops to maintain glass face clearances and to prevent sealant from extruding into glass channel and blocking weep systems until sealants cure. Secure spacers or spacers and backings in place and in position to control depth of installed sealant relative to edge clearance for optimum sealant performance.
- B. Force sealants into glazing channels to eliminate voids and to ensure complete wetting or bond of sealant to glass and channel surfaces.
- C. Tool exposed surfaces of sealants to provide a substantial wash away from glass.

3.7 LOCK-STRIP GASKET GLAZING

- A. Comply with ASTM C 716 and gasket manufacturer's written instructions. Provide supplementary wet seal and weep system unless otherwise indicated.

3.8 CLEANING AND PROTECTION

- A. Protect exterior glass from damage immediately after installation by attaching crossed streamers to framing held away from glass. Do not apply markers to glass surface. Remove nonpermanent labels and clean surfaces.
- B. Protect glass from contact with contaminating substances resulting from construction operations. If, despite such protection, contaminating substances do come into contact with glass, remove substances immediately as recommended in writing by glass manufacturer.
- C. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for buildup of dirt, scum, alkaline deposits, or stains; remove as recommended in writing by glass manufacturer.
- D. Remove and replace glass that is broken, chipped, cracked, or abraded or that is damaged from natural causes, accidents, and vandalism, during construction period.

- E. Wash glass on both exposed surfaces in each area of Project not more than four days before date scheduled for inspections that establish date of Substantial Completion. Wash glass as recommended in writing by glass manufacturer.

END OF SECTION 088000

SECTION 088853 - SECURITY GLAZING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes glazing for the following products and applications and of the following types:
 - 1. Products and applications specified in other Sections where glazing requirements are specified by reference to this Section:
 - a. Security windows.
 - 2. Security Glazing Types:
 - a. Fire-rated glass-clad polycarbonate.
- B. Related Sections:
 - 1. Division 01, High Performance Buildings Requirements Section for credits 16a-38k-4(b)4
 - a. The above listed HPB credits are related to this section. Other HPB credits may apply and shall be reviewed for their potential applicability and conformed with as though listed.
 - 2. Section 088000 "Glazing" for non-security glazing in the form of monolithic glass, laminated glass, and insulating glass.

1.3 DEFINITIONS

- A. Glazing Manufacturers: Firms that produce primary glass, monolithic plastic glazing, or fabricated security glazing, as defined in referenced glazing publications.

1.4 PERFORMANCE REQUIREMENTS

- A. General:
 - 1. Installed security glazing shall withstand security-related loads and forces without damage to the glazing beyond that allowed by referenced standards.
- B. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on glazing framing members and glazing components.

1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

1.5 ACTION SUBMITTALS

- A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.
- B. Product Data: For each type of product indicated.
- C. Security Glazing Samples: For each type of security glazing; 12 inches (300 mm) square.
- D. Glazing Accessory Samples: For gaskets,, in 12-inch (300-mm) lengths.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For manufacturers of security glazing.
- B. Product Certificates: For each type of product indicated, from manufacturer.
- C. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for each type of security glazing glazing gasket.
- D. Warranties: Sample of special warranties.

1.7 CLOSEOUT SUBMITTALS

- A. Warranty: For Security Glazing specified in Form 816 Article 1.20-1.06.08 and described in NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS.

1.8 QUALITY ASSURANCE

- A. Source Limitations for Security Glazing: Obtain security glazing from single source from single manufacturer using the same type of lites, plies, interlayers, and spacers for each security glazing type indicated.
- B. Source Limitations for Glazing Gaskets: Obtain from single source from single manufacturer for each product and installation method.
- C. Glazing Publications: Comply with published recommendations of security glazing and glazing material manufacturers and organizations below, unless more stringent requirements are indicated. Refer to these publications for glazing terms not otherwise defined in this Section or in referenced standards.
 1. GANA Publications: GANA's "Laminated Glazing Reference Manual" and GANA's "Glazing Manual."

- D. Plastic Glazing Labeling: Identify plastic sheets with appropriate markings of applicable testing and inspecting agency, indicating compliance with required fire-test-response characteristics.

1.9 DELIVERY, STORAGE, AND HANDLING

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

1.10 PROJECT CONDITIONS

- A. Environmental Limitations: Do not proceed with glazing when ambient and substrate temperature conditions are outside limits permitted by glazing material manufacturers and when glazing channel substrates are wet from rain, frost, condensation, or other causes.

- 1. Do not install glazing sealants when ambient and substrate temperature conditions are outside limits permitted by sealant manufacturer or below 40 deg F (4.4 deg C).

1.11 COORDINATION

- A. Coordinate dimensions, including thickness, of security glazing with dimensions of construction that receives security glazing.

1.12 WARRANTY

- A. Manufacturer's Special Warranty for Glass-Clad Polycarbonate: Manufacturer's standard form in which glass-clad polycarbonate manufacturer agrees to replace glass-clad polycarbonate that deteriorates within specified warranty period. Deterioration is defined as defects developed from normal use that are not attributed to glass breakage or to maintaining and cleaning glass-clad polycarbonate contrary to manufacturer's written instructions. Defects include edge separation, delamination materially obstructing vision through glazing, blemishes exceeding those allowed by referenced glass-clad polycarbonate standard, yellowing, and loss of light transmission.

- 1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SECURITY GLAZING, GENERAL

- A. Thickness: Where thickness is indicated, it is a minimum. Provide security glazing in thicknesses as needed to comply with requirements indicated.
- B. Fire-Test-Response Characteristics of Plastic Sheets: As determined by testing plastic sheets identical to those used in security glazing products by a qualified testing agency acceptable to authorities having jurisdiction.

1. Self-ignition temperature of 650 deg F (343 deg C) or more when tested per ASTM D 1929 on plastic sheets in thicknesses indicated for the Work.
2. Smoke-developed index of 450 or less when tested according to ASTM E 84, or smoke density of 75 or less when tested per ASTM D 2843 on plastic sheets in thicknesses indicated for the Work.
3. Burning extent of 1 inch (25 mm) or less when tested per ASTM D 635 at a nominal thickness of 0.060 inch (1.52 mm) or thickness indicated for the Work.

2.2 GLASS PRODUCTS

- A. Float Glass: ASTM C 1036, Type I, Quality-Q3, Class I (clear) unless otherwise indicated.
- B. Heat-Treated Float Glass: ASTM C 1048; Type I; Quality-Q3; Class I (clear) unless otherwise indicated; of kind and condition indicated.
 1. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed unless otherwise indicated.
 2. For heat-strengthened float glass, comply with requirements for Kind HS.
 3. For fully tempered float glass, comply with requirements for Kind FT.
 4. For uncoated glass, comply with requirements for Condition A.

2.3 POLYCARBONATE SECURITY GLAZING

- A. Polycarbonate Sheet: ASTM C 1349, Appendix X1, Type II, coated, mar-resistant, UV-stabilized polycarbonate with coating on exposed surfaces and Type I, standard, UV-stabilized polycarbonate where no surfaces are exposed.
- B. Laminated Polycarbonate: Polycarbonate sheets laminated with clear urethane interlayer that complies with ASTM C 1349, Appendix X2, and has a proven record of no tendency to bubble, discolor, or lose physical and mechanical properties after fabrication and installation. Provide laminated units that comply with requirements of ASTM C 1349 for maximum allowable laminating process blemishes and haze.
- C. Glass-Clad Polycarbonate: ASTM C 1349, and other requirements specified.

2.4 Provide glass-clad polycarbonate that complies with testing requirements in 16 CFR 1201 for Category II materials, and with other requirements specified.SPALL-RESISTANT FILM

- A. Spall-Resistant Film: Composite of clear polyvinyl butyral film and clear abrasion-resistant polyester film.
 1. Basis-of-Design Product: Subject to compliance with requirements, provide the following:
 - a. DuPont Glass Laminating Solutions, DuPont Company; SpallShield.
- B. Laminating Process: Laminate spall-resistant film to glazing assemblies in factory to produce laminated lites free of foreign substances, air, and glass pockets.

2.5 GLAZING GASKETS

- A. Dense Compression Gaskets: Molded or extruded gaskets of profile and hardness required to maintain watertight seal, made from one of the following:
 1. Neoprene complying with ASTM C 864.
 2. EPDM complying with ASTM C 864.
 3. Silicone complying with ASTM C 1115.
 4. Thermoplastic polyolefin rubber complying with ASTM C 1115.
- B. Soft Compression Gaskets: Extruded or molded, closed-cell, integral-skinned neoprene, EPDM, silicone or thermoplastic polyolefin rubber gaskets complying with ASTM C 509, Type II, black; of profile and hardness required to maintain watertight seal.
 1. Application: Use where soft compression gaskets will be compressed by inserting dense compression gaskets on opposite side of glazing or pressure applied by means of pressure-glazing stops on opposite side of glazing.

2.6 GLAZING TAPES

- A. Back-Bedding Mastic Glazing Tapes: Preformed, butyl-based, 100 percent solids elastomeric tape; non-staining and non-migrating in contact with nonporous surfaces; with or without spacer rod as recommended in writing by tape and security glazing manufacturers for application indicated; and complying with ASTM C 1281 and AAMA 800 for products indicated below:
 1. AAMA 806.3 tape, for glazing applications in which tape is subject to continuous pressure.
 2. AAMA 807.3 tape, for glazing applications in which tape is not subject to continuous pressure.
- B. Expanded Cellular Glazing Tapes: Closed-cell, PVC foam tapes; factory coated with adhesive on both surfaces; and complying with AAMA 800 for the following types:
 1. AAMA 810.1, Type 1, for glazing applications in which tape acts as the primary sealant.
 2. AAMA 810.1, Type 2, for glazing applications in which tape is used in combination with a full bead of liquid sealant.

2.7 MISCELLANEOUS GLAZING MATERIALS

- A. General: Provide products of material, size, and shape complying with referenced glazing standard, requirements of manufacturers of security glazing and other glazing materials for application indicated, and with a proven record of compatibility with surfaces contacted in installation.
- B. Cleaners, Primers, and Sealers: Types recommended by sealant or gasket manufacturer.
- C. Setting Blocks: Elastomeric material with a Shore, Type A durometer hardness of 85, plus or minus 5.

- D. Spacers: Elastomeric blocks or continuous extrusions of hardness required by security glazing manufacturer to maintain security glazing lites in place for installation indicated.
- E. Edge Blocks: Elastomeric material of hardness needed to limit security glazing lateral movement (side walking).
- F. Cylindrical Glazing Sealant Backing: ASTM C 1330, Type O (open-cell material), of size and density to control glazing sealant depth and otherwise produce optimum glazing sealant performance.

2.8 FABRICATION OF SECURITY GLAZING

- A. Fabricate security glazing in sizes required to fit openings indicated for Project, with edge and face clearances, edge and surface conditions, and bite complying with written instructions of product manufacturer and referenced glazing publications, to comply with system performance requirements.

2.9 GLASS-CLAD POLYCARBONATE SECURITY GLAZING TYPES

- A. Security Glazing : Fire rated clear glass-glad polycarbonate.
 - 1. Basis-of-Design Product: Inferno-lite, Ultimax 90-SP311; Global Security Glazing.
 - a. Ballistics: Level 3 per U.L. 752.
 - b. Fire Resistance: 90 minute.
 - c. Overall Unit Thickness: 2.561 inches.

PART 3 - EXECUTION

3.1 EXAMINATION

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

3.2 PREPARATION

- A. Clean glazing channels and other framing members receiving security glazing immediately before glazing. Remove coatings not firmly bonded to substrates.

3.3 GLAZING, GENERAL

- A. Comply with combined written instructions of manufacturers of security glazing, sealants, gaskets, and other glazing materials, unless more stringent requirements are indicated, including those in referenced glazing publications.
- B. Protect edges of security glazing from damage during handling and installation. Remove damaged security glazing from Project site and legally dispose of off Project site. Damaged security glazing includes units with edge or face damage or other imperfections that, when installed, could weaken security glazing, impair performance, or impair appearance.
- C. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction testing.
- D. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications unless otherwise required by glazing unit manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.
- E. Do not exceed edge pressures stipulated by security glazing manufacturers for installing lites.
- F. Provide spacers for security glazing lites where the length plus width is larger than 50 inches (1270 mm).
 - 1. Locate spacers directly opposite each other on both inside and outside faces of security glazing. Install correct size and spacing to preserve required face clearances unless gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances and to comply with performance requirements.
 - 2. Provide 1/8-inch (3-mm) minimum bite of spacers on glazing lites and use thickness equal to sealant width. With glazing tape, use thickness slightly less than final compressed thickness of tape.
- G. Provide edge blocking where indicated or needed to prevent security glazing from moving sideways in glazing channel, as recommended in writing by security glazing manufacturer and according to requirements in referenced glazing publications.
- H. Set security glazing in each series with uniform pattern, draw, bow, and similar characteristics.
- I. Set coated security glazing with proper orientation so that coatings face exterior or interior as specified.
- J. Square cut wedge-shaped gaskets at corners and install gaskets in a manner recommended by gasket manufacturer to prevent corners from pulling away; seal corner joints and butt joints with sealant recommended by gasket manufacturer.

3.4 TAPE GLAZING

- A. Position tapes on fixed stops so that, when compressed by security glazing, their exposed edges are flush with or protrude slightly above sightline of stops.

- B. Install tapes continuously, but not necessarily in one continuous length. Do not stretch tapes to make them fit opening.
- C. Cover vertical framing joints by applying tapes to heads and sills first and then to jambs. Cover horizontal framing joints by applying tapes to jambs and then to heads and sills.
- D. Place joints in tapes at corners of opening with adjoining lengths butted together, not lapped. Seal joints in tapes with compatible sealant approved by tape manufacturer.
- E. Do not remove release paper from tape until just before each glazing unit is installed.
- F. Center security glazing in openings on setting blocks and press firmly against tape by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings.
- G. Apply cap bead of elastomeric sealant over exposed edge of tape.

3.5 GASKET GLAZING (DRY)

- A. Cut compression gaskets to lengths recommended by gasket manufacturer to fit openings exactly, with allowance for stretch during installation.
- B. Insert soft compression gasket securely in place between glazing unit and frame or fixed stop, with joints miter cut and bonded together at corners.
- C. Installation with Drive-in Wedge Gaskets: Center security glazing in openings on setting blocks and press firmly against soft compression gasket by inserting dense compression gaskets formed and installed to lock in place against faces of removable stops. Start gasket applications at corners and work toward centers of openings. Compress gaskets to produce a weathertight seal without developing bending stresses in security glazing. Seal gasket joints with sealant recommended by gasket manufacturer.
- D. Installation with Pressure-Glazing Stops: Center security glazing in openings on setting blocks and press firmly against soft compression gasket. Install dense compression gaskets and pressure-glazing stops, applying pressure uniformly to compression gaskets. Compress gaskets to produce a weathertight seal without developing bending stresses in security glazing. Seal gasket joints with sealant recommended by gasket manufacturer.
- E. Install gaskets so they protrude past face of glazing stops.

3.6 PROTECTION AND CLEANING

- A. Protect exterior security glazing from damage immediately after installation by attaching crossed streamers to framing held away from glazing unit. Do not apply markers to security glazing surfaces. Remove nonpermanent labels, and clean surfaces.
- B. Protect security glazing from contact with contaminating substances resulting from construction operations, including weld splatter. If, despite such protection, contaminating substances do come into contact with security glazing, remove substances immediately as recommended in writing by security glazing manufacturer.

- C. Examine security glazing surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for buildup of dirt, scum, alkaline deposits, or stains; remove as recommended in writing by security glazing manufacturer.
- D. Remove and replace security glazing that is broken, chipped, cracked, or abraded or that is damaged from natural causes, accidents, or vandalism during construction period.
- E. Wash security glazing on exposed surfaces in each area of Project not more than four days before date scheduled for inspections that establish date of Substantial Completion. Wash security glazing as recommended in writing by security glazing manufacturer.

END OF SECTION 088853

SECTION 092900 - GYPSUM BOARD

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

- 1. Interior gypsum board.
- 2. Tile backing panels.

B. Related Requirements:

- 1. Division 01, High Performance Buildings Requirements Section for credits 16a-38k-4(b)4, 16a-38k-4(b)5, 16a-38k-4(d)9 and 16a-38k-4(d)11
 - a. The above listed HPB credits are related to this section. Other HPB credits may apply and shall be reviewed for their potential applicability and conformed with as though listed.
- 2. Section 055000 "Metal Fabrications" for installing expanded wire mesh.
- 3. Section 061600 "Sheathing" for gypsum sheathing for exterior walls.
- 4. Section 092216 "Non-Structural Metal Framing" for non-structural framing and suspension systems that support gypsum board panels.

1.3 ACTION SUBMITTALS

- A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.
- B. Product Data: For each type of product.

1.4 QUALITY ASSURANCE SUBMITTALS

- A. Manufacturers Certification Letter in accordance with NOTICE TO CONTRACTOR – POTENTIAL FOR ASBESTOS CONTAINING MATERIALS.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Store materials inside under cover and keep them dry and protected against weather, condensation, direct sunlight, construction traffic, and other potential causes of damage. Stack panels flat and supported on risers on a flat platform to prevent sagging.
- B. All materials shall be delivered in original packages, containers or bundles bearing brand name, applicable standard designation and name of manufacturer or product manufactured.
- C. Comply with GA-216 and manufacturers written recommendations.

1.6 FIELD 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 paper-faced gypsum panels 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 PERFORMANCE REQUIREMENTS

- A. Fire-Resistance-Rated Assemblies: For fire-resistance-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 119 by an independent testing agency.
- B. STC-Rated Assemblies: For STC-rated assemblies, provide materials and construction identical to those tested in assembly indicated according to ASTM E 90 and classified according to ASTM E 413 by an independent testing agency.

2.2 GYPSUM BOARD, GENERAL

- A. Size: Provide maximum lengths and widths available that will minimize joints in each area and that correspond with support system indicated.

2.3 INTERIOR GYPSUM BOARD

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Georgia-Pacific Gypsum LLC.
 - 2. National Gypsum Company.
 - 3. USG Corporation.
- B. Gypsum Board, Type X: ASTM C 1396/C 1396M.
 - 1. Thickness: 5/8 inch (15.9 mm).
 - 2. Long Edges: Tapered.
- C. Gypsum Ceiling Board: ASTM C 1396/C 1396M.
 - 1. Thickness: 1/2 inch (12.7 mm).
 - 2. Long Edges: Tapered.
 - 3. Sag Resistant.
- D. Foil-Backed Gypsum Board: ASTM C 1396/C 1396M.
 - 1. Core: 5/8 inch (15.9 mm), Type X.
 - 2. Long Edges: Tapered.
- E. Abuse-Resistant Gypsum Board: ASTM C 1629/C 1629M, Level 3.
 - 1. Core: 5/8 inch (15.9 mm), Type X.
 - 2. Long Edges: Tapered.
 - 3. Mold Resistance: ASTM D 3273, score of 10 as rated according to ASTM D 3274.
- F. Moisture- and Mold-Resistant Gypsum Board: ASTM C 1396/C 1396M. With moisture- and mold-resistant core and paper surfaces.
 - 1. Core: 5/8 inch (15.9 mm), Type X.
 - 2. Long Edges: Tapered.
 - 3. Mold Resistance: ASTM D 3273, score of 10 as rated according to ASTM D 3274.

2.4 TILE BACKING PANELS

- A. Cementitious Backer Units: ANSI A118.9 and ASTM C 1288 or 1325, with manufacturer's standard edges.
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Custom Building Products; Wonderboard.
 - b. National Gypsum Company, Permabase Cement Board.
 - c. USG Corporation; DUROCK Cement Board.
 - 2. Thickness: 5/8 inch (15.9 mm).
 - 3. Mold Resistance: ASTM D 3273, score of 10 as rated according to ASTM D 3274.

2.5 TRIM ACCESSORIES

A. Interior Trim: ASTM C 1047.

1. Material: Galvanized or aluminum-coated steel sheet or rolled zinc.
2. Shapes:
 - a. Cornerbead.
 - b. Bullnose bead.
 - c. LC-Bead: J-shaped; exposed long flange receives joint compound.
 - d. L-Bead: L-shaped; exposed long flange receives joint compound.
 - e. U-Bead: J-shaped; exposed short flange does not receive joint compound.
 - f. Expansion (control) joint.
 - g. Curved-Edge Cornerbead: With notched or flexible flanges.

B. Structural Laminate Drywall Corner: ASTM C 1047, NFPA Class A, UBC Class 1 when tested in accordance with ASTM E84 with a flame spread index of 5 and smoke density index of 100.

1. Basis of Design Product: Subject to compliance with requirements, provide, No-Coat; Structus Building Technologies.
2. Material: Copolymer core, tight fibered paper surface, joint paper back.
3. Shapes:
 - a. Outside cornerbead.
4. Accessories: Transition caps and corner caps

C. Exterior Trim: ASTM C 1047.

1. Material: -Hot-dip galvanized steel sheet, - or rolled zinc .
2. Shapes:
 - a. Cornerbead.
 - b. LC-Bead: J-shaped; exposed long flange receives joint compound.
 - c. Expansion (Control) Joint: One-piece, rolled zinc with V-shaped slot and removable strip covering slot opening.

2.6 JOINT TREATMENT MATERIALS

A. General: Comply with ASTM C 475/C 475M.

B. Joint Tape:

1. Interior Gypsum Board: Paper.
2. Exterior Gypsum Soffit Board: Paper.
3. Tile Backing Panels: As recommended by panel manufacturer.

C. Joint Compound for Interior Gypsum Board: For each coat use formulation that is compatible with other compounds applied on previous or for successive coats.

1. Prefilling: At open joints 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 and or drying-type, all-purpose compound.
 - a. Use setting-type compound for installing paper-faced metal trim accessories.
3. Fill Coat: For second coat, use setting-type, sandable topping and / or drying-type, all-purpose compound.
4. Finish Coat: For third coat, use setting-type, sandable topping and / or drying-type, all-purpose compound.
5. Skim Coat: For final coat of Level 5 finish, use setting-type, sandable topping compound and / or drying-type, all-purpose compound.

D. Joint Compound for Exterior Applications:

1. Exterior Gypsum Soffit Board: Use setting-type taping compound and setting-type, sandable topping compound.
2. Glass-Mat Gypsum Sheathing Board: As recommended by sheathing board manufacturer.

E. Joint Compound for Tile Backing Panels:

1. Cementitious Backer Units: As recommended by backer unit manufacturer.

2.7 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.
 1. Laminating adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- 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 (0.84 to 2.84 mm) thick.
 2. For fastening cementitious backer units, use screws of type and size recommended by panel manufacturer.
- D. Acoustical Joint Sealant: Refer to Division 07 Section "Joint Sealants."
- E. Thermal and Sound Attenuation Blanket Insulation: As specified in Section 072100 "Thermal Insulation."
- F. Vapor Retarder: As specified in Section 072100 "Thermal Insulation."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and substrates including welded hollow-metal frames and framing, with Installer present, 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 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 (1.5 mm) 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. Refer to drawings for gypsum panel applications above ceilings.
 - 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- (6.4- to 9.5-mm-) 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- (6.4- to 12.7-mm-) wide spaces at these locations and trim edges with edge trim where edges of panels are exposed. Seal joints between edges and abutting structural surfaces with acoustical sealant.
- H. Attachment to Steel Framing: Attach panels so leading edge or end of each panel is attached to open (unsupported) edges of stud flanges first.

- I. Sound Rated Assemblies (STC-Rated Assemblies): Seal construction at perimeters, behind control joints, and at openings and penetrations with a continuous bead of acoustical sealant. Install acoustical sealant at both faces of partitions at perimeters and through penetrations. Comply with ASTM C 919 and with manufacturer's written recommendations for locating edge trim and closing off sound-flanking paths around or through assemblies, including sealing partitions above acoustical ceilings.
 - 1. Unless otherwise indicated, provide STC 50 rated assemblies.
- J. Install sound attenuation blankets before installing gypsum panels unless blankets are readily installed after panels have been installed on one side.

3.3 APPLYING INTERIOR GYPSUM BOARD

- A. Install interior gypsum board in the following locations:
 - 1. Wallboard Type: As indicated on Drawings.
 - 2. Type X: Where required for fire-resistance-rated assembly.
 - 3. Ceiling Type: Ceiling surfaces.
 - 4. Foil-Backed Type: at exterior walls and where indicated.
 - 5. Abuse-Resistant Type: Where indicated below:
 - a. Rooms: A105, A106, A108, A109 and A117.
 - 6. Moisture- and Mold-Resistant Type: Install at damp areas such as Toilet Rooms, Janitor's Closets and Utility Rooms and where indicated.
 - 7. Cementitious Backer Units: Install at showers, tubs and other wet areas.
- B. Single-Layer Application:
 - 1. On ceilings, apply gypsum panels before wall/partition board application to greatest extent possible and at right angles to framing unless otherwise indicated.
 - 2. On partitions/walls, apply gypsum panels vertically (parallel to framing) unless otherwise indicated or required by fire-resistance-rated assembly, and minimize end joints.
 - a. Stagger abutting end joints not less than one framing member in alternate courses of panels.
 - b. At stairwells and other high walls, install panels horizontally unless otherwise indicated or required by fire-resistance-rated assembly.
 - 3. On Z-furring members, apply gypsum panels vertically (parallel to framing) with no end joints. Locate edge joints over furring members.
 - 4. Fastening Methods: Apply gypsum panels to supports with steel drill screws.
- C. Multilayer Application:
 - 1. On ceilings, apply gypsum board indicated for base layers before applying base layers on walls/partitions; apply face layers in same sequence. Apply base layers at right angles to framing members and offset face-layer joints one framing member, 16 inches (400 mm) minimum, from parallel base-layer joints, unless otherwise indicated or required by fire-resistance-rated assembly.

2. On partitions/walls, apply gypsum board indicated for base layers and face layers vertically (parallel to framing) with joints of base layers located over stud or furring member and face-layer joints offset at least one stud or furring member with base-layer joints, unless otherwise indicated or required by fire-resistance-rated assembly. Stagger joints on opposite sides of partitions.
3. On Z-furring members, apply base layer vertically (parallel to framing) and face layer either vertically (parallel to framing) or horizontally (perpendicular to framing) with vertical joints offset at least one furring member. Locate edge joints of base layer over furring members.
4. Fastening Methods: Fasten layers in accordance with the manufacturers written recommendations

D. Laminating to Substrate: Where gypsum panels are indicated as directly adhered to a substrate (other than studs, joists, furring members, or base layer of gypsum board), comply with gypsum board manufacturer's written recommendations and temporarily brace or fasten gypsum panels until fastening adhesive has set.

3.4 APPLYING EXTERIOR GYPSUM PANELS FOR CEILINGS AND SOFFITS

- A. Apply panels perpendicular to supports, with end joints staggered and located over supports.
 1. Install with 1/4-inch (6.4-mm) open space where panels abut other construction or structural penetrations.
 2. Fasten with corrosion-resistant screws.

3.5 APPLYING TILE BACKING PANELS

- A. Cementitious Backer Units: ANSI A108.11, at showers, tubs, and where indicated.
- B. Where tile backing panels abut other types of panels in same plane, shim surfaces to produce a uniform plane across panel surfaces.

3.6 INSTALLING TRIM ACCESSORIES

- A. General: For trim with back flanges intended for fasteners, attach to framing with same fasteners used for panels. Otherwise, attach trim according to manufacturer's written instructions.
- B. Control Joints: Install control joints at locations indicated on Drawings.
- C. Interior Trim: Install in the following locations:
 1. Cornerbead: Use at outside corners unless otherwise indicated.
 2. Bullnose Bead: Use where indicated.
 3. LC-Bead: Use at exposed panel edges.
 4. L-Bead: Use where indicated.
 5. U-Bead: Use at exposed panel edges.
 6. Curved-Edge Cornerbead: Use at curved openings.

D. Exterior Trim: Install in the following locations:

1. Cornerbead: Use at outside corners.
2. LC-Bead: Use at exposed panel edges.

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 and damaged surface areas.
- C. Apply joint tape over gypsum board joints, except for trim products specifically indicated as not intended to receive tape.
- D. Gypsum Board Finish Levels: Finish panels to levels indicated below and according to ASTM C 840:
 1. Level 1: Ceiling plenum areas, concealed areas, and where indicated.
 2. Level 2: Panels that are substrate for tile or acoustical tile.
 3. Level 4: At panel surfaces that will be exposed to view unless otherwise indicated.
 - a. Primer and its application to surfaces are specified in Section 099123 "Interior Painting."
- E. Cementitious Backer Units: Finish according to manufacturer's written instructions.

3.8 PROTECTION

- A. Protect adjacent surfaces from drywall compound and promptly remove from floors and other non-drywall surfaces. Repair surfaces stained, marred, or otherwise damaged during drywall application.
- B. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.
- C. Remove and replace panels that are wet, moisture damaged, and mold damaged.
 1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, or irregular shape.
 2. Indications that panels are mold damaged include, but are not limited to, fuzzy or splotchy surface contamination and discoloration.

END OF SECTION 092900

SECTION 102600 - WALL AND DOOR PROTECTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Corner guards.

1.3 ACTION SUBMITTALS

- A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.
- B. Product Data: Include construction details, material descriptions, impact strength, fire-test-response characteristics, dimensions of individual components and profiles, and finishes for each impact-resistant wall protection unit.
- C. Shop Drawings: For each impact-resistant wall protection unit showing locations and extent. Include sections, details, and attachments to other work.
 - 1. For installed products indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- D. Samples for Initial Selection: For each type of impact-resistant wall protection unit indicated.
 - 1. Include similar Samples of accent strips and accessories involving color selection.
- E. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below.
 - 1. Corner Guards: 12 inches (300 mm) long. Include examples of joinery, corners, end caps, top caps, and field splices.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.
- B. Material Certificates: For each impact-resistant plastic material, from manufacturer.

- C. Material Test Reports: For each impact-resistant plastic material.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For each impact-resistant wall protection unit to include in emergency, operation, and maintenance manuals specified in Form 816 Article 1.20-1.08.14 subsection 2 and described in NOTICE TO CONTRACTOR - CLOSEOUT DOCUMENTS.
 - 1. Include recommended methods and frequency of maintenance for maintaining optimum condition of plastic covers under anticipated traffic and use conditions. Include precautions against using cleaning materials and methods that may be detrimental to plastic finishes and performance.
- B. Warranty: For each impact-resistant wall protection unit specified in Form 816 Article 1.20-1.06.08 and described in NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Corner-Guard Covers: Full-size plastic covers of maximum length equal to 2 percent of each type, color, and texture of units installed, but no fewer than two, 4-foot- (1.2-m-) long units.
- B. Include mounting and accessory components. Replacement materials shall be from same production run as installed units.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: An employer of workers trained and approved by manufacturer.
- B. Source Limitations: Obtain impact-resistant wall protection units from single source from single manufacturer.
- C. Product Options: Drawings indicate size, profiles, and dimensional requirements of impact-resistant wall protection units and are based on the specific system indicated.
 - 1. Do not modify intended aesthetic effects, as judged solely by Architect, except with Architect's approval. If modifications are proposed, submit comprehensive explanatory data to Architect for review.
- D. Surface-Burning Characteristics: Provide impact-resistant, plastic wall protection units with surface-burning characteristics as determined by testing identical products per ASTM E 84, NFPA 255, or UL 723 by UL or another qualified testing agency.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Store impact-resistant wall protection units in original undamaged packages and containers inside well-ventilated area protected from weather, moisture, soiling, extreme temperatures, and humidity.
1. Maintain room temperature within storage area at not less than 70 deg F (21 deg C) during the period plastic materials are stored.
 2. Keep plastic sheet material out of direct sunlight.
 3. Store plastic wall protection components for a minimum of 72 hours, or until plastic material attains a minimum room temperature of 70 deg F (21 deg C).
 - a. Store corner-guard covers in a vertical position.

1.9 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install impact-resistant wall protection units until building is enclosed and weatherproof, wet work is complete and dry, and HVAC system is operating and maintaining temperature at 70 deg F (21 deg C) for not less than 72 hours before beginning installation and for the remainder of the construction period.

1.10 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of impact-resistant wall protection units that fail in materials or workmanship within specified warranty period.
1. Failures include, but are not limited to, the following:
 - a. Structural failures.
 - b. Deterioration of plastic and other materials beyond normal use.
 2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. PVC Plastic: ASTM D 1784, Class 1, textured, chemical- and stain-resistant, high-impact-resistant PVC or acrylic-modified vinyl plastic with integral color throughout; extruded and sheet material, thickness as indicated.
1. Impact Resistance: Minimum 25.4 ft-lbf/in. (1356 J/m) of notch when tested according to ASTM D 256, Test Method A.
 2. Chemical and Stain Resistance: Tested according to ASTM D 543.
 3. Self-extinguishing when tested according to ASTM D 635.
 4. Flame-Spread Index: 25 or less.
 5. Smoke-Developed Index: 450 or less.

- B. Polycarbonate Plastic Sheet: ASTM D 6098, S-PC01, Class 1 or 2, abrasion resistant; with a minimum impact-resistance rating of 15 ft-lbf/in. (800 J/m) of notch when tested according to ASTM D 256, Test Method A.
- C. Fasteners: Aluminum, nonmagnetic stainless-steel, or other noncorrosive metal screws, bolts, and other fasteners compatible with items being fastened. Use security-type fasteners where exposed to view.
- D. Adhesive: As recommended by impact-resistant plastic wall protection manufacturer and with a VOC content of 70 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.2 CORNER GUARDS

- A. Surface-Mounted, Resilient, Plastic Corner Guards: Assembly consisting of snap-on plastic cover installed over continuous retainer; including mounting hardware; fabricated with 90- or 135-degree turn to match wall condition.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Construction Specialties, Inc.
 - b. IPC Door and Wall Protection Systems; Division of InPro Corporation.
 - c. Korogard Wall Protection Systems; a division of RJF International Corporation.
 - 2. Cover: Extruded rigid plastic, minimum 0.100-inch (2.5-mm) wall thickness; as follows:
 - a. Profile: Nominal 2-inch- (50-mm-) long leg and 1/4-inch (6-mm) corner radius.
 - b. Height: 4 feet (1.2 m).
 - c. Color and Texture: As selected by Architect from manufacturer's full range.
 - 3. Retainer: Minimum 0.060-inch- (1.5-mm-) thick, one-piece, extruded aluminum.
 - 4. Retainer Clips: Manufacturer's standard impact-absorbing clips.
 - 5. Top and Bottom Caps: Prefabricated, injection-molded plastic; color matching cover; field adjustable for close alignment with snap-on cover.

2.3 FABRICATION

- A. Fabricate impact-resistant wall protection units to comply with requirements indicated for design, dimensions, and member sizes, including thicknesses of components.
- B. Assemble components in factory to greatest extent possible to minimize field assembly. Disassemble only as necessary for shipping and handling.
- C. Fabricate components with tight seams and joints with exposed edges rolled. Provide surfaces free of wrinkles, chips, dents, uneven coloration, and other imperfections. Fabricate members and fittings to produce flush, smooth, and rigid hairline joints.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and wall areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of work.
- B. Examine walls to which impact-resistant wall protection will be attached for blocking, grounds, and other solid backing that have been installed in the locations required for secure attachment of support fasteners.
 - 1. For impact-resistant wall protection units attached with adhesive or foam tape, verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Complete finishing operations, including painting, before installing impact-resistant wall protection system components.
- B. Before installation, clean substrate to remove dust, debris, and loose particles.

3.3 INSTALLATION

- A. General: Install impact-resistant wall protection units level, plumb, and true to line without distortions. Do not use materials with chips, cracks, voids, stains, or other defects that might be visible in the finished Work.
 - 1. Provide splices, mounting hardware, anchors, and other accessories required for a complete installation.
 - a. Provide anchoring devices to withstand imposed loads.
 - b. Where splices occur in horizontal runs of more than 20 feet (6.1 m), splice aluminum retainers and plastic covers at different locations along the run, but no closer than 12 inches (305 mm).
 - c. Adjust end and top caps as required to ensure tight seams.
- B. Impact-Resistant Wall Covering: Install top and edge moldings, corners, and divider bars as required for a complete installation.

3.4 CLEANING

- A. Immediately after completion of installation, clean plastic covers and accessories using a standard, ammonia-based, household cleaning agent.

- B. Remove excess adhesive using methods and materials recommended in writing by manufacturer.

END OF SECTION 102600

SECTION 105113 - METAL LOCKERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

- 1. Welded wardrobe lockers.
- 2. Locker benches.

- B. Related Sections:

- 1. Division 01, High Performance Buildings Requirements Section for credits 16a-38k-4(d)9
 - a. The above listed HPB credits are related to this section. Other HPB credits may apply and shall be reviewed for their potential applicability and conformed with as though listed.

1.3 PREINSTALLATION MEETINGS

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

1.4 ACTION SUBMITTALS

- A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

- B. Product Data: For each type of metal locker.

- 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for each type of metal locker and bench.

- C. Shop Drawings: For metal lockers.

- 1. Include plans, elevations, sections, details, and attachments to other work.
- 2. Show locker trim and accessories.
- 3. Include locker identification system and numbering sequence.

- D. Samples for Initial Selection: Manufacturer's color charts showing the full range of colors available.

- E. Product Schedule: For lockers. Use same designations indicated on Drawings.

1.5 INFORMATIONAL SUBMITTALS

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

1.6 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For Metal Lockers to include in emergency, operation, and maintenance manuals specified in Form 816 Article 1.20-1.08.14 subsection 2 and described in NOTICE TO CONTRACTOR - CLOSEOUT DOCUMENTS.
- B. Warranty: For Metal Lockers specified in Form 816 Article 1.20-1.06.08 and described in NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Do not deliver metal lockers until spaces to receive them are clean, dry, and ready for their installation.

1.8 FIELD CONDITIONS

- A. Field Measurements: Verify actual dimensions of recessed openings by field measurements before fabrication.

1.9 COORDINATION

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

1.10 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of metal lockers that fail in materials or workmanship, excluding finish, within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Structural failures.
 - b. Faulty operation of latches and other door hardware.
 - 2. Damage from deliberate destruction and vandalism is excluded.
 - 3. Warranty Period for Welded Metal Lockers: Lifetime from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain metal lockers, locker benches, and accessories from single source from single locker manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. Accessibility Requirements: For lockers indicated to be accessible, comply with applicable provisions in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines and ICC A117.1, 2003 with 2009 Connecticut Amendment.

2.3 WELDED WARDROBE LOCKERS

- A. Products: Subject to compliance with requirements, provide one of the following:
 - 1. Art Metal Products; Champ Corridor.
 - 2. Lyon Workspace Products, LLC; Integrated Frame.
 - 3. Penco Products, Inc; All-Welded.
- B. Doors: One piece; fabricated from 0.075-inch (1.90-mm) nominal-thickness steel sheet; formed into channel shape with double bend at vertical edges and with right-angle single bend at horizontal edges.
 - 1. Door Style: Vented panel as follows:
 - a. Louvered Vents: No fewer than six louver openings at top and bottom for single-tier, three louver openings at top and bottom for double-tier, two louver openings at top and bottom, or three louver openings at top or bottom, for triple-tier lockers.
- C. Body: Assembled by welding body components together. Fabricate from unperforated steel sheet with thicknesses as follows:
 - 1. Tops, Bottoms, and Sides: 0.060-inch (1.52-mm) nominal thickness.
 - 2. Backs: 0.048-inch (1.21-mm) nominal thickness.
 - 3. Shelves: 0.060-inch (1.52-mm) nominal thickness, with double bend at front and single bend at sides and back.
- D. Frames: Channel formed; fabricated from 0.060-inch (1.52-mm) nominal-thickness steel sheet; lapped and factory welded at corners; with top and bottom main frames factory welded into vertical main frames. Form continuous, integral, full-height door strikes on vertical main frames.
 - 1. Cross Frames between Tiers: Channel formed and fabricated from same material as main frames; welded to vertical main frames.

- E. Hinges: Welded to door and attached to door frame with no fewer than two factory-installed rivets per hinge that are completely concealed and tamper resistant when door is closed; fabricated to swing 180 degrees.
 - 1. Continuous Hinges: Manufacturer's standard, steel, full height.
- F. Recessed Door Handle and Latch: Stainless-steel cup with integral door pull, recessed so locking device does not protrude beyond door face; pry and vandal resistant.
 - 1. Multipoint Latching: Finger-lift latch control designed for use with built-in combination locks or padlocks; positive automatic latching and prelocking.
 - a. Latch Hooks: Equip doors 48 inches (1219 mm) and higher with three latch hooks and doors less than 48 inches (1219 mm) high with two latch hooks; fabricated from 0.120-inch (3.04-mm) nominal-thickness steel sheet; welded to full-height door strikes; with resilient silencer on each latch hook.
 - b. Latching Mechanism: Manufacturer's standard, rattle-free latching mechanism and moving components isolated to prevent metal-to-metal contact, and incorporating a prelocking device that allows locker door to be locked while door is open and then closed without unlocking or damaging lock or latching mechanism.
- G. Identification Plates: Manufacturer's standard, etched, embossed, or stamped aluminum plates, with numbers and letters at least 3/8 inch (9 mm) high.
- H. Hooks: Manufacturer's standard ball-pointed type, aluminum or steel; zinc plated.
- I. Continuous Sloping Tops: Fabricated from 0.060-inch (1.52-mm) nominal-thickness steel sheet, with a pitch of approximately 20 degrees.
 - 1. Closures: Hipped-end type.
- J. Recess Trim: Fabricated from 0.048-inch (1.21-mm) nominal-thickness steel sheet.
- K. Filler Panels: Fabricated from 0.048-inch (1.21-mm) nominal-thickness steel sheet.
- L. Boxed End Panels: Fabricated from 0.048-inch (1.21-mm) nominal-thickness steel sheet.
- M. Materials:
 - 1. Cold-Rolled Steel Sheet: ASTM A 1008/A 1008M, Commercial Steel (CS), Type B, suitable for exposed applications.
- N. Size: As indicated on the drawings.
- O. Finish: Baked enamel or powder coat.
 - 1. Color: As selected by Architect from manufacturer's full range.

2.4 HANDICAPPED BENCHES (HB)

- A. Provide bench units with overall assembly height of 17-1/2 inches (445 mm).
- B. Bench Tops: Manufacturer's standard one-piece units, with rounded corners and edges.
 - 1. Size: 1-1/4 inches thick (32 mm thick) provide 20-inch- (508-mm-) wide tops where handicapped benches are indicated.
 - 2. Laminated clear hardwood with one coat of clear sealer on all surfaces and one coat of clear lacquer on top and sides.
- C. Fixed Pedestals: Manufacturer's standard supports, with predrilled fastener holes for attaching bench top and anchoring to floor, complete with fasteners and anchors, and as follows:
 - 1. Tubular Steel: 1-1/4-inch- (32-mm-) diameter steel tubing, with 0.1265-inch- (3.2-mm-) thick steel flanges welded at top and base; with baked-enamel finish; anchored with exposed fasteners.
 - a. Color: As selected by Architect from manufacturer's full range.
- D. Materials:
 - 1. Steel Tube: ASTM A 500/A 500 M, cold rolled.

2.5 FABRICATION

- A. Fabricate metal lockers square, rigid, without warp, and with metal faces flat and free of dents or distortion. Make exposed metal edges safe to touch and free of sharp edges and burrs.
 - 1. Form body panels, doors, shelves, and accessories from one-piece steel sheet unless otherwise indicated.
 - 2. Provide fasteners, filler plates, supports, clips, and closures as required for complete installation.
- B. Fabricate each metal locker with an individual door and frame; individual top, bottom, and back; and common intermediate uprights separating compartments. Factory weld frame members of each metal locker together to form a rigid, one-piece assembly.
- C. Equipment: Provide each locker with an identification plate and the following equipment:
 - 1. Single-Tier Units: Shelf, one double-prong ceiling hook, and two single-prong wall hooks.
 - 2. Double-Tier Units: One double-prong ceiling hook and two single-prong wall hooks.
 - 3. Triple-Tier Units: One double-prong ceiling hook.
- D. Welded Construction: Factory preassemble metal lockers by welding all joints, seams, and connections; with no bolts, nuts, screws, or rivets used in assembly of main locker groups. Factory weld main locker groups into one-piece structures. Grind exposed welds flush.

- E. Accessible Lockers: Fabricate as follows:
 - 1. Locate bottom shelf no lower than 15 inches (381 mm) above the floor.
 - 2. Where hooks, coat rods, or additional shelves are provided, locate no higher than 48 inches (1219 mm) above the floor.
- F. Continuous Sloping Tops: Fabricated in lengths as long as practical, without visible fasteners at splice locations; finished to match lockers.
 - 1. Sloping-top corner fillers, mitered.
- G. Recess Trim: Fabricated with minimum 2-1/2-inch (64-mm) face width and in lengths as long as practical; finished to match lockers.
- H. Filler Panels: Fabricated in an unequal leg angle shape; finished to match lockers. Provide slip-joint filler angle formed to receive filler panel.
- I. Boxed End Panels: Fabricated with 1-inch- (25-mm-) wide edge dimension, and designed for concealing fasteners and holes at exposed ends of nonrecessed metal lockers; finished to match lockers.
 - 1. Provide one-piece panels for double-row (back-to-back) locker ends.
- J. Finished End Panels: Designed for concealing unused penetrations and fasteners, except for perimeter fasteners, at exposed ends of nonrecessed metal lockers; finished to match lockers.
 - 1. Provide one-piece panels for double-row (back-to-back) locker ends.
- K. Center Dividers: Full-depth, vertical partitions between bottom and shelf; finished to match lockers.

2.6 ACCESSORIES

- A. Fasteners: Zinc- or nickel-plated steel, slotless-type, exposed bolt heads; with self-locking nuts or lock washers for nuts on moving parts.
- B. Anchors: Material, type, and size required for secure anchorage to each substrate.
 - 1. Provide nonferrous-metal or hot-dip galvanized anchors and inserts on inside face of exterior walls for corrosion resistance.
 - 2. Provide toothed-steel or lead expansion sleeves for drilled-in-place anchors.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine walls, floors, and support bases, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

- B. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. General: Install lockers level, plumb, and true; shim as required, using concealed shims.
 - 1. Anchor locker runs at ends and at intervals recommended by manufacturer, but not more than 36 inches (910 mm) o.c. Using concealed fasteners, install anchors through backup reinforcing plates, channels, or blocking as required to prevent metal distortion.
 - 2. Anchor single rows of metal lockers to walls near top and bottom of lockers.
 - 3. Anchor back-to-back metal lockers to floor.
- B. Welded Lockers: Connect groups together with standard fasteners, with no exposed fasteners on face frames.
- C. Equipment:
 - 1. Attach hooks with at least two fasteners.
 - 2. Attach door locks on doors using security-type fasteners.
 - 3. Identification Plates: Identify metal lockers with identification indicated on Drawings.
 - a. Attach plates to each locker door, near top, centered, with at least two aluminum rivets.
- D. Trim: Fit exposed connections of trim, fillers, and closures accurately together to form tight, hairline joints, with concealed fasteners and splice plates.
 - 1. Attach recess trim to recessed metal lockers with concealed clips.
 - 2. Attach filler panels with concealed fasteners. Locate filler panels where indicated on Drawings.
 - 3. Attach sloping-top units to metal lockers, with closures at exposed ends.
 - 4. Attach boxed end panels using concealed fasteners to conceal exposed ends of nonrecessed metal lockers.
 - 5. Attach finished end panels using fasteners only at perimeter to conceal exposed ends of nonrecessed metal lockers.
- E. Fixed Locker Benches: Provide no fewer than two pedestals for each bench, uniformly spaced not more than 72 inches (1830 mm) apart. Securely fasten tops of pedestals to undersides of bench tops, and anchor bases to floor.

3.3 ADJUSTING

- A. Clean, lubricate, and adjust hardware. Adjust doors and latches to operate easily without binding.

3.4 PROTECTION

- A. Protect metal lockers from damage, abuse, dust, dirt, stain, or paint. Do not permit use during construction.
- B. Touch up marred finishes, or replace metal lockers that cannot be restored to factory-finished appearance. Use only materials and procedures recommended or furnished by locker manufacturer.

END OF SECTION 105113

SECTION 122413 - ROLLER WINDOW SHADES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

- 1. Motor-operated roller shades with single rollers.
- 2. Manually operated roller shades with single rollers.

B. Related Requirements:

- 1. Division 01, High Performance Buildings Requirements Section for credits 16a-38k-4(b)4
 - a. The above listed HPB credits are related to this section. Other HPB credits may apply and shall be reviewed for their potential applicability and conformed with as though listed.
- 2. Section 061053 "Miscellaneous Rough Carpentry" for wood blocking and grounds for mounting roller shades and accessories.
- 3. Section 079200 "Joint Sealants" for sealing the perimeters of installation accessories for light-blocking shades with a sealant.

1.3 ACTION SUBMITTALS

- A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.
- B. Product Data: For each type of product.
 - 1. Include styles, material descriptions, construction details, dimensions of individual components and profiles, features, finishes, and operating instructions for roller shades.
- C. Shop Drawings: Show fabrication and installation details for roller shades, including fabric materials, their orientation to rollers, and their seam and batten locations.
 - 1. Motor-Operated Shades: Include details of installation and diagrams for power, signal, and control wiring.
- D. Samples: For each exposed product and for each color and texture specified, 10 inches (250 mm) long.

- E. Samples for Initial Selection: For each type and color of fabric material.
 - 1. Include Samples of accessories involving color selection.
- F. Samples for Verification: For each type of roller shade.
 - 1. Fabric Material: Not less than 10 inches (250 mm) square. Mark inside face of material if applicable.
 - 2. Roller Shade: Full-size operating unit, not less than 16 inches (400 mm) wide by 36 inches (900 mm) long for each type of roller shade indicated.
 - 3. Installation Accessories: Full-size unit, not less than 10 inches (250 mm) long.
- G. Roller-Shade Schedule: Use same designations indicated on Drawings.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Product Certificates: For each type of fabric material, signed by product manufacturer.
- C. Product Test Reports: For each type of fabric material, for tests performed by manufacturer and witnessed by a qualified testing agency.

1.5 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For Roller Window Shades to include in emergency, operation, and maintenance manuals specified in Form 816 Article 1.20-1.08.14 subsection 2 and described in NOTICE TO CONTRACTOR - CLOSEOUT DOCUMENTS.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Roller Shades: Full-size units equal to 5 percent of quantity installed for each size, color, and fabric material indicated, but no fewer than two units.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: Fabricator of products.
- B. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.
 - 1. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.

2. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver roller shades in factory packages, marked with manufacturer, product name, and location of installation using same designations indicated on Drawings.

1.9 FIELD CONDITIONS

- A. Environmental Limitations: Do not install roller shades until construction and finish work in spaces, including painting, is complete and dry and ambient temperature and humidity conditions are maintained at the levels indicated for Project when occupied for its intended use.
- B. Field Measurements: Where roller shades are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication and indicate measurements on Shop Drawings. Allow clearances for operating hardware of operable glazed units through entire operating range. Notify Architect of installation conditions that vary from Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Motor Mounted in Shade Pocket:
 1. Basis-of-Design Product: Subject to compliance with requirements, provide Radiance Motorized Shade; Insolroll.
- B. Manually operated roller shades with single rollers:
 1. Basis-of-Design Product: Subject to compliance with requirements, provide Clutch Shade with Fascia; Insolroll.
- C. Fabric Material:
 1. Basis-of-Design Product: Subject to compliance with requirements, provide Silverscreen; Verosol.
- D. Source Limitations: Obtain roller shades from single source from single manufacturer.

2.2 MOTOR-OPERATED, SINGLE-ROLLER SHADES

- A. Motorized Operating System: Provide factory-assembled, shade-operator system of size and capacity and with features, characteristics, and accessories suitable for conditions indicated, complete with electric motor and factory-prewired motor controls, power disconnect switch,

enclosures protecting controls and operating parts, and accessories required for reliable operation without malfunction. Include wiring from motor controls to motors. Coordinate operator wiring requirements and electrical characteristics with building electrical system.

1. Electrical Components: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 2. Electric Motor: Manufacturer's standard quiet operation tubular, enclosed in roller.
 - a. Electrical Characteristics: Single phase, 110V, 60 Hz.
 3. Remote Control: Electric controls with NEMA ICS 6, Type 1 enclosure for recessed or flush mounting. Provide the following for remote-control activation of shades:
 - a. Individual/Group Control Station: Maintained-contact, three-position, rocker-style, wall-switch-operated control station with open, close, and center off functions for individual and group control.
 - b. Color: As selected by Architect from manufacturer's full range.
 4. Limit Switches: Adjustable switches interlocked with motor controls and set to stop shades automatically at fully raised and fully lowered positions.
 5. Operating Features:
 - a. Group switching with integrated switch control; single faceplate for multiple switch cutouts.
- B. Rollers: Corrosion-resistant steel or extruded-aluminum tubes of diameters and wall thicknesses required to accommodate operating mechanisms and weights and widths of fabric panels indicated without deflection. Provide with permanently lubricated drive-end assemblies and idle-end assemblies designed to facilitate removal of shadebands for service.
1. Roller Drive-End Location: Right side of inside face of shade.
 2. Direction of Shadeband Roll: Regular, from back of roller.
 3. Fabric-to-Roller Attachment: Manufacturer's standard method, as recommended by the manufacturer..
- C. Mounting Hardware: Brackets or endcaps, corrosion resistant and compatible with roller assembly, operating mechanism, installation accessories, and mounting location and conditions indicated.
- D. Fabric:
1. Fabric Panel : Refer to 2.4
- E. Installation Accessories:
1. Exposed Headbox: Rectangular, extruded-aluminum enclosure including front fascia, top and back covers, endcaps, and removable bottom closure.
 - a. Height: Manufacturer's standard in height required to enclose roller and shadeband when shade is fully open, but not less than 4 inches (102 mm).

2. Endcap Covers: To cover exposed endcaps.
3. Closure Panel and Wall Clip: Removable aluminum panel designed for installation at bottom of site-constructed ceiling recess or pocket and for snap-in attachment to wall clip without fasteners.
4. Installation Accessories Color and Finish: As selected from manufacturer's full range.

2.3 MANUALLY OPERATED SHADES WITH SINGLE ROLLERS

- A. Chain-and-Clutch Operating Mechanisms: With continuous-loop bead chain and clutch that stops shade movement when bead chain is released; permanently adjusted and lubricated.
 1. Bead Chains: Nickel-plated metal.
 - a. Loop Length: Full length of roller fabric panel.
 - b. Limit Stops: Provide upper and lower ball stops.
 - c. Chain-Retainer Type: Chain tensioner, sill mounted.
- B. Rollers: Corrosion-resistant steel or extruded-aluminum tubes of diameters and wall thicknesses required to accommodate operating mechanisms and weights and widths of fabric panels indicated without deflection. Provide with permanently lubricated drive-end assemblies and idle-end assemblies designed to facilitate removal of fabric panels for service.
 1. Roller Drive-End Location: Right side of inside face of fabric panel.
 2. Direction of Shadeband Roll: Regular, from back of roller.
 3. Fabric Panel to-Roller Attachment: Manufacturer's standard method.
- C. Mounting Hardware: Brackets or endcaps, corrosion resistant and compatible with roller assembly, operating mechanism, installation accessories, and mounting location and conditions indicated.
- D. Roller-Coupling Assemblies: Coordinated with operating mechanism and designed to join up to three inline rollers into a multiband shade that is operated by one roller drive-end assembly.
- E. Fabric:
 1. Fabric Panel: Refer to 2.4.
- F. Installation Accessories:
 1. Front Fascia: Aluminum extrusion that conceals front and underside of roller and operating mechanism and attaches to roller endcaps without exposed fasteners.
 - a. Shape: L-shaped.
 - b. Height: Manufacturer's standard height required to conceal roller and fabric panel when panel is fully open, but not less than 4 inches (102 mm).
 2. Endcap Covers: To cover exposed endcaps.

3. Installation Accessories Color and Finish: As selected from manufacturer's full range.

2.4 FABRIC PANEL MATERIALS

- A. Fabric Panel Flame-Resistance Rating: Comply with NFPA 701. Testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
- B. Light-Filtering Fabric: Woven fabric, stain and fade resistant.
 1. Source: Verosol..
 2. Composition: One layer of aluminum vacuum formed to PVC-coated fiberglass fabric.
 3. Weave: Mesh.
 4. Thickness: 0.50mm.
 5. Weight: 400 g/sq. m.
 6. Roll Width: Varies.
 7. Openness Factor: 5 percent.
 8. Color: As selected by Architect from manufacturer's full range.

2.5 ROLLER-SHADE FABRICATION

- A. Product Safety Standard: Fabricate roller shades to comply with WCMA A 100.1, including requirements for flexible, chain-loop devices; lead content of components; and warning labels.
- B. Unit Sizes: Fabricate units in sizes to fill window and other openings as follows, measured at 74 deg F (23 deg C):
 1. Outside of Jamb Installation: Width and length as indicated, with terminations between shades of end-to-end installations at centerlines of mullion or other defined vertical separations between openings.
- C. Fabric Panel Fabrication: Fabricate fabric panels without battens or seams to extent possible except as follows:
 1. Vertical Shades: Where width-to-length ratio of fabric panel is equal to or greater than 1:4, provide battens and seams at uniform spacings along fabric panel length to ensure fabric panel tracking and alignment through its full range of movement without distortion of the material.
 2. Railroaded Materials: Railroad material where material roll width is less than the required width of fabric panel and where indicated. Provide battens and seams as required by railroaded material to produce fabric panels with full roll-width panel(s) plus, if required, one partial roll-width panel located at top of fabric panel.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances, operational clearances, accurate locations of

connections to building electrical system, and other conditions affecting performance of the Work.

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

3.2 ROLLER-SHADE INSTALLATION

- A. Install roller shades level, plumb, and aligned with adjacent units according to manufacturer's written instructions.
- B. Electrical Connections: Connect motor-operated roller shades to building electrical system.

3.3 ADJUSTING

- A. Adjust and balance roller shades to operate smoothly, easily, safely, and free from binding or malfunction throughout entire operational range.

3.4 CLEANING AND PROTECTION

- A. Clean roller-shade surfaces after installation, according to manufacturer's written instructions.
- B. Provide final protection and maintain conditions, in a manner acceptable to manufacturer and Installer that ensure that roller shades are without damage or deterioration at time of Substantial Completion.
- C. Replace damaged roller shades that cannot be repaired, in a manner approved by Architect, before time of Substantial Completion.

3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain motor-operated roller shades.

END OF SECTION 122413

SECTION 129300 - SITE FURNISHINGS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Benches.
2. Tables and Chairs.
3. Trash receptacles.
4. Ash receptacles.
5. Bike Rack

1.2 ACTION SUBMITTALS

- A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.
- B. Product Data: For each type of product.
- C. Samples: For each exposed product and for each color and texture specified.
- D. Samples for Initial Selection: For units with factory-applied finishes.
- E. Samples for Verification: For each type of exposed finish, not less than 6-inch- (152-mm-) long linear components and 4-inch- (102-mm-) square sheet components.
- F. Product Schedule: For site furnishings. Use same designations indicated on Drawings.

1.3 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For site furnishings to include in the maintenance manuals specified in Form 816 Article 1.20-1.08.14 subsection 2 and described in NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS.

1.4 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Trash Receptacle Inner Containers: Two full-size units for each size indicated.

1.5 QUALITY ASSURANCE

- A. Source Limitations: Obtain bench, table and chairs, litter and ash receptacle, litter receptacle, and bike rack products from single source with resources to provide materials and products of consistent quality in appearance and physical properties.

PART 2 - PRODUCTS

2.1 BENCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Forms+Surfaces.
 - 2. Landscape Forms.
 - 3. Maglin Site Furniture Inc.
- B. Frame: Cast aluminum
- C. Seat:
 - 1. Material:
 - a. Perforated steel.
 - 2. Seat Height: 18" +/-.
 - 3. Seat Surface Shape: Contoured.
 - 4. Overall Height: 18" +/-.
 - 5. Overall Width: 68" +/-.
 - 6. Overall Depth: 18" +/-.
 - 7. Arms: None.
- D. Aluminum Finish: Powdercoated.
 - 1. Color: Metallic Silver.
- E. Steel Finish: Powdercoated.
 - 1. Color: Metallic Silver.
- F. Surface Mount Hardware: Provide paver adapters to mount bench to concrete slab below unit paver pavement.

2.2 TABLES AND CHAIRS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Forms+Surfaces.
 - 2. Landscape Forms.

3. Maglin Site Furniture Inc.
- B. Table Frame: Cast aluminum.
- C. Chair:
 1. Material:
 - a. Cast Aluminum.
 2. Seat Height: 18" +/-.
 3. Seat Surface Shape: Contoured or dished.
 4. Overall Height: 33" +/-.
 5. Overall Width: 20" +/-.
 6. Overall Depth: 21" +/-.
 7. Arms: None.
 8. Seating Configuration: Multiple units, four chairs per table.
- D. Table Top:
 1. Material:
 - a. Steel
 2. Surface Shape: Round.
 3. Feature: 30" +/- height.
- E. Aluminum Finish: Powdercoated.
 1. Color: Metallic Silver
- F. Steel Finish: Powdercoated.
 1. Color: Metallic Silver.

2.3 LITTER AND ASH RECEPTACLES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Forms+Surfaces.
 2. Landscape Forms.
 3. Maglin Site Furniture Inc.
- B. Steel Facing Surrounds: Perforated-steel sheet.
- C. Support Frames: Steel.
- D. Litter and Ash Receptacles:
 1. Receptacle Shape and Form: Round cylinder; with opening for depositing trash in receptacle side.

2. Ash Receptacle Function: Uncovered receptacle with sand pan for depositing cigarette butts; fire-proof design; bowl and pan removable for cleaning.
3. Inner Container: Rigid plastic container with drain holes; designed to be removable and reusable.
4. Disposable Liners: Provide receptacle designed to accommodate disposable liners.
5. Capacity: Not less than 30 gal. (114 L).
6. Service Access: Basket pivots forward for trash removal.
7. Post Mount: Color-coated steel pipe; color to match receptacle.

E. Steel Finish: Powdercoated.

1. Color: Metallic Silver.

2.4 LITTER RECEPTACLES

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

1. Forms+Surfaces.
2. Landscape Forms.
3. Maglin Site Furniture Inc.

B. Support Frames: Cast aluminum.

C. Litter Receptacles:

1. Receptacle Shape and Form: Shape and form shall closely match litter and ash receptacle; with opening for depositing trash in lid or top.
2. Inner Container: Rigid plastic container with drain holes.
3. Disposable Liners: Provide receptacle designed to accommodate disposable liners.
4. Capacity: 30 gal. (114 L).
5. Service Access: Basket pivots forward for trash removal.

D. Aluminum Finish: Powdercoated.

1. Color: Metallic Silver

2.5 BIKE RACKS

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

1. Forms+Surfaces.
2. Landscape Forms.
3. Maglin Site Furniture Inc.

B. Size:

- a. Depth: 3-1/2 inches.
- b. Height: 30-1/4 inches
- c. Length: 20 inches

- C. Mounting:
 - 1. Surface Mount
- D. Materials:
 - 1. Frame: Aluminum Casting
 - 2. Adjustable Leveler: Stainless steel round bar
 - 3. Anchor Cover: Aluminum Casting
 - 4. Anchor Set Screw: ¼-20x1” set screw, cup point, hex drive, magni-coated.
 - 5. Anchor Bolts: Corrosion resistant

2.6 FABRICATION

- A. Metal Components: Form to required shapes and sizes with true, consistent curves, lines, and angles. Separate metals from dissimilar materials to prevent electrolytic action.
- B. Welded Connections: Weld connections continuously. Weld solid members with full-length, full-penetration welds and hollow members with full-circumference welds. At exposed connections, finish surfaces smooth and blended so no roughness or unevenness shows after finishing and welded surface matches contours of adjoining surfaces.
- C. Pipes and Tubes: Form simple and compound curves by bending members in jigs to produce uniform curvature for each repetitive configuration required; maintain cylindrical cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of handrail and railing components.
- D. Exposed Surfaces: Polished, sanded, or otherwise finished; all surfaces smooth, free of burrs, barbs, splinters, and sharpness; all edges and ends rolled, rounded, or capped.
- E. Factory Assembly: Assemble components in the factory to greatest extent possible to minimize field assembly. Clearly mark units for assembly in the field.

2.7 GENERAL FINISH REQUIREMENTS

- A. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.8 ALUMINUM FINISHES

- A. Baked-Enamel, Powder-Coat Finish: Manufacturer's standard, baked, polyester, powder-coat finish complying with finish manufacturer's written instructions for surface preparation, including pretreatment, application, baking, and minimum dry film thickness.

2.9 STEEL AND GALVANIZED-STEEL FINISHES

- A. Baked-Enamel, Powder-Coat Finish: Manufacturer's standard, baked, polyester, powder-coat finish complying with finish manufacturer's written instructions for surface preparation, including pretreatment, application, baking, and minimum dry film thickness.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for correct and level finished grade, mounting surfaces, installation tolerances, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

- A. Comply with manufacturer's written installation instructions unless more stringent requirements are indicated. Complete field assembly of site furnishings where required.
- B. Unless otherwise indicated, install site furnishings after landscaping and paving have been completed.
- C. Install site furnishings level, plumb, true, and securely anchored or positioned as indicated at locations indicated on Drawings.
- D. Post Setting: Set cast-in support posts in concrete footing with smooth top, shaped to shed water. Protect portion of posts above footing from concrete splatter. Verify that posts are set plumb or at correct angle and are aligned and at correct height and spacing. Hold posts in position during placement and finishing operations until concrete is sufficiently cured.

END OF SECTION 129300

SECTION 142100 – MACHINE- ROOM-LESS ELECTRIC TRACTION ELEVATORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

- 1. Electric geared traction elevators, machinery and operating equipment.

B. Related Sections:

- 1. Section 033000 "Cast-in-Place Concrete" for setting sleeves, inserts, and anchoring devices in concrete.
- 2. Section 042000 "Unit Masonry" for setting sleeves, inserts, and anchoring devices in masonry and for grouting elevator entrance frames installed in masonry walls.
- 3. Section 055000 "Metal Fabrications" for the following:
 - a. Attachment plates and angle brackets for supporting guide-rail brackets.
 - b. Structural-steel shapes for subsills.
 - c. Pit ladders.
 - d. Cants in hoistways made from steel sheet.
 - e. Hoist beams
- 4. Section 071616 "Crystalline Waterproofing" for waterproofing of elevator pits.
- 5. Section 271500 "Communications Horizontal Cabling" for telephone service for elevators.
- 6. Section 282304 "Indoor and Outdoor Surveillance CCTV System" for security cameras installed in elevator cab.
- 7. Section 283100 "Addressable Fire-Alarm Detection System" for smoke detectors in elevator lobbies to initiate emergency recall operation and heat detectors in shafts and machine rooms to disconnect power from elevator equipment before sprinkler activation and for connection to elevator controllers.

1.3 DEFINITIONS

- A. Definitions in ASME A17.1 apply to work of this Section.

1.4 ACTION SUBMITTALS

- A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

- B. Professional Certification: Provide Shop Drawings and engineering calculations, which indicate loading requirements on structural elements of building, prepared and sealed by a Registered Professional Engineer, licensed in the State of Connecticut.
- C. Product Data: Submit for each elevator, include capacities, sizes, performances, operations, safety features, finishes, and similar information. Include product data for car enclosures, hoistway entrances, and operation, control system, environmental limitations and signal systems.
- D. Shop Drawings:
 1. Include plans, elevations, sections, and large-scale details of each elevator cab and hoistway entrance, indicating service at each landing, machine room layout, coordination with building structure, relationships with other construction, and locations of equipment.
 2. Include large-scale layout of car-control station and standby power operation control panel.
 3. Indicate maximum dynamic and static loads imposed on building structure at points of support, and maximum and average power demands.
 4. Complete wiring diagrams of system circuits and controls.
 5. Rail bracket spacing and maximum loads on guide rails.
 6. Weights of principal components.
 7. Loads on hoisting beams.
 8. Member sizes.
 9. Power configuration data, including horsepower, voltage and amperage requirements, starting current. Full load running current and demand factor for applicable motors. Include maximum and average power demands.
 10. Variations from specified requirements.
 11. Seismic requirements.
- E. Samples for Initial Selection: For finishes involving color selection.
- F. Samples for Verification: For exposed car, hoistway door and frame, and signal equipment finishes; 3-inch (75-mm) square Samples of sheet materials; and 4-inch (100-mm) lengths of running trim members.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Seismic Qualification Certificates: For elevator equipment, accessories, and components, from manufacturer.
 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
 3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.
- C. Manufacturer Certificates: Signed by elevator manufacturer certifying that hoistway, pit, and machine room layout and dimensions, as shown on Drawings, and electrical service including standby power generator, as shown and specified, are adequate for elevator system being provided.

- D. Sample Warranty: For special warranty.

1.6 CLOSEOUT SUBMITTALS

- 1. Maintenance Data: For Machine-Room-Less Electrical Traction Elevators to include in emergency, operation, and maintenance manuals specified in Form 816 Article 1.20-1.08.14 subsection 2 and described in NOTICE TO CONTRACTOR - CLOSEOUT DOCUMENTS. Include the following:
 - 2. Submit operation, cleaning and maintenance data for materials and systems provided.
 - 3. Include description of elevator system method of operation and control, including door operation, signals, fire fighter's service, emergency power operation, and other special or non-standard features provided.
 - 4. Provide parts catalogs with complete list of equipment replacement parts with equipment description and identifying numbers.
 - 5. Provide legible schematic wiring diagrams covering electrical equipment installed, including changes made in final Work, with symbols listed corresponding to identity or markings on both machine room and hoistway apparatus.
 - 6. Provide following maintenance details:
 - a. Lubrication chart.
 - b. Trouble shooting procedures.
 - c. Adjustment techniques.
 - d. Operating checks.
- B. Inspection and Acceptance Certificates and Operating Permits: As required by authorities having jurisdiction for normal, unrestricted elevator use.
- C. Continuing Maintenance Proposal: Submit a continuing maintenance proposal from Installer to Owner, in the form of a standard one-year maintenance agreement, starting on date initial maintenance service is concluded. State services, obligations, conditions, and terms for agreement period and for future renewal options.
- D. Warranty: For Machine-Room-Less Electric Traction Elevators specified in Form 816 Article 1.20-1.06.08 and described in NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: Elevator manufacturer or an authorized representative who is trained and approved by manufacturer.
- B. Designer/Engineer Qualifications: Design components with loading requirements on structural elements of building under direct supervision of a Registered Professional Engineer, licensed in the State of Connecticut.
- C. Maintenance Personnel Qualifications: Employees of elevator installer.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Deliver, store, and handle materials, components and equipment in manufacturer's protective packaging. Store materials, components, and equipment off of ground, under cover, and in a dry location.

1.9 COORDINATION

- A. Coordinate installation of sleeves, block outs, elevator equipment with integral anchors, and other items that are embedded in concrete or masonry for elevator equipment. Furnish templates, sleeves, elevator equipment with integral anchors, and installation instructions and deliver to Project site in time for installation.
- B. Coordinate sequence of elevator installation with other work to avoid delaying the work.
- C. Coordinate locations and dimensions of other work relating to elevators including pit ladders; sumps and floor drains in pits; entrance subsills; electrical service; and electrical outlets, lights, and switches in hoistways, pits, and machine rooms.

1.10 PROJECT CONDITIONS

- A. Verify dimensions of supporting structure at site by accurate field measurements so that elevator Work will be accurately fabricated and fitted to structure and that clearances and alignments are proper for installation of Work.
- B. Provide for erection tolerances corresponding with specified tolerances for other Work where field measurements cannot be obtained.
- C. Remedy unsatisfactory tolerances in adjoining Work.

1.11 WARRANTY

- A. Manufacturer's Special Warranty: Manufacturer agrees to repair, restore, or replace elevator work that fails in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, operation or control system failure, including excessive malfunctions; performances below specified ratings; excessive wear; unusual deterioration or aging of materials or finishes; unsafe conditions; need for excessive maintenance; abnormal noise or vibration; and similar unusual, unexpected, and unsatisfactory conditions.
 - 2. Warranty Period: One year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide Ecospace by Kone Inc.

- B. Source Limitations: Obtain elevators from single manufacturer.
 - 1. Major elevator components, including pump-and-tank units, plunger-cylinder assemblies, controllers, signal fixtures, door operators, car frames, cars, and entrances, shall be manufactured by single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. Comply with requirements of local authority having jurisdiction and any authority which may govern requirements for elevators.
- B. Regulatory Requirements: Comply with ASME A17.1/CSA B44.
- C. ASME A17.1 "Safety Code for Elevators and Escalators".
- D. Accessibility Requirements: Comply with Section 407 in the U.S. Architectural & Transportation Barriers Compliance Board's ADA-ABA Accessibility Guidelines and ICC A117.1 – 2003 w/ 2009 State of Connecticut amendment.
- E. Seismic Performance: Elevator system shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
 - 1. The term "withstand" means "the system will remain in place without separation of any parts when subjected to the seismic forces specified and the system will be fully operational after the seismic event."
 - 2. Provide earthquake equipment required by ASME A17.1/CSA B44.
 - 3. Provide seismic switch required by ASCE/SEI 7.
 - 4. Design earthquake spectral response acceleration short period (Sds) for Project: See Structural Drawings.
 - 5. Seismic design category is determined by Project's occupancy category and design earthquake spectral response acceleration coefficients (Sds and Sd1).
 - 6. Project's Seismic Design Category: See Structural Drawings.
 - 7. Elevator Component Importance Factor: See Structural Drawings.

2.3 MATERIALS

- A. Carbon Steel: ASTM A1008, cold rolled, commercial quality sheet steel, free from scale, pitting or other defects; matte finish and stretcher leveled.
- B. Finish Materials: As indicated in subsequent sections.
- C. Light Fixtures: As selected by Architect from manufacturers standards.
- D. Protection Pads and Buttons:
 - 1. Type: Flame resistant fabric and filling with sufficient stitching to prevent sagging of filling.
 - 2. Attachment devices: Manufacturer's standard stainless steel buttons and grommets.
 - 3. Cutouts: Provide cutouts for control stations and other signal devices.

2.4 EQUIPMENT

- A. Motors, Controller, Controls, Buttons, Wiring, Devices, and Indicators: UL approved
- B. Microprocessor:
 - 1. Provide elevator manufacturer's microprocessor-based control system with software suitable for intended building occupancy to perform car operational control and hardware necessary to connect, transfer and interrupt power and protect motor against overloading.
 - 2. Properly shield each controller cabinet containing memory equipment from line pollution.
 - 3. Design microprocessor system to accept re-programming with minimum down time.
- C. General Operational Control:
 - 1. Operate without attendants as group and be capable of balancing service and continuing operation with one or more cars removed from system.
 - 2. Provide means to periodically review and modify assignments to improve service.
- D. Elevator Machine: AC gearless traction machine, with permanent magnet synchronous motor, direct current electro-mechanical disc brakes, and integral traction drive sheave, mounted to the car guide rail at the top of the hoistway.
- E. Drive: Provide variable voltage variable frequency AC drive system to develop high starting torque with low starting current.
- F. Controller Location: Locate controller in an integral cabinet adjacent to the entrance frame at the top landing of the elevator. See floor plans for controller location.
- G. Hoisting Motor:
 - 1. Reversible motor with high starting torque and low starting current designed to withstand severe loads encountered in elevator service; rated for 30 minutes, conforming to NEMA standards.
 - 2. Provide Class A insulation for 50..-C rise.
 - 3. Provide sufficient capacity to operate with contract load at contract speed.
 - 4. Provide motor starting controls such that under no circumstances shall motor starting current exceed 3.0 times motor full load current.
- H. Voltage Control:
 - 1. Provide elevator manufacturer's solid-state power converters.
 - 2. Provide line filters or chokes to prevent electrical peaks or spikes from feeding back into building power system.
- I. Guide Rails, Ropes, Cables, Counterweights, Sheaves, Buffers, Attachment Brackets and Supports, and Anchors: Designed and sized according to code with applicable safety factors.

2.5 COMPONENTS AND FABRICATION

- A. Electrical Components:

1. Fittings: Steel compression type for electrical metallic tubing; fittings with set screws are acceptable only when separate grounding conductor is installed across joint.
2. Do not parallel conductors to increase current carrying capacity unless individually fused.
3. Do not use armored flexible metal conduit as grounding conductor.
4. Provide additional disconnect switches and wiring to suit machine room layout.
5. Include wiring and connections to elevator devices remote from hoistway and between elevator machine.

B. Cars:

1. Frame and platform:
 - a. Construct frame of structural or formed steel members.
 - b. Construct platform of steel reinforcing with plywood or steel plate subfloor components.
 - c. Mount platform on resilient pads.
2. Shells:
 - a. Fabricate from manufacturer's standard gage sheet steel for walls and canopy, suitably reinforced for rigidity and cut out for accessories and panels.
 - b. Make joints between panels vertical, flush, even and light tight.
 - c. Provide vents at bottom of panels.
 - d. Provide sound deadening at backs of panels.
 - e. Provide black finish on panel recesses and corner straps.
 - f. Reinforce canopy/ceiling construction as necessary to maintain loads applied during car top inspection.
 - g. Provide car top emergency and inspection hatches as required by code. h. Provide side emergency access panels as required by code.
 - i. Provide car top railings as required by code.
3. Door panels:
 - a. Flush hollow metal construction, minimum 16 gage (1.5 mm thick) sheet steel, sound deadened, minimum 1 inch (25 mm) thickness.
 - b. Reinforce by continuous vertical reinforcing as required for adequate support and surface flatness for configurations indicated.
 - c. Provide each door panel with 2 accurately machined guides of design that will permit replacement without removal of doors.
4. Return panels:
 - a. Fixed configuration, suitably reinforced as required for surface flatness and support of equipment cutouts.
 - b. Incorporate operating controls, control panel, signals, required signage, certificate holder, telephone cabinets and other features as required, indicated or specified.
5. Sills: Extruded aluminum; manufacturer's standard profile.
6. Ventilation:
 - a. Provide exhaust unit with 2-speed operation.
 - b. Furnish suitable isolation mountings and sound insulation to provide quiet operation.
7. Emergency lighting: Furnish one emergency light in each cab; manufacturer's standard, unless otherwise indicated.
8. Telephones and cabinets:
 - a. Provide one cabinet for each cab, in front return.
 - b. Provide one phone for emergency communications, connected to security service (security office) for 24-hour monitoring, as required to comply with authorities having jurisdiction and with requirements of the ADA. Provide telephone with the following features:
 - 1) Battery back-up system.
 - 2) Internal speaker and microphone, for use without handset. Mount speaker button 4'-0" maximum above car floor.

- 3) Emergency communication system shall not require voice communication. At a minimum, provide both audio and visual indication that call has been answered.
 - 4) Field-programmable auto-dial memory and location identification signal device, activated by push button which illuminates when call is answered.
 - 5) Raised tactile lettering in panel, reading "EMERGENCY USE ONLY", and providing instructions for use in both English and Braille.
9. Security Features: Provide the following security features. Security features shall not affect emergency firefighters' service.
- a. Card-Reader Operation: System uses card readers at car-control stations and hall push-button stations to authorize calls. Security system determines which landings and at what times calls require authorization by card reader. Provide required conductors in traveling cable and panel in machine room for interconnecting card readers, other security access system equipment, and elevator controllers. Provide stripe-swipe card reader integral with each car-control station.
 - 1) Security access system equipment is specified in Section 281300 "Access Control."
 - b. Security Camera: Provide required conductors in traveling cable and panel in machine room for interconnecting security camera equipment.
 - 1) Security camera equipment is specified in Section 282304 "Indoor and Outdoor Surveillance CCTV System."
- C. Hoistway Entrances:
1. Fire rating:
 - a. Fabricate assemblies as tested and approved by Underwriters' Laboratories or other nationally recognized testing agency approved by authorities having jurisdiction.
 - b. Comply with requirements of NFPA 80.
 - c. Comply with requirements of ASTM E152, NFPA 252m or UL 10B.
 - d. Identify each assembly with factory applied label indicating applicable fire rating.
 2. Doors:
 - a. Fabricate doors of flush hollow metal construction, minimum 16 gage sheet steel; minimum 1-1/4 inch thick.
 - b. Reinforce by continuous vertical reinforcing as required for adequate support and surface flatness for configurations indicated.
 - c. Provide sight guards formed of minimum 16 gage steel, finish to match exposed door finish.
 3. Frames:
 - a. Fabricate frames of hollow metal construction, minimum 16 gage sheet steel with sound deadening material applied to back surface.
 - b. Where gypsum board hoistway partitions are indicated, fabricate frames with reinforced head sections.
 - c. Provide sizes and profiles indicated.
 4. Sills: Extruded aluminum; manufacturer's standard profile.
- D. Hoistway and Cab Door Operators:
1. General:
 - a. Provide adjustable heavy-duty electric operators designed to smoothly open and close cab and hoistway doors simultaneously.
 - b. Standing time:
 - 1) Normal time doors remain open after stopping for demand: Separately adjustable for car calls and landing calls, and capable of adjustment from minimum of 3 seconds to 30 seconds after doors reach fully open position.

- 2) Initial adjustment: Set to minimum time equal to distance/1.5 feet per second for car call and 5.0 seconds for landing call.
2. Door safety devices: Provide safety device with uniform array of 36 or more microprocessor-controlled infrared light beams projecting across car entrance. Interruption of one or more beams shall cause doors to stop and re-open.

2.6 SHOP FINISHES

- A. General: Finishes to match Architect's samples.
- B. Cab Finishes:
 1. Material: Stainless steel.
 2. Basis-of-Design: Stainless Steel Series, Autumn, by Kone.
- C. Handrails:
 1. Material: Stainless steel.
 2. Shape: Flat, 2 inch high.
- D. Ceiling:
 1. Stainless steel with (6) square LED fixtures.
 2. Basis-of-Design: Model LF-97 by Kone.
- E. Signalization:
 1. Stainless steel.
 2. Basis-of-Design: Model KSS570 by Kone.
- F. Cab floors:
 1. Elevator B: Floor recessed and prepared to receive Resinous Matrix Terrazzo Flooring specified in section 096623 "Resinous Matrix Terrazzo Flooring".
 2. Elevator C: Floor prepared to receive vinyl composition tile specified in section 096519 "Resilient Tile Flooring".

2.7 CONTROLS, SIGNALS AND SIGNAGE

- A. Cab Controls and Signals:
 1. Car operating panel in front return:
 - a. General:
 - 1) Provide manufacturer's standard panel.
 - 2) Incorporate car operating controls, control panel, signals, signage, certificate holder, telephone cabinet, and other features.
 - 3) Provide one operating panel per cab.
 - b. Buttons:
 - 1) Manufacturer's standard flush illuminated buttons of minimum 3/4 inch diameter, corresponding to each landing served, "door open" and "door close".
 - 2) When pressed buttons illuminate and remain illuminated until call is answered.
 - c. Additional controls: Emergency call buttons, stop switch, fire department keyed switch.
 - d. Provide raised markings and Grade 2 braille to left of each button, in compliance with ADA; markings and braille shall be black on stainless steel plate of same

finish as front return panels.

- e. Conceal switches for lighting, top-of-car inspection and fan in panel.
 - f. Provide fully connected phone for emergency communications equipment in telephone cabinet.
2. Car position indicators:
- a. Digital type, with minimum 1/2 inch high numerals.
 - b. Mount over car operating panels.
 - c. As car passes each floor and as car stops at a floor, the corresponding numerals shall illuminate and an audible signal shall sound. Audible signal in car shall sound minimum of 5 seconds before doors open.
- B. Hall Buttons:
- 1. At each terminal landing, provide single push button.
 - 2. At each intermediate landing, provide button fixture containing "UP" and "DOWN" push buttons.
 - 3. Provide one hall button for each elevator.
 - 4. Buttons:
 - a. Manufacturer's standard flush illuminated buttons of minimum 3/4 inch diameter.
 - b. When pressed, buttons illuminate and remain illuminated until call is answered.
 - 5. Provide raised markings and Grade 2 braille to left of each button, in compliance with ADA; markings and braille shall be black on stainless steel plate of same finish as call button plate.
 - 6. Configurations and finishes: Mount in manufacturer's standard satin finish stainless steel plate.
- C. Hall Lanterns:
- 1. Direction lantern illuminating white for up and red for down, adjacent to each hoistway entrance.
 - 2. Lantern illuminates indicating direction of travel.
 - 3. Audible signal:
 - a. Provide lantern with gong sound approximately four seconds before car door opening; once for up direction, twice for down direction.
 - b. Equip gong with adjustable volume.
 - c. Permit gong to sound in response to hall calls but not in response to car calls.
 - 4. Faceplate material: Manufacturer's standard satin stainless steel.
- D. Emergency and Braille/Number Signage:
- 1. General: Provide as required by authorities having jurisdiction.
 - 2. Emergency signage:
 - a. Cabs: Text shall be engraved in stainless steel front return panel, with etched letters infilled with black enamel.
 - b. Halls: Text shall be etched in satin stainless steel plate below hall buttons, with etched letters infilled with black enamel.
 - 3. Cab braille/number signage: As specified above under "Cab Controls".
 - 4. Hall braille/number signage: As specified above under "Hall Buttons".
 - 5. Hoistway jamb braille/number plates:
 - a. Provide combination braille/number plates on both sides of each hoistway entrance, to identify floor. Characters shall be at least 2 inches high.
 - b. Permanently mount plates using adhesive, centered in frame width and 5'-0" to center of jamb plate above finish floor. Exposed fasteners are not acceptable.

2.8 ELEVATOR SCHEDULE

A. Description – Elevator ‘B’:

1. Machine Location: Hoistway; no machine room is provided.
2. Rated Load: 3500 lb (1588 kg).
3. Rated Speed: 150 fpm (0.76 mps).
4. Landings: 3 .
5. Openings: 3 front, 0 back.
6. Travel: 28'-0"
7. Operation System: Simplex.
8. Clear Inside Dimensions (W x D): 6'-8" x 5'-7"
9. Cab Height: 8'
10. Clear height under suspended ceiling: 7'-6"
11. Entrance Width & Type: 3' - 6" & as shown.
12. Entrance Height: 7'
13. Main Power Supply: 480 Volts.
14. Machine Location: Inside the hoistway mounted on car guide rail
15. Control Space Location: R e m o t e Room.
16. Sills: Nickel silver, polished.
17. Hall Fixtures: Satin stainless steel, No. 4 finish.
18. Additional Requirements:
 - a. Provide inspection certificate in each car, mounted under acrylic cover with frame made from satin stainless steel, No. 4 finish.
 - b. Provide hooks for protective pads and one complete set(s) of full-height protective pads.

B. Description – Elevator ‘C’:

1. Machine Location: Hoistway; no machine room is provided.
2. Rated Load: 3500 lb (1588 kg).
3. Rated Speed: 150 fpm (0.76 mps).
4. Landings: 3 .
5. Openings: 2 front, 1 back.
6. Travel: 28'-0"
7. Operation System: Simplex.
8. Clear Inside Dimensions (W x D): 6'-8" x 5'-7"
9. Cab Height: 8'
10. Clear height under suspended ceiling: 7'-6"
11. Entrance Width & Type: 3' - 6" & as shown.
12. Entrance Height: 7'
13. Main Power Supply: 480 Volts.
14. Machine Location: Inside the hoistway mounted on car guide rail
15. Control Space Location: R e m o t e Room
16. Sills: Nickel silver, polished.
17. Hall Fixtures: Satin stainless steel, No. 4 finish.
18. Additional Requirements:
 - a. Provide inspection certificate in each car, mounted under acrylic cover with frame made from satin stainless steel, No. 4 finish.
 - b. Provide hooks for protective pads and one complete set(s) of full-height protective pads.

2.9 FABRICATION

- A. Fabricate and assemble various parts in shop to minimize field assembly.
- B. Trial assemble parts which cannot be shop assembled and which require close field fit; mark for field erection.
- C. Do not permit name plates or logos identifying manufacturer to be visible to general public.
- D. Provide concealed fasteners on surfaces exposed to public view.
- E. Factory finish components concealed from public view with manufacturer's standard finish systems.

2.10 ELEVATOR OPERATIONS

- A. General: Provide operations specified in related Sections in addition to operations specified in this Section.
- B. Fire Emergency Operation:
 - 1. Provide in accordance with requirements of local authorities and ASME A17.1.
 - 2. Connect elevators to auxiliary (isolated) contacts of smoke and heat sensing devices. When smoke is detected by elevator lobby or elevator machine room devices, registered calls for associated elevators are canceled and cars automatically return to designated Fire Floor. If smoke is detected on Fire Floor, cars stop on floor above Fire Floor.
 - 3. Designated Fire Floor: Unless otherwise determined by Fire Marshall, provide as scheduled above.
 - 4. Cab provisions: Provide three-position keyed switch in each cab in one of cab control panels to provide for fireman's access.
 - 5. Hoistway entrance provisions:
 - a. Provide manufacturer's standard three-position key switch at designated Fire Floor for each group of elevators.
 - b. Locate adjacent to one hall call button for each group, unless otherwise required by Fire Marshall.
 - c. Provide with manufacturer's standard, surface mounted key box (for key required to call or operate elevators); mount where directed by Fire Marshall.
 - d. Match finish of key switch plate and key box with finish of hall call button plate and engrave to read "EMERGENCY ONLY".
 - 6. Fire emergency control and operation must be approved by Fire Marshall prior to fabrication.
- 1. C. Emergency Power Operation: Provide battery powered lowering for each elevator, capable of providing power to lower car to First Floor after loss of normal power, open doors, and operate lights in car to maintain minimum footcandle levels required by Code. System includes rechargeable battery and automatic recharging system.
- D. Independent Service Operation:
 - 1. Provide keyed switch in car station of each elevator for independent service operation.
 - 2. When switch is turned to "SERVICE" position, it shall cancel previously registered car calls for that elevator, transfer corridor calls to other elevators and permit operation of elevator in response to calls registered from car buttons only.
 - 3. When switch is turned to "OFF" position, elevator will return to normal operation.

2.11 CONTROL/ INDICATOR PANELS

- A. Supervisory Control Panels: Provide manufacturer's standard panels located in elevator remote closet.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine elevator areas, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work. Verify critical dimensions and examine supporting structure and other conditions under which elevator work is to be installed.
- B. Verify that hoistways, pits, and equipment rooms comply with applicable standards and requirements of Contract Documents.
- C. Review and approve structural tolerances, location of structural supports, miscellaneous metal fabrications, pit ladders, hoistway construction, heating, ventilating and air conditioning of equipment rooms; ventilating of hoistways; and electrical power, lighting and outlets required for elevator Work.
- D. Verify that sill support angles are properly installed.
- E. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- F. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install components of each elevator system in accordance with final Shop Drawings, manufacturer's written instructions and requirements of ASME A17.1.
- B. Machine Equipment:
 - 1. Install with clearances complying with referenced codes and specifications.
 - 2. Install items to allow removal by portable hoists or other means for maintenance and repair.
 - 3. Install items so that maintenance access is safe and readily available.
- C. Welded Construction: Provide welded connections for installing elevator work where bolted connections are not required for subsequent removal or for normal operation, adjustment, inspection, maintenance, and replacement of worn parts. Comply with AWS workmanship and welding operator qualification standards.
- D. Sound Isolation: Mount rotating and vibrating equipment on vibration-isolating mounts to minimize vibration transmission to structure and structure-borne noise due to elevator system.
- E. Install piping above the floor, where possible. Install underground piping in casing.
- F. Lubricate operating parts of systems as recommended by manufacturers.

- G. Alignment: Coordinate installation of hoistway entrances with installation of elevator guide rails for accurate alignment of entrances with car. Where possible, delay installation of sills and frames until car is operable in shaft. Reduce clearances to minimum, safe, workable dimension at each landing.
- H. Leveling Tolerance: 1/4 inch (6 mm), up or down, regardless of load and travel direction.
- I. Set sills flush with finished floor surface at landing. Fill space under sill solidly with nonshrink, nonmetallic grout.
- J. Locate hall signal equipment for elevators as follows, unless otherwise indicated:
 1. Place hall lanterns above each hoistway entrance.
 2. Mount hall lanterns at a minimum of 72 inches (1829 mm) above finished floor.

3.3 FIELD QUALITY CONTROL

- A. Acceptance Testing: On completion of elevator installation and before permitting elevator use (either temporary or permanent), perform acceptance tests as required and recommended by ASME A17.1/CSA B44 and by governing regulations and agencies. The contractor shall arrange and pay for these tests.
- B. Advise Owner, Architect, and authorities having jurisdiction in advance of dates and times that tests are to be performed on elevators.
- C. Test Results: In test conditions, ensure speed and performance times specified be met, leveling accuracy maintained without releveling, and general riding quality is acceptable to Owner.
- D. Performance Adjustments:
 1. Should tests uncover defects or poor workmanship, variance or noncompliance with requirements of specified codes and ordinances or variance or noncompliance with specified requirements, complete following Work and repairs at no additional expense to Owner.
 2. Replace equipment that does not meet ASME A17.1 or specified requirements.
 3. Perform Work and furnish materials and equipment necessary to complete specified operation and performance.
 4. Perform retesting required by governing authority and Owner to verify specified operation or performance.

3.4 ADJUSTING

- A. Balance cars to equalize pressure of roller guide shoes on rails.
- B. Adjust motors, pumps, valves, generators, brakes, controllers, leveling switches, limit switches, stopping switches, door operators, interlocks, safety devices and other components to achieve required performance levels.
- C. Adjust car movement on aligned guide rails to provide smooth movement, with no perceptible lateral or oscillating movement or vibration.

3.5 ADJUSTING

- A. Keep Work areas orderly and free from debris.
- B. Remove loose materials and filings resulting from Work within hoistways.
- C. Clean machine room equipment and floor of dirt, oil and grease.
- D. Remove temporary protection and clean hoistway, car, cab enclosures, entrances, operating and signal fixtures, handrails and trim to remove dirt, oil, grease and finger marks.

3.6 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to operate elevator(s).
- B. Check operation of each elevator with Owner's personnel present before date of Substantial Completion. Determine that operation systems and devices are functioning properly.

3.7 PROTECTION

- A. Temporary Use: Limit temporary use for construction purposes to one elevator. Comply with the following requirements for each elevator used for construction purposes:
 - 1. Provide car with temporary enclosure, either within finished car or in place of finished car, to protect finishes from damage.
 - 2. Provide strippable protective film on entrance and car doors and frames.
 - 3. Provide padded wood bumpers on entrance door frames covering jambs and frame faces.
 - 4. Provide other protective coverings, barriers, devices, signs, and procedures as needed to protect elevator and elevator equipment.
 - 5. Do not load elevators beyond their rated weight capacity.
 - 6. Engage elevator Installer to provide full maintenance service. Include preventive maintenance, repair or replacement of worn or defective components, lubrication, cleanup, and adjustment as necessary for proper elevator operation at rated speed and capacity. Provide parts and supplies same as those used in the manufacture and installation of original equipment.
 - 7. Engage elevator Installer to restore damaged work, if any, so no evidence remains of correction. Return items that cannot be refinished in the field to the shop, make required repairs and refinish entire unit, or provide new units as required.
- B. Elevators not used for construction purposes:
 - 1. At time of substantial completion of elevator Work, provide suitable protective coverings, barriers, devices, signs or such other methods or procedures to protect elevator Work from damage or deterioration.
 - 2. Maintain protective measures throughout remainder of construction period so that elevator systems and components will be without any evidence of damage or use at time of acceptance.

3.8 MAINTENANCE

- A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by skilled employees of elevator Installer. Include monthly preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper elevator operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
1. Perform maintenance during normal working hours.
 2. Perform emergency callback service during normal working hours with response time of two hours or less.

END OF SECTION 142100

SECTION 230993 SEQUENCE OF OPERATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. The work included in this specification consists of furnishing all labor, material, accessories and equipment necessary for a complete, operational temperature control system as described herein.
- B. Related Sections:
 - 1. Division 01, High Performance Buildings Requirements Section 018113.13 for credits 16a-38k-3(1), 16a-38k-4(a)11, 16a-38k-4(b)11.
 - 2. The above listed HPB credits are related to this section. Other HPB credits may apply and shall be reviewed for their potential applicability and conformed with as though listed. Division 23 Section 230900 Instrumentation and Control for HVAC contains requirements that relate to this Section.
- C. The following specification sections contain requirements that relate to this section:
 - 1. 260501 – Basic Electrical Materials & Methods
 - 2. 260533 – Raceways and Boxes for Electrical Systems
 - 3. 260519 – Building Wire and Cable
 - 4. 260553 – Electrical Identification
 - 5. 260526 – Grounding and Bonding for Electrical Systems
 - 6. 262813 – Fuses
 - 7. 262416 – Panelboards and Circuit Breakers

1.3 SUBMITTALS

- A. Refer to Section 230900 Instrumentation and Control for HVAC for submittal requirements.

1.4 DEFINITIONS

- A. Point Types:
 - 1. Digital Input - DI
 - 2. Digital Output - DO
 - 3. Analog Output - AO
 - 4. Analog Input - AI

PART 2 – PRODUCTS (NOT USED)

PART 3 - EXECUTION

3.1 GENERAL

- A. Refer to the Electrical Demand Monitoring and Trending Measurement and Verification Plan section for equipment energy usage trending requirements. Provide the required sensors and devices necessary to trend energy usage for the equipment listed. Coordinate provision of energy usage signals which may be standard from the equipment manufacturer, available from electric meters at panels (provided by electrical contractor), or added per this specification section.
- B. All setpoints and schedules shall be adjustable by the owner through operator interface with no additional programming required. Coordinate the various levels of security and access with the Facilities Maintenance Supervisor.
- C. Provide control components compatible with individual manufacturer's equipment.
- D. Provide wall mount space thermostats with temperature indication, set point adjustment and override button. Indicate space temperature, set point and override status.
 - 1. Provide space temperature sensors only in Spaces associated with RTU-7, Spaces associated with RTU-9, Lobby A201, Vestibules, Stairs, Corridors, Toilet rooms and Locker rooms.
 - 2. Space temperature shall be monitored using RTU return air duct temperature sensors for the following areas: Bus Storage S113, Maintenance M104 & M108, Chassis Wash M103, Service Lanes S111 & Bus Wash S112.
 - 3. Spaces served by Cabinet Unit Heaters (CUH) and Unit Heaters (UH) not shown with associated temperature sensors shall be provided with unit mounted temperature sensors in the return airstream.
- E. Provide Window Operation Indicators where shown on construction drawings. Provide wall plate with red and green LEDs mounted at 6ft above finished floor, for the purpose of notifying occupants whenever outdoor temperature and humidity conditions are suitable for opening windows.
- F. Upon a signal from a the fire alarm panel, HVAC air handling equipment shall be shut down and outside air dampers shall close, with the exception of vehicle exhaust systems. The controls contractor shall provide wiring, conduit and all necessary devices from the fire control panel to the Building Automation System (BAS). When the fire alarm signal has cleared, each unit shall revert to its scheduled operating mode.
- G. Provide data jacks for BAS laptop access in control cabinets of all RTUs and Boiler Room M130.
- H. Provide starters/contactors/relays required for the control of HVAC equipment that are not provided by equipment manufacturers or electrical contractor.
- I. Current transmitters shall be provided on each electrical power leg of equipment noted in points lists for the purpose of monitoring energy usage. Variable frequency drives on fan motors and pumps shall provide energy usage output. Provide all devices and components necessary for reading and trending max kWh and max kW for each piece of equipment. Refer to 'Electrical Demand Monitoring and Trending' within this specification section.

- J. Current transmitters shall be provided on each electrical power leg of electrical panels serving lighting. Provide all devices and components necessary for reading and trending max kWh and max kW for each electrical panel. Refer to 'Electrical Demand Monitoring and Trending' within this specification section.
- K. Note considerable distance to Guard Booth from facility building. Controls contractor shall provide all conduit and/or controls devices and components necessary for communications with the Guard Booth.
- L. Provide the following general points for monitoring and use as required by individual equipment and terminal unit operating sequences.

Points List:

Point ID	Description	Type	Remarks
G-1	Outdoor Air Temperature	AI	
G-2	Outdoor Air Humidity	AI	
G-3	Outdoor Air CO2 Concentration	AI	
G-4	Fire Alarm Status	DI	
G-5	CO & NOx Sensors (See electrical plans)	AI	Separate CO & NOx inputs from multiple sensors
G-6	Gas Service Meter	AI	Gas usage
G-7	Water Meter	AI	Water usage
G-8	Electrical Panel Current Transmitters	AI	Multiple current transmitters, on each electrical power leg, for trending total electrical usage – Multiple panels
G-9	Alarms to Security Systems	DO	Multiple - Coordinate alarm types with owner's representative

3.2 HEATING PLANT

A. Points List:

Point ID	Description	Type	Remarks
Boilers B-1/2/3/4	Boiler Enable/Disable	DO	
Boilers B-1/2/3/4	Boiler Status	DI	Monitor Boiler Control Panel Alarm
Boilers	Boiler Management System		Provide (6) points for

Point ID	Description	Type	Remarks
B-1/2/3/4			monitoring system
Boilers B-1/2/3/4	Boiler Current Sensors	AI	Multiple current transmitters, on each electrical power leg, for trending total electrical usage
Boilers B-1/2/3/4	Boiler Supply Water Temperature	AI	
Boilers	Boilers Gas Usage	AI	Boiler gas meter output
Pumps BP-1/2/3/4	Boiler Pump Start / Stop	DO	
Pumps BP-1/2/3/4	Bldg Pump Flow Status	DI	Current transmitter
Pumps BP-1/2/3/4	Boiler Pump Current Transmitters	AI	Multiple current transmitters, on each electrical power leg, for trending total electrical usage
Pumps P-1&2	Bldg Distribution Pump Start / Stop	DO	
Pumps P-1&2	Bldg Distribution Pump Status	DI	Current sensor
Pumps P-1&2	Bldg Distribution Pump Speed	AO	Variable Frequency Drive
Pumps P-1&2	Bldg Distribution Pump Energy Output from Variable Frequency Drive	AI	
HHW System	Distribution Loop Supply Temperature	AI	Downstream of P-1A/B
HHW System	Distribution Loop Return Temperature	AI	Upstream of Boiler take offs
HHW System	Piping System Differential Pressure	AI	
HHW SYSTEM	Piping System Flow	AI	
GLYCOL INJECTION SYSTEM	Alarm	DI	Monitor system alarm

B. Heating:

1. Coordinate sequence with boiler manufacturer's boiler management system. On boiler graphics screen show return water temperature and respective boiler's supply water temperature.
2. Whenever the OAT is below 60 degrees, the designated lead primary building distribution pump shall start and run continuously. Above 60 degrees OAT the pumps shall be off. If proof of flow is not established by the lead building distribution pump, the standby pump shall start and an alarm shall be generated. Lead and standby pump assignments shall be determined by the BAS based on overall runtime and number of starts. The lead pump speed shall vary to maintain system differential pressure setpoint; on a loss of the differential pressure signal, the lead pump shall default to 50% pump speed and an alarm shall be generated.

3. When the lead pump has proven operation for at least one minute, the boilers shall be enabled and the boiler manufacturer's control panel shall control the boilers. The boilers shall provide the discharge water temperature necessary to maintain the building distribution water supply temperature as determined by the reset schedule. Provide all necessary control devices and wiring necessary for the control panel to operate the boilers and respective boiler pumps.
 - a. Each boiler's circulation pump shall prove operation for at least one minute before the boiler fires. An alarm shall be generated whenever a pump does not prove operation, and the next pump/boiler in sequence shall be brought on line.
 - b. Boiler circulation pump speed shall be manually adjustable through the BAS graphic screens.
4. Provide building distribution water supply temperature reset based on ambient temperature. Also provide a manual water supply temperature setpoint schedule which overrides the reset schedule – heating plant graphics screens shall indicate manual override operation whenever it is engaged.

Ambient Air Temperature	Building Distribution Hot Water Supply Temperature
0°F	140°F
60°F	90°F

5. If the heating hot water supply temperature varies by more than 10°F from setpoint, an alarm shall be generated.
6. The BAS shall monitor the alarm status of each boiler's on board controller, the boiler management system and the glycol injection system, and initiate a BAS alarm.

3.3 VARIABLE AIR VOLUME H/C ROOFTOP UNITS RTU-11/12/13

A. Points List:

Point ID	Description	Type	Remarks
RTU	Supply Fan Start/Stop	DO	
RTU	Supply Fan Status	DI	Current sensor
RTU	Supply Fan Speed	AO	Display on respective unit's graphic screen
RTU	Duct Static Pressure	AI	Locate sensors approx. 2/3 downstream of supply fan
RTU	Exhaust Fan Start/Stop	DO	
RTU	Exhaust Fan Status	DI	Current sensor
RTU	Exhaust Fan Speed	AO	Display on respective unit's graphic screen
RTU	Supply Air Temperature	AI	Ductstat
RTU	Return Air Temperature	AI	Ductstat
RTU	Mixed Air Temperature	AI	
RTU	Heating Coil Control Valve	AO	Modulating Actuator
RTU	Cooling Stages Start/Stop	DO	For each stage
RTU	Compressor Variable Speed	AO	

Point ID	Description	Type	Remarks
RTU	Refrigerant Suction Pressure	AI	Each circuit
RTU	Mixed Air Damper	AO	Modulating Actuator
RTU	Supply Airflow – Array for each fan	AI	Display on respective unit’s graphic screen
RTU	Return Airflow– Array for each fan	AI	Display on respective unit’s graphic screen
RTU	Outside Airflow	AI	Display on respective unit’s graphic screen
RTU	Energy Recovery Wheel Rotation	DO	
RTU	Filter Status	DI	Differential Press Switch
RTU	Duct Smoke Detectors	DI	Multiple
RTU	Space Humidity	AI	Duct humidistat. Display on respective unit’s graphic screen
RTU	RTU Supply Fan Energy Output from Variable Frequency Drive	AI	
RTU	RTU Exhaust Fan Energy Output from Variable Frequency Drive	AI	
RTU	RTU Compressor Current Transmitters (for each compressor)	AI	Multiple current transmitters, on each electrical power leg, for trending total electrical usage
RTU	CO2 Concentration Rooms A115, A202, A212, M101, M131	AI	Monitor

- B. The rooftop units shall operate in either Occupied, Unoccupied, Warmup or Cooldown modes as scheduled. Optimization programming shall determine start time of occupancy mode. The energy recovery wheel shall rotate only when the unit is in occupied mode, except the wheel shall stop whenever the unit is in economizer operation.
- C. During Occupied mode, the supply and exhaust fans shall operate continuously and the outside air damper shall modulate to provide the minimum ventilation air requirement.
1. The supply fan variable frequency drive shall vary the supply fan speed to maintain the duct static pressure setpoint, which shall be automatically reset to meet zone airflow demands. The exhaust fan variable frequency drive shall modulate the exhaust fan speed to maintain building pressurization control via airflow station data; provide adjustable outside air/exhaust air differential setpoint.
 - a. Coordinate initial balance fan speed settings with the balance contractor to determine the supply and exhaust fan speeds at maximum design supply and exhaust airflows. Note the VFD frequency settings as “MAX DESIGN AIRFLOW” for each, plainly visible, in the control cabinet adjacent to the VFD. Provide a list of RTU unit designations and the noted frequencies/airflows accessible through the controls system as a reference document.
 2. The outside air damper and exhaust fan speed shall modulate to maintain building pressurization, via airflow station data, and to ensure the minimum ventilation airflow requirements are met.

3. The heating coil normally closed control valve shall modulate to maintain the discharge air temperature setpoint 55°F (adjustable).
 4. The cooling stages shall cycle to maintain the discharge air temperature setpoint 55°F. Provide compressor(s) enable/disable, as well as 1.5 to 5 volt signal to operate variable speed compressor sensing discharge air temperature. Monitor refrigerant suction pressure and shut down compressor(s) on low limit temperature.
 - a. Provide differential enthalpy economizer operation to modulate outside air and return air dampers from minimum outdoor air position to 100% outdoor air to maintain space temperature setpoint. Optimization control shall cycle cooling stages during economizer operation if deemed efficient to do so. The exhaust fan speed shall modulate to maintain building pressurization. Provide mixed air low limit control to prevent mixed air temperature from dropping below the discharge air temperature setpoint. During economizer operation the energy recovery wheel shall stop.
 - b. Whenever an air handling unit's return air relative humidity (RH) is below setpoint 50% (adjustable), the respective unit's discharge air temperature shall be reset upward to maintain 80 to 95% airflow through the VAV box with the most cooling demand. If airflow through the most demanding VAV box drops below 80%, the discharge air temperature shall be reset to 65°F. If airflow through the most demanding VAV box rises toward 95%, the discharge air temperature shall be reset to 55°F.
- D. During Unoccupied mode, the supply and exhaust fans shall stop, the outside air damper shall close and the return air damper shall fully open, unless night purge is active.
1. Whenever any space temperature drops below the unoccupied setpoint temperature 60°F, the respective unit's supply fan shall operate at full airflow and the heating coil control valve shall fully open. The supply fan shall stop and the coil valve shall close when all spaces reach the unoccupied setpoint temperature.
 - a. Provide an adjustable time delay to prevent the supply fan from starting again until time delay has expired (default -15 minutes). If the number of supply fan cycles exceeds an operator adjustable maximum cycles (default - 8) during an unoccupied period, the fan shall run continuously until the end of the next scheduled occupied period.
 2. Night Purge shall be enabled whenever the average of space temperatures for a respective air handling unit system is above 75 °F, the outdoor air temperature is above 50°F and the outdoor air dewpoint is below 60°F. During Night Purge the outside air and exhaust air dampers shall fully open, and the supply and exhaust fans shall operate continuously at full airflow. Night Purge shall cease whenever the average space temperature drops below 72°F, or the outdoor air temperature drops below 50°F, or the outdoor air dewpoint rises above 60°F, or the outdoor air temperature is less than 5°F cooler than the average space temperature.
 3. Upon activation of the unoccupied mode override, the unit control shall revert to occupied mode operation for an operator defined interval (default – 2 hrs).
- E. During Warmup, the outside air dampers shall be closed, the return air damper shall be fully open, the exhaust fan shall be off, the supply fan shall operate continuously, the heating coil control valve shall modulate to maintain a minimum 55°F supply air temperature, and the VAV box reheat coils shall operate in occupied mode. When all spaces reach their occupied space temperature setpoint, the system shall revert to occupied mode operation.
- F. During Cooldown, the outside air damper shall be closed, the return air damper shall be fully open, the exhaust fan shall be off, the supply fan shall operate continuously, the cooling stages shall cycle to maintain the occupied discharge air temperature setpoint and the respective system's VAV boxes shall operate in occupied mode. When all spaces reach their occupied space temperature setpoint,

the system shall revert to occupied mode operation. Provide economizer cooling during favorable conditions.

- G. Monitor the unit's filter differential pressure switch and generate an alarm for dirty filters (default - 0.5" wc above clean filter).
- H. Safety Controls:
1. The duct smoke detectors auxiliary contacts shall be hard-wired into the respective unit's fan control circuits to shut down the fans upon activation. Shut down fans and close outdoor air damper whenever the building fire alarm is activated. Restart units when the alarm signal is cleared.

3.4 AIR TERMINAL VAV BOXES AND FINNED TUBE RADIATION

A. Points List:

Point I.D.	Description	Type	Remarks
VAV	Space Temperature Sensor	AI	
VAV	Space Temperature Setpoint	AI	
VAV	Supply Airflow	AI	
VAV	Supply Airflow Damper	AO	Modulating Actuator
VAV	Supply Air Temperature	AI	
VAV	Coil Control Valve	AO	Modulating Actuator
Space	Space Temperature Sensor	AI	
Space	Space Temperature Setpoint	AI	
Space	Unoccupied Mode Override Button	DI	
Space	Open Window Signal	DI	All operable windows in areas D and G
Space	Window Operation Indicator (Green pilot light)	DO	Lit when conditions are favorable
FT	Finned Tube Control Valve Open/Close	DO	Modulating

- B. The air terminals shall operate in either Occupied, Unoccupied, Warmup or Cooldown modes as scheduled. Finned tube radiation shall be enabled during occupied mode. Provide a range of outdoor air temperatures and outdoor humidity conditions within which ambient conditions are favorable for opening windows by the building occupants. Under favorable conditions the Window Operation Indicator (WO) shall be lit.
- C. During Occupied mode, Warmup and Cooldown:
1. On a rise in space temperature from 75°F setpoint, the VAV box damper shall modulate from minimum damper position to maximum airflow to maintain the space setpoint temperature for cooling. The coil control valve shall be closed. When the space temperature is satisfied the damper shall be at minimum position.
 2. On a drop in space temperature from 70°F setpoint, the VAV box shall be in minimum damper position and the heating coil control valve shall modulate to satisfy the space temperature setpoint for heating. For spaces with radiation heating, the radiation shall integrate with VAV box control.

- a. For each VAV box, provide a heating mode damper position, a cooling mode minimum ventilation damper position and a window open damper position. Whenever a window is open, the respective VAV box damper shall maintain the window open damper position.
 3. Enable finned tube heating whenever OAT is below 65°F. Integrate finned tube radiation as primary heat source with VAV box operation. Modulate finned tube control valve to maintain space temperature occupied setpoint.
 4. During occupied mode, whenever one or more windows in a space is open, the damper of the VAV air terminal serving the space shall fully close.
- D. During Unoccupied mode:
1. The VAV boxes dampers shall be open for full airflow, for unoccupied heating and Night Purge operation.

3.5 CONSTANT VOLUME ROOFTOP H/C UNITS RTU-14 & 15

A. Points List:

Point ID	Description	Type	Remarks
RTU	Supply Fan Start/Stop	DO	
RTU	Supply Fan Status	DI	Current sensor
RTU	Supply Fan Speed	AO	Manual setting
RTU	Exhaust Fan Start/Stop	DO	
RTU	Exhaust Fan Status	DI	Current sensor
RTU	Exhaust Fan Speed	AO	Manual setting
RTU	Supply Air Temperature	AI	Ductstat
RTU	Return Air Temperature	AI	Ductstat
RTU	Mixed Air Temperature	AI	
RTU	Heating Coil Control Valve	AO	Modulating Actuator
RTU	Cooling Stages Start/Stop	DO	For each stage
RTU	Compressor Variable Speed	AO	
RTU	Refrigerant Suction Pressure	AI	Each circuit
RTU	Mixed Air Damper	AO	Modulating Actuator
RTU	Supply Airflow – Array for each fan	AI	Display on respective unit's graphic screen
RTU	Return Airflow	AI	Display on respective unit's graphic screen
RTU	Outside Airflow	AI	Display on respective unit's graphic screen
RTU	Filter Status	DI	Differential Press Switch
RTU	Space Humidity	AI	Duct Humidistat. Display on respective unit's graphic screen
RTU	RTU Supply Fan Energy Output from Variable Frequency Drive	AI	
RTU	RTU Exhaust Fan Energy Output from Variable Frequency Drive	AI	
RTU	RTU Compressor Current Transmitters	AI	Multiple current transmitters, on

	(for each compressor)		each electrical power leg, for trending total electrical usage
--	-----------------------	--	--

- B. The rooftop units shall operate in either Occupied, Unoccupied, Warmup or Cooldown modes as scheduled. Optimization programming shall determine start time of occupancy mode.
- C. During Occupied mode, the supply and exhaust fans shall operate continuously and the outside air damper shall modulate to provide the minimum ventilation air requirement.
 - 1. Coordinate initial balance fan speed settings with the balance contractor to determine the design supply and exhaust fan speeds. Note the VFD frequency settings as “DESIGN AIRFLOW” for each, plainly visible, in the control cabinet adjacent to the VFD. Provide a list of RTU unit designations and the noted frequencies/airflows accessible through the controls system as a reference document
 - 2. The heating coil normally closed control valve shall modulate to maintain the discharge air temperature setpoint 55°F (adjustable).
 - 3. The cooling stages shall cycle to maintain the discharge air temperature setpoint 55°F. Provide compressor(s) enable/disable, as well as 1.5 to 5 volt signal to operate variable speed compressor sensing discharge air temperature. Monitor refrigerant suction pressure and shut down compressor(s) on low limit temperature.
 - a. Provide differential enthalpy economizer operation to modulate outside air and return air dampers from minimum outdoor air position to 100% outdoor air to maintain space temperature setpoint. Optimization control shall cycle cooling stages during economizer operation if deemed efficient to do so. The exhaust fan speed shall modulate to maintain building pressurization. Provide mixed air low limit control to prevent mixed air temperature from dropping below s the discharge air temperature setpoint.
- D. During Unoccupied mode, the supply and exhaust fans shall stop, the outside air damper shall close and the return air damper shall fully open, unless night purge is active.
 - 1. Whenever space temperature drops below the unoccupied setpoint temperature 60°F, the respective unit’s supply fan shall operate at full airflow and the heating coil control valve shall fully open. The supply fan shall stop and the coil valve shall close when all spaces reach the unoccupied setpoint temperature.
 - a. Provide an adjustable time delay to prevent the supply fan from starting again until time delay has expired (default -15 minutes). If the number of supply fan cycles exceeds an operator adjustable maximum cycles (default - 8) during an unoccupied period, the fan shall run continuously until the end of the next scheduled occupied period.
 - 2. Night Purge shall be enabled whenever the average of space temperatures for a respective air handling unit system is above 75 °F, the outdoor air temperature is above 50°F and the outdoor air dewpoint is below 60°F. During Night Purge the outside air and exhaust air dampers shall fully open, and the supply and exhaust fans shall operate continuously at full airflow. Night Purge shall cease whenever the average space temperature drops below 72°F, or the outdoor air temperature drops below 50°F, or the outdoor air dewpoint rises above 60°F , or the outdoor air temperature is less than 5°F cooler than the average space temperature.
 - 3. Upon activation of the unoccupied mode override, the unit control shall revert to occupied mode operation for an operator defined interval (default – 2 hrs).
- E. During Warmup, the outside air dampers shall be closed, the return air damper shall be fully open, the exhaust fan shall be off, the supply fan shall operate continuously, the heating coil control valve

shall fully open. When the space has reached occupied space temperature setpoint, the system shall revert to occupied mode operation.

- F. During Cooldown, the outside air damper shall be closed, the return air damper shall be fully open, the exhaust fan shall be off, the supply fan shall operate continuously, the cooling stages shall cycle to maintain the occupied discharge air temperature setpoint. When the space has reached occupied space temperature setpoint, the system shall revert to occupied mode operation. Provide economizer cooling during favorable conditions.
- G. Monitor the unit's filter differential pressure switch and generate an alarm for dirty filters (default - 0.5" wc above clean filter).
- H. Safety Controls:
1. Shut down fans and close outdoor air damper whenever the building fire alarm is activated. Restart units when the alarm signal is cleared.

3.6 ENERGY RECOVERY ROOFTOP UNITS RTU-1 THRU 10

A. Points List:

Point ID	Description	Type	Remarks
RTU	Supply Fan Start/Stop	DO	
RTU	Supply Fan Status	DI	Current sensor
RTU	Supply Fan Speed	AO	Display on respective unit's graphic screen
RTU	Exhaust Fan Start/Stop	DO	
RTU	Exhaust Fan Status	DI	Current sesnor
RTU	Exhaust Fan Speed	AO	Display on respective unit's graphic screen
RTU	Supply Air Temperature	AI	Ductstat
RTU	Return Air Temperature	AI	Ductstat
RTU	Mixed Air Temperature	AI	
RTU	Heating Coil Control Valve	AO	Modulating Actuator
RTU	Exhaust Air Damper	AO	Modulating Actuator
RTU	Exhaust Air Damper End Switch	DI	
RTU	Outside Air Damper	AO	Modulating Actuator
RTU	Outside Air Damper End Switch	DI	
RTU	Heat Exchanger Bypass damper		Provided by unit manufacturer's defrost control.
RTU	Supply Airflow – Array for each fan	AI	Display on respective unit's graphic screen
RTU	Exhaust Airflow– Array for each fan	AI	Display on respective unit's graphic screen
RTU	Outside Airflow	AI	Display on respective unit's graphic screen
RTU	Filter Status	DI	Differential Press Switch

RTU	Duct Smoke Detectors	DI	Multiple
RTU	Return Duct Temperature Sensor	AI	
RTU	Space Temperature Setpoint	AI	
RTU-7, 8 & 9	Space Temperature Sensor	AI	Multiple
RTU-7, 8 & 9	Space Temperature Setpoint	AI	Average – selectable inclusion and priority
RTU	Space CO/NOx Sensor Separate CO and NOx readings	AI	Multiple for each unit
RTU	RTU Supply Fan Energy Output from Variable Frequency Drive	AI	
RTU	RTU Exhaust Fan Energy Output from Variable Frequency Drive	AI	

- B. The air handling units shall operate continuously. RTUs are provided with manufacturer's defrost controls and associated on-board dampers and devices. Provide associated startup services for defrost operation. Separate 4-20ma CO & 4-20ma NOx signals from multiple sensors shall be associated with each rooftop unit.
- C. During Occupied mode, the supply and exhaust fans shall operate continuously. Outside air and exhaust air dampers shall open prior to fan starts, damper shall be closed whenever a unit is off. Provide night purge operation.
1. Coordinate initial balance fan speed settings with the balance contractor to determine the design supply and exhaust fan speeds. Note the VFD frequency settings as "DESIGN AIRFLOW" for each, plainly visible, in the control cabinet adjacent to the VFD. Provide a list of RTU unit designations and the noted frequencies/airflows accessible through the controls system as a reference document.
 2. The heating coil control valve shall modulate to maintain the discharge air temperature setpoint to satisfy space temperature (Bus Storage: 55 degrees F – Maintenance Area: 68 degrees F)
 - a. RTU-7, 8 & 9: Provide settings for an average space temperature to drive the system, polling the respective space temperature sensors with selectable inclusion and priority, and settings for any one of the space temperature sensors to drive the system.
 - b. The unit manufacturer's on-board controls shall initiate defrost control to prevent frosting of the heat exchanger. Coordinate BAS requirements with RTU manufacturer.
 3. Provide a high limit CO setpoint and a high limit NOx setpoint (PPM) and minimum ventilation airflow rate (CFM). The CO/NOx levels shall be monitored continuously. Below the high limit, the supply fan and exhaust fan shall modulate fan speed to provide the minimum ventilation airflow rate. Whenever any CO/NOx sensor exceeds the upper limit setpoint, the associated rooftop units shall provide 100% outside air and exhaust until the levels drop below the upper limit.
 - a. RTU-8 & 9 shall operate at full airflow, 100% outside air and exhaust air at all times.
 - b. The RTU-8 exhaust fan shall reduce airflow by 800 cfm for each hose reel fan in operation.
- D. Monitor the unit's filter differential pressure switch and generate an alarm for dirty filters (default - 0.5" wc above clean filter).
- E. Safety Controls:

1. The duct smoke detector auxiliary contacts shall be hard-wired into the respective unit’s fan control circuits to shut down the fans upon activation. Shut down fans and close outdoor and exhaust air dampers whenever the building fire alarm is activated. Restart units when the alarm signal is cleared.
2. Provide a set of contacts to close whenever RTU-7 status indicates proper unit operation, for the purpose of enabling fuel dispensers. Provide wiring from contact to fuel dispenser control panels. Coordinate with fuel dispenser controls technician.

3.7 SPLIT SYSTEMS

A. Points List:

Point I.D.	Description	Type	Remarks
AC, HPC	Split System Enable/Disable	DO	
AC, HPC, FC	Fan Status	DI	Current sensor
HPC	Ventilation Fan Status	DI	Current sensor
AC& FC	Space Temperature Sensor	AI	AC: High temperature alarm
AC & FC	Space Temperature Setpoint	AI	AC: High temperature alarm
FC	Heating Coil Control Valve	AO	
ACCU	ACCU Compressor Start/Stop	DO	
ACCU	ACCU Compressor Current Transmitters	AI	Multiple current transmitters, on each electrical power leg, for trending total electrical usage
AC, FC, HPC VENTILATION FAN	Fan Motor Current Transmitters	AI	Multiple current transmitters, on each electrical power leg, for trending total electrical usage

- B. For AC and HPC systems temperature controls are provided by the manufacturer with BAS capability to enable/disable; provide individual system schedules. In spaces with the symbol TA, a separate space temperature sensor (no adjustment) shall be provided to alarm whenever the high limit temperature setpoint is exceeded. Provide interconnecting wiring between indoor units and respective ACCUs, and between HPC and respective ventilator fans.
- C. The FC-1/ACCU-16 split systems shall operate in either occupied or unoccupied mode as scheduled.
- D. During occupied mode the FC-1 fan unit shall operate continuously, the ACCU-16 compressor shall cycle to maintain space temperature setpoint. The FC-1 heating coil control valve shall modulate to maintain space temperature setpoint; cooling or heating operation shall be locked out whenever the opposite mode is engaged.
- E. During unoccupied mode the indoor fan unit shall be off. The unit shall cycle occupied mode operation to satisfy the unoccupied space temperature setpoint. The FC-1 fan shall cycle and the heating coil control valve shall modulate to maintain unoccupied space temperature setpoint.
- F. Safety Controls:
 1. Shut down units whenever the building fire alarm is activated. Restart units when the alarm signal is cleared.

3.8 UNIT VENTILATORS

A. Points List:

Point I.D.	Description	Type	Remarks
------------	-------------	------	---------

UV	Fan Start/Stop	DO	
UV	Fan Status	DI	Current sensor
UV	Supply Air Temperature	AI	
UV	Outdoor Air Damper	DO	
UV	Face and Bypass Damper	DO	Two position
UV	Heating Coil Control Valve	AO	
UV	Space Temperature Sensor	AI	
UV	Space Temperature Setpoint	AI	
UV	UV Current Transmitters	AI	Multiple current transmitters, on each electrical power leg, for trending total electrical usage

- B. The unit ventilator shall operate in either occupied or unoccupied mode as scheduled.
- C. During occupied mode the fan shall operate continuously, the outside air damper shall be open, the coil control valve shall open and the face & bypass dampers shall modulate to maintain the discharge air temperature setpoint to satisfy the space temperature setpoint.
- D. During unoccupied mode the fan shall be off, the outside air damper shall be closed and the coil control valve shall be closed. The unit shall cycle occupied mode operation to satisfy the unoccupied space temperature setpoint.
- E. Safety Controls:
1. Shut down unit ventilator and close outdoor air damper whenever the building fire alarm is activated. Restart units when the alarm signal is cleared.

3.9 OVERHEAD DOOR HEATERS

A. Points List:

Point ID	Description	Type	Remarks
ODH	Fan Start/Stop	DO	
ODH	Fan Status	DI	Current sensor
ODH	Discharge Air Temperature	AI	
ODH	Discharge Air Temperature setpoint	AO	
ODH	Coil Control Valve	AO	
ODH	Overhead Door Open Signal	DI	
ODH	Outside Air Temperature Enable/Disable		Operator manual setting
ODH	Fan Time Delay ON After Door Open Signal		Operator manual setting
ODH	Fan Time Delay OFF After Door Closed		Operator manual setting

Point ID	Description	Type	Remarks
ODH	ODH Current Transmitters	AI	Multiple current transmitters, on each electrical power leg, for trending total electrical usage

- A. Whenever the outside air temperature is below the operator manual setting and the door signal is open, the fan shall start and the coil control valve shall modulate to maintain the discharge air temperature setpoint. When the door signals closed, the fan shall stop and the coil control valve shall close. Provide settings for fan time delay when door opens and continued operation time delay when door is closed.

3.10 CABINET UNIT HEATERS/UNIT HEATERS

- A. Points List:

Point ID	Description	Type	Remarks
CUH/UH	Fan Start/Stop	DO	
CUH/UH	Fan Status	DI	Current sensor
CUH/UH	Coil Control Valve	DO	Two position
CUH/UH	Space Temperature Sensor	AI	Unit mounted in return air path if not shown on drawings
CUH/UH	Space Temperature Setpoint	AI	
CUH/UH	CUH/UH Current Transmitters	AI	Multiple current transmitters, on each electrical power leg, for trending total electrical usage

- B. Units shall operate in either occupied or unoccupied mode as scheduled.
- C. The fan and coil control valve shall cycle to maintain space occupied and unoccupied space temperature setpoint.

3.11 EXHAUST FANS

- A. Points List:

Point ID	Description	Type	Remarks
EF	Fan Start/Stop	DO	
EF	Fan Status	DI	Current sensor
EF	Damper	DO	Curb mounted
EF	Damper End Switch	DI	
EF-3/4/6/14	Exhaust Fan Button	DI	EXHAUST FAN on push button wall plate
GRV-2	Damper Open/Close	DO	
GRV-2	Damper End Switch	DI	
EF-1	Damper Open/Close	DO	EF and OSA
EF-1	Damper End Switch	DI	EF and OSA
EF-15	Fan Airflow Switch	DI	

Point ID	Description	Type	Remarks
EF-6	Space Temperature Sensor	AI	
EF-6	Space Temperature Setpoint	AI	
EF-17	Fan Speed	AI	
EF-17	Exhaust Fan Energy Output from Variable Frequency Drive	AI	
AIR COMPRESSOR	Air Compressor Status	DI	Current sensor
EF	Current Transmitters	AI	Multiple current transmitters, on each electrical power leg, for trending total electrical usage
HOSE REEL FANS	Current Sensor	DI	Monitor fans for operation to reduce AHU-8 exhaust fan

- B. The exhaust fans shall operate as scheduled and the associated damper shall open, and prove open via end switch, prior to fan start, otherwise the fans shall be off and the dampers closed. If end switch does not prove open an alarm shall be generated and the fan shall remain off.
1. EF-1 and OSA dampers shall open prior to fan start.
 2. EF-3/4/6/14 in Lunch Rooms and Boiler Room shall operate from a wall push button switch. When the exhaust fan button is depressed, the fan shall run continuously for an operator defined interval (default - 60 min). Provide laminated nameplate on wall push button plate: EXHAUST FAN.
 - a. EF-6 shall also operate to maintain space temperature setpoint whenever the space temperature exceeds the space temperature setpoint. EF-6 and GRV-2 dampers shall open prior to fan start.
 3. EF-15 shall be scheduled to operate continuously. Provide a red warning light with audible alarm and lockable silence button within sight of the Maintenance service pit. The alarm shall activate whenever the airflow switch proves no airflow.
 4. EF-17 shall vary airflow dependent on number of air compressors operating. Modulate fan to exhaust 2000 cfm for each air compressor operating, for a total of 6000 cfm. Coordinate VFD frequency settings with the air balance contractor. Add EF-17 to the reference document accessible through the controls system noting "STEPPED DESIGN AIRFLOW", with airflow and associated frequency for each step.

3.12 FINNED TUBE RADIATION BELOW 2ND FLOOR

A. Points List:

Point I.D.	Description	Type	Remarks
FT-4	Finned Tube Control Valve Open/Close	DO	Two Position
Space	Space Temperature Sensor	AI	Multiple
Space	Space Temperature Setpoint	AI	

- B. Provide settings for an average space temperature to drive the system, polling the respective space temperature sensors, and settings for any one of the space temperature sensors to drive the system.
- C. Cycle the finned tube control valve to satisfy the space temperature setpoint.

3.13 PAINTBOOTH

A. Points List:

Point I.D.	Description	Type	Remarks
MAU	Makeup Air Fan Status	DI	Current sensor
MAU	Supply Air Temperature	AI	
EF	Paintbooth Fan Status	DI	Current sensor

- B. Provide interconnecting control wiring and all necessary devices between the makeup air unit, exhaust fan and manufacturer's control panel. Set up system operation per manufacturer's instructions.

3.15 RADIANT FLOOR HEATING SYSTEM

C. Points List:

Point ID	Description	Type	Remarks
RZ	Pump Start/Stop	DO	
RZ	Pump Status	AI	Current transmitter
RZ	Mixing Valve	AO	
RZ	Supply Water Temperature	AI	
RZ	Return Water Temperature	AI	
RZ	Mixed Water Temperature	AI	
RZ	Slab Sensor	AI	
RZ	Slab Sensor Setpoint	AI	
RZ	Pump Current Transmitters	AI	Multiple current transmitters, on each electrical power leg, for trending total electrical usage

- D. The pump shall cycle to maintain the respective slab sensor setpoint. The mixing valve shall modulate to maintain the radiant supply water temperature 98°F. Provide high and low slab temperature limit settings beyond which an alarm shall be generated.
- E. There shall be no electronic devices within 18" of the Maintenance floor, or within the Maintenance Pits.

3.14 PRESSURE WASHER DRAFT INDUCER (DIF-1)

- A. Provide wiring between pressure washer and draft inducer, and set up system operation per manufacturer's instructions. Draft inducer shall provide proof of flow prior to burner ignition.

3.15 STORAGE & MAINTENANCE WINDOW OPEN SIGNAL

- A. The BAS shall monitor open/closed window positions in Storage and Maintenance clearstories. The windows open/close in groups – (10) groups in Storage clearstory and (5) groups in Maintenance clearstory. Provide a switch for one window in each group. BAS shall monitor, provide graphics screen representation of clearstory with window positions.

3.16 ELECTRICAL DEMAND MONITORING AND TRENDING MEASUREMENT AND VERIFICATION PLAN

- A. Trend electrical demand and voltage at electrical service, individual HVAC equipment current sensors, site lighting panels, interior lighting panels and gas meters.. Trending shall continue at 15 minute intervals for a minimum of one year. As a minimum throughout the first year, the contractor is responsible for a monthly all inclusive energy usage report indicating current month and previous months energy usage, as well as a Summary of Savings to Date report. Provide data equipment necessary for storage of a year’s worth of trend data and reports, with each point trending at 15 minute intervals.
 - 1. Trend domestic water usage through water meter for record.

- B. Trending: Provide trending for the following categories:
 - 1. Voltage at electrical service
 - 2. Facility-wide electrical usage
 - 3. Individual HVAC equipment electrical usage
 - a. Space heating
 - b. Pumps
 - c. Fans
 - d. Space Cooling
 - 4. Site lighting electrical energy usage
 - 5. Interior lighting electrical energy usage
 - a. Conditioned Spaces
 - b. Non-Conditioned Spaces
 - 6. Natural gas usage
 - a. Site Meter
 - b. Boiler Service
 - 7. Domestic water usage (refer to dwg P-106 for water meter location in Mech Room 130)

C. Provide Trending of the following items for the above categories:

End Use	Usage	Monthly Total												Annual Total
		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	
Gas Meter Serving Boilers - B-1, B-2, B-3, B-4	Total MMBtu													
Space Heating Total	Total MMBtu													
(2) Gas Meters shall be trended: - Gas service meter outside Mech Room 130 - Boiler gas main meter in Mech Room 130 Refer to dwg P-106														

End Use	Usage	Monthly Total												Annual Total	
		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec		
Electrical Distribution Total	Total kWh Max kW														
<p>(4) Electrical Panels shall be trended: - Main Service Disconnect in room M132 - Panel FBSH1 in room S113B - Panel FBSH1D in room M002 -Panel FBSH1C in room A102A Refer to electrical one-line diagram E-601</p>															
Boiler B-1	Total kWh														
	Max kW														
Boiler B-2	Total kWh														
	Max kW														
Boiler B-3	Total kWh														
	Max kW														
Boiler B-4	Total kWh														
	Max kW														
Space Heating Total	Total kWh														
	Max kW														
Pump P-1	Total kWh														
	Max kW														
Pump P-2	Total kWh														
	Max kW														
Pump BP-1	Total kWh														
	Max kW														
Pump BP-2	Total kWh														
	Max kW														

End Use	Usage	Monthly Total												Annual Total
		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	
Pump BP-3	Total kWh													
	Max kW													
Pump BP-4	Total kWh													
	Max kW													
Radiant System RZ-1	Total kWh													
	Max kW													
Radiant System RZ-2	Total kWh													
	Max kW													
Radiant System RZ-3	Total kWh													
	Max kW													
Radiant System RZ-4	Total kWh													
	Max kW													
Radiant System RZ-5	Total kWh													
	Max kW													
Radiant System RZ-6	Total kWh													
	Max kW													
Radiant System RZ-7	Total kWh													
	Max kW													
Radiant System RZ-8	Total kWh													
	Max kW													
Radiant System RZ-9	Total kWh													
	Max kW													
Radiant System RZ-10	Total kWh													
	Max kW													

End Use	Usage	Monthly Total												Annual Total
		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	
Radiant System RZ-11	Total kWh													
	Max kW													
Pumps Total	Total kWh													
	Max kW													
Exhaust Fan EF-1	Total kWh													
	Max kW													
Exhaust Fan EF-2	Total kWh													
	Max kW													
Exhaust Fan EF-3	Total kWh													
	Max kW													
Exhaust Fan EF-4	Total kWh													
	Max kW													
Exhaust Fan EF-5	Total kWh													
	Max kW													
Exhaust Fan EF-6	Total kWh													
	Max kW													
Exhaust Fan EF-7	Total kWh													
	Max kW													
Exhaust Fan EF-8	Total kWh													
	Max kW													
Exhaust Fan EF-9	Total kWh													
	Max kW													
Exhaust Fan EF-10	Total kWh													
	Max kW													

End Use	Usage	Monthly Total												Annual Total
		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	
Exhaust Fan EF-11	Total kWh													
	Max kW													
Exhaust Fan EF-12	Total kWh													
	Max kW													
Exhaust Fan EF-13	Total kWh													
	Max kW													
Exhaust Fan EF-14	Total kWh													
	Max kW													
Exhaust Fan EF-15	Total kWh													
	Max kW													
Exhaust Fan EF-16	Total kWh													
	Max kW													
Exhaust Fan EF-17	Total kWh													
	Max kW													
Unit Heater ODH-1	Total kWh													
	Max kW													
Unit Heater ODH-2	Total kWh													
	Max kW													
Unit Heater ODH-3	Total kWh													
	Max kW													
Unit Heater ODH-4	Total kWh													
	Max kW													
Unit Heater ODH-5	Total kWh													
	Max kW													

End Use	Usage	Monthly Total												Annual Total
		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	
Unit Heater ODH-6	Total kWh													
	Max kW													
Unit Heater ODH-7	Total kWh													
	Max kW													
Unit Heater ODH-8	Total kWh													
	Max kW													
Unit Heater UH-1	Total kWh													
	Max kW													
Unit Heater UH-2	Total kWh													
	Max kW													
Unit Heater UH-3	Total kWh													
	Max kW													
Unit Heater UH-4	Total kWh													
	Max kW													
Unit Heater UH-5	Total kWh													
	Max kW													
Unit Heater UH-6	Total kWh													
	Max kW													
Unit Heater UH-7	Total kWh													
	Max kW													
Unit Heater UH-8	Total kWh													
	Max kW													
Unit Heater UH-9	Total kWh													
	Max kW													
Unit Heater UH-10	Total kWh													
	Max kW													

End Use	Usage	Monthly Total												Annual Total
		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	
Unit Heater UH-11	Max kW													
	Total kWh													
Unit Heater UH-12	Max kW													
	Total kWh													
Unit Heater UH-13	Max kW													
	Total kWh													
Unit Heater UH-14	Max kW													
	Total kWh													
Unit Heater UH-15	Max kW													
	Total kWh													
Unit Heater UH-16	Max kW													
	Total kWh													
Unit Heater UH-17	Max kW													
	Total kWh													
Unit Heater UH-18	Max kW													
	Total kWh													
Unit Ventilator UV-1	Max kW													
	Total kWh													
Unit Ventilator UV-2	Max kW													
	Total kWh													
Cabinet Heater CUH-1	Max kW													
	Total kWh													
Cabinet Heater CUH-2	Max kW													
	Total kWh													

End Use	Usage	Monthly Total												Annual Total
		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	
	Max kW													
Cabinet Heater CUH-3	Total kWh													
	Max kW													
Cabinet Heater CUH-4	Total kWh													
	Max kW													
Cabinet Heater CUH-5	Total kWh													
	Max kW													
Cabinet Heater CUH-6	Total kWh													
	Max kW													
Cabinet Heater CUH-7	Total kWh													
	Max kW													
Cabinet Heater CUH-8	Total kWh													
	Max kW													
Cabinet Heater CUH-9	Total kWh													
	Max kW													
RTU-1 Supply Fan VFD	Total kWh													
	Max kW													
RTU-1 Exhaust Fan VFD	Total kWh													
	Max kW													
RTU-2 Supply Fan VFD	Total kWh													
	Max kW													
RTU-2 Exhaust Fan VFD	Total kWh													
	Max kW													
RTU-3 Supply Fan	Total kWh													

End Use	Usage	Monthly Total												Annual Total
		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	
VFD	Max kW													
RTU-3 Exhaust Fan VFD	Total kWh													
	Max kW													
RTU-4 Supply Fan VFD	Total kWh													
	Max kW													
RTU-4 Exhaust Fan VFD	Total kWh													
	Max kW													
RTU-5 Supply Fan VFD	Total kWh													
	Max kW													
RTU-5 Exhaust Fan VFD	Total kWh													
	Max kW													
RTU-6 Supply Fan VFD	Total kWh													
	Max kW													
RTU-6 Exhaust Fan VFD	Total kWh													
	Max kW													
RTU-7 Supply Fan VFD	Total kWh													
	Max kW													
RTU-7 Exhaust Fan VFD	Total kWh													
	Max kW													
RTU-8 Supply Fan VFD	Total kWh													
	Max kW													
RTU-8 Exhaust Fan VFD	Total kWh													
	Max kW													
RTU-9 Supply Fan	Total kWh													

End Use	Usage	Monthly Total												Annual Total
		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	
VFD	Max kW													
RTU-9 Exhaust Fan VFD	Total kWh													
	Max kW													
RTU-10 Supply Fan VFD	Total kWh													
	Max kW													
RTU-10 Exhaust Fan VFD	Total kWh													
	Max kW													
RTU-11 Supply Fan VFD	Total kWh													
	Max kW													
RTU-11 Exhaust Fan VFD	Total kWh													
	Max kW													
RTU-12 Supply Fan VFD	Total kWh													
	Max kW													
RTU-12 Exhaust Fan VFD	Total kWh													
	Max kW													
RTU-13 Supply Fan VFD	Total kWh													
	Max kW													
RTU-13 Exhaust Fan VFD	Total kWh													
	Max kW													
RTU-14 Supply Fan VFD	Total kWh													
	Max kW													
RTU-14 Exhaust Fan VFD	Total kWh													
	Max kW													
RTU-15 Supply Fan VFD	Total kWh													
	Max kW													

End Use	Usage	Monthly Total												Annual Total
		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	
RTU-15 Exhaust Fan VFD	Total kWh													
	Max kW													
Fans Total	Total kWh													
	Max kW													
RTU-1 (subtract VFD's)	Total kWh													
	Max kW													
RTU-2 (subtract VFD's)	Total kWh													
	Max kW													
RTU-3 (subtract VFD's)	Total kWh													
	Max kW													
RTU-4 (subtract VFD's)	Total kWh													
	Max kW													
RTU-5 (subtract VFD's)	Total kWh													
	Max kW													
RTU-6 (subtract VFD's)	Total kWh													
	Max kW													
RTU-7 (subtract VFD's)	Total kWh													
	Max kW													
RTU-8 (subtract VFD's)	Total kWh													
	Max kW													
RTU-9 (subtract VFD's)	Total kWh													
	Max kW													
RTU-10 (subtract VFD's)	Total kWh													
	Max kW													

End Use	Usage	Monthly Total												Annual Total
		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	
RTU-11 (subtract VFD's)	Total kWh													
	Max kW													
RTU-12 (subtract VFD's)	Total kWh													
	Max kW													
RTU-13 (subtract VFD's)	Total kWh													
	Max kW													
RTU-14 (subtract VFD's)	Total kWh													
	Max kW													
RTU-15 (subtract VFD's)	Total kWh													
	Max kW													
Split System AC-1	Total kWh													
	Max kW													
Split System ACCU-1	Total kWh													
	Max kW													
Split System AC-2	Total kWh													
	Max kW													
Split System ACCU-2	Total kWh													
	Max kW													
Split System AC-3	Total kWh													
	Max kW													
Split System ACCU-3	Total kWh													
	Max kW													
Split System AC-4	Total kWh													
	Max kW													

End Use	Usage	Monthly Total												Annual Total
		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	
Split System ACCU-4	Total kWh													
	Max kW													
Split System AC-5	Total kWh													
	Max kW													
Split System ACCU-5	Total kWh													
	Max kW													
Split System AC-6	Total kWh													
	Max kW													
Split System ACCU-6	Total kWh													
	Max kW													
Split System AC-7	Total kWh													
	Max kW													
Split System ACCU-7	Total kWh													
	Max kW													
Split System AC-8	Total kWh													
	Max kW													
Split System ACCU-8	Total kWh													
	Max kW													
Split System AC-9	Total kWh													
	Max kW													
Split System ACCU-9	Total kWh													
	Max kW													
Split System AC-10	Total kWh													
	Max kW													

End Use	Usage	Monthly Total												Annual Total
		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	
Split System ACCU-10	Total kWh													
	Max kW													
Split System AC-11	Total kWh													
	Max kW													
Split System ACCU-11	Total kWh													
	Max kW													
Split System AC-12	Total kWh													
	Max kW													
Split System ACCU-12	Total kWh													
	Max kW													
Split System AC-13	Total kWh													
	Max kW													
Split System ACCU-13	Total kWh													
	Max kW													
Split System AC-14	Total kWh													
	Max kW													
Split System ACCU-14	Total kWh													
	Max kW													
Split System AC-15	Total kWh													
	Max kW													
Split System ACCU-15	Total kWh													
	Max kW													
Split System FC-1	Total kWh													
	Max kW													
Split System ACCU-16	Total kWh													

End Use	Usage	Monthly Total												Annual Total
		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	
Split System HPC-1/ACHP-1	Total kWh													
	Max kW													
Split System HPC-2/ACHP-2	Total kWh													
	Max kW													
Split System HPC-3/ACHP-3	Total kWh													
	Max kW													
Split System HPC-4/ACHP-4	Total kWh													
	Max kW													
Split System HPC-5/ACHP-5	Total kWh													
	Max kW													
Space Cooling Total	Total kWh													
	Max kW													
Lighting-conditioned	Total kWh													
	Max kW													
Lighting-unconditioned	Total kWh													
	Max kW													
Lighting-Site	Total kWh													
	Max kW													
Guard Booth	Total kWh													
	Max kW													

End Use	Usage	Monthly Total												Annual Total
		Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	
Balance of Site meter Consumption - Electric	Total kWh													
	Max kW													
Balance of Site meter Consumption - Gas	Total kWh													
	Max kW													

END OF SECTION 230993

SECTION 233300 - DUCT ACCESSORIES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Backdraft dampers.
2. Manual-volume dampers.
3. Fire and smoke dampers.
4. Turning vanes.
5. Duct-mounted access doors and panels.
6. Flexible ducts.
7. Flexible connectors.
8. Lagging
9. Duct accessory hardware.

B. Related Sections:

1. Division 01, High Performance Buildings Requirements Section 018113.13 for credits 16a-38k-4(b)4, 16a-38k-4(b)5.
 - a. The above listed HPB credits are related to this section. Other HPB credits may apply and shall be reviewed for their potential applicability and conformed with as though listed.

1.2 ACTION SUBMITTALS

A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.

B. Product Data: For the following products.

1. Backdraft dampers.
2. Manual-volume dampers.
3. Fire dampers.
4. Duct silencers.
5. Duct-mounted access doors and panels.
6. Flexible ducts.

C. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loadings, required clearances, method of field assembly, components, location, and size of each field connection. Detail the following:

1. Special fittings and manual- and automatic-volume-damper installations.
2. Fire- and smoke-damper installations, including sleeves and duct-mounted access doors and panels.

1.3 CLOSEOUT SUBMITTALS

A. Maintenance Data: For fire dampers to include in the operation and maintenance manuals specified in Form 816 Article 1.20-1.08.14 subsection 2 and described in NOTICE TO CONTRACTOR –

CLOSEOUT DOCUMENTS.

1.4 QUALITY ASSURANCE

- A. NFPA Compliance: Comply with the following NFPA standards:
1. NFPA 90A, "Installation of Air Conditioning and Ventilating Systems."
 2. NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

1.5 QUALITY ASSURANCE SUBMITTALS

- A. Manufacturer's Certification Letter in accordance with NOTICE TO CONTRACTOR – POTENTIAL FOR ASBESTOS CONTAINING MATERIALS.

1.6 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed, are packaged with protective covering for storage, and are identified with labels describing contents.
1. Fusible Links: Furnish quantity equal to 10 percent of amount installed.

PART 2 - PRODUCTS

2.1 SHEET METAL MATERIALS

- A. Galvanized, Sheet Steel: Lock-forming quality; ASTM A 653/A 653M, G90 (Z275) coating designation; mill-phosphatized finish for surfaces of ducts exposed to view.
- B. Carbon-Steel Sheets: ASTM A 366/A 366M, cold-rolled sheets, commercial quality, with oiled, exposed matte finish.
- C. Aluminum Sheets: ASTM B 209 (ASTM B 209M), Alloy 3003, Temper H14, sheet form; with standard, one-side bright finish for ducts exposed to view and mill finish for concealed ducts.
- D. Extruded Aluminum: ASTM B 221 (ASTM B 221M), Alloy 6063, Temper T6.
- E. Reinforcement Shapes and Plates: Galvanized steel reinforcement where installed on galvanized, sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.
- F. Tie Rods: Galvanized steel, 1/4-inch (6-mm) minimum diameter for 36-inch (900-mm) length or less; 3/8-inch (10-mm) minimum diameter for lengths longer than 36 inches (900 mm).

2.2 BACKDRAFT DAMPERS

- A. Description: Suitable for horizontal or vertical installations.
- B. Frame: 0.052-inch- (1.3-mm-) thick, galvanized, sheet steel, with welded corners and mounting flange.
- C. Blades: 0.025-inch- (0.6-mm-) thick, roll-formed aluminum.
- D. Blade Seals: Neoprene.
- E. Blade Axles: Nonferrous.

- F. Blade Axles: Galvanized steel.
- G. Tie Bars and Brackets: Galvanized steel.
- H. Return Spring: Adjustable tension.

2.3 MANUAL-VOLUME DAMPERS

- A. General: Factory fabricated with required hardware and accessories. Stiffen damper blades for stability. Include locking device to hold single-blade dampers in a fixed position without vibration. Close duct penetrations for damper components to seal duct consistent with pressure class.
 - 1. Pressure Classifications of 3-Inch wg (750 Pa) or Higher: End bearings or other seals for ducts with axles full length of damper blades and bearings at both ends of operating shaft.
- B. Standard Volume Dampers: Multiple- or single-blade, parallel- or opposed-blade design as indicated, standard leakage rating, with linkage outside airstream, and suitable for horizontal or vertical applications.
- C. Standard Volume Dampers: Multiple- or single-blade, parallel- or opposed-blade design as indicated, standard leakage rating, and suitable for horizontal or vertical applications.
 - 1. Steel Frames: Hat-shaped, galvanized, sheet steel channels, minimum of 0.064 inch (1.62 mm) thick, with mitered and welded corners; frames with flanges where indicated for attaching to walls; and flangeless frames where indicated for installing in ducts.
 - 2. Aluminum Frames: Hat-shaped, 0.10-inch- (2.5-mm-) thick, aluminum sheet channels; frames with flanges where indicated for attaching to walls; and flangeless frames where indicated for installing in ducts.
 - 3. Roll-Formed Steel Blades: 0.064-inch- (1.62-mm-) thick, galvanized, sheet steel.
 - 4. Roll-Formed Aluminum Blades: 0.10-inch- (2.5-mm-) thick aluminum sheet.
 - 5. Extruded-Aluminum Blades: 0.050-inch- (1.2-mm-) thick extruded aluminum.
 - 6. Blade Axles: Nonferrous.
 - 7. Blade Axles: Galvanized steel.
 - 8. Tie Bars and Brackets: Aluminum.
 - 9. Tie Bars and Brackets: Galvanized steel.
- D. Low-Leakage Volume Dampers: Multiple- or single-blade, parallel- or opposed-blade design as indicated, low-leakage rating, with linkage outside airstream, and suitable for horizontal or vertical applications.
- E. Low-Leakage Volume Dampers: Multiple- or single-blade, parallel- or opposed-blade design as indicated, low-leakage rating, and suitable for horizontal or vertical applications.
 - 1. Steel Frames: Hat-shaped, galvanized, sheet steel channels, minimum of 0.064 inch (1.62 mm) thick, with mitered and welded corners; frames with flanges where indicated for attaching to walls; and flangeless frames where indicated for installing in ducts.
 - 2. Aluminum Frames: Hat-shaped, 0.063-inch- (1.6-mm-) thick, extruded-aluminum channels; frames with flanges where indicated for attaching to walls; and flangeless frames where indicated for installing in ducts.

3. Roll-Formed Steel Blades: 0.064-inch- (1.62-mm-) thick, galvanized, sheet steel.
 4. Roll-Formed Aluminum Blades: 0.10-inch- (2.5-mm-) thick aluminum sheet.
 5. Extruded-Aluminum Blades: 0.050-inch- (1.2-mm-) thick extruded aluminum.
 6. Blade Seals: Felt.
 7. Blade Seals: Vinyl.
 8. Blade Seals: Neoprene.
 9. Blade Axles: Nonferrous.
 10. Blade Axles: Galvanized steel.
 11. Tie Bars and Brackets: Aluminum.
 12. Tie Bars and Brackets: Galvanized steel.
- F. High-Performance Volume Dampers: Multiple- or single-blade, parallel- or opposed-blade design as indicated, low-leakage rating, with linkage outside airstream, and suitable for horizontal or vertical applications.
1. Steel Frames: Hat-shaped, galvanized steel channels, minimum of 0.064 inch (1.62 mm) thick, with mitered and welded corners; frames with flanges where indicated for attaching to walls; and flangeless frames where indicated for installing in ducts.
 2. Aluminum Frames: Hat-shaped, 0.125-inch- (3-mm-) thick, extruded-aluminum channels; frames with flanges where indicated for attaching to walls; and flangeless frames where indicated for installing in ducts.
 3. Steel Blades: 0.052-inch- (1.3-mm-) thick, galvanized, sheet steel; airfoil shaped.
 4. Extruded-Aluminum Blades: Minimum of 0.081-inch- (2-mm-) thick, 6063T extruded aluminum.
 5. Blade Seals: Dual-durometer vinyl on blade edges; metallic compression on jambs.
 6. Blade Axles: Nonferrous.
 7. Blade Axles: Galvanized steel.
 8. Tie Bars and Brackets: Aluminum.
 9. Tie Bars and Brackets: Galvanized steel.
- G. Jackshaft: 1-inch- (25-mm-) diameter, galvanized steel pipe rotating within a pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
1. Length and Number of Mountings: Appropriate to connect linkage of each damper of a multiple-damper assembly.
- H. Damper Hardware: Zinc-plated, die-cast core with dial and handle made of 3/32-inch- (2.4-mm-) thick zinc-plated steel, and a 3/4-inch (19-mm) hexagon locking nut. Include center hole to suit damper operating-rod size. Include elevated platform for insulated duct mounting.

2.4 FIRE DAMPERS

- A. General: Labeled to UL 555.
- B. Fire Rating: One and one-half hours.

- C. Fire Rating: One and one-half and three hours.
- D. Frame: SMACNA Type A with blades in airstream; fabricated with roll-formed, 0.034-inch- (0.85-mm-) thick galvanized steel; with mitered and interlocking corners.
- E. Frame: SMACNA Type B with blades out of airstream; fabricated with roll-formed, 0.034-inch- (0.85-mm-) thick galvanized steel; with mitered and interlocking corners.
- F. Mounting Sleeve: Factory- or field-installed galvanized, sheet steel.
 - 1. Minimum Thickness: 0.052 inch (1.3 mm) or 0.138 inch (3.5 mm) thick as indicated, and length to suit application.
 - 2. Exceptions: Omit sleeve where damper frame width permits direct attachment of perimeter mounting angles on each side of wall or floor, and thickness of damper frame complies with sleeve requirements.
- G. Mounting Orientation: Vertical or horizontal as indicated.
- H. Blades: Roll-formed, interlocking, 0.034-inch- (0.85-mm-) thick, galvanized, sheet steel. In place of interlocking blades, use full-length, 0.034-inch- (0.85-mm-) thick, galvanized steel blade connectors.
- I. Horizontal Dampers: Include a blade lock and stainless-steel negator closure spring.
- J. Fusible Link: Replaceable, 165 or 212° F (74 or 100° C) rated as indicated.

2.5 TURNING VANES

- A. Fabricate to comply with SMACNA's "HVAC Duct Construction Standards--Metal and Flexible."
- B. Manufactured Turning Vanes: Fabricate of 1-1/2-inch- (38-mm-) wide, curved blades set 3/4 inch (19 mm) o.c.; support with bars perpendicular to blades set 2 inches (50 mm) o.c.; and set into side strips suitable for mounting in ducts.

2.6 DUCT-MOUNTED ACCESS DOORS AND PANELS

- A. General: Fabricate doors and panels airtight and suitable for duct pressure class.
- B. Frame: Galvanized, sheet steel, with bend-over tabs and foam gaskets.
- C. Door: Double-wall, galvanized, sheet metal construction with insulation fill and thickness, and number of hinges and locks as indicated for duct pressure class. Include vision panel where indicated. Include 1-by-1-inch (25-by-25-mm) butt or piano hinge and cam latches.
- D. Seal around frame attachment to duct and door to frame with neoprene or foam rubber.
- E. Insulation: 1-inch- (25-mm-) thick, fibrous-glass or polystyrene-foam board.

2.7 FLEXIBLE CONNECTORS

- A. General: Flame-retarded or noncombustible fabrics, coatings, and adhesives complying with UL 181, Class 1.

- 1. Standard Metal-Edged Connectors: Factory fabricated with a strip of fabric 3-1/2 inches (89 mm) wide attached to two strips of 2-3/4-inch- (70-mm-) wide, 0.028-inch- (0.7-mm-) thick, galvanized, sheet steel or 0.032-inch (0.8-mm) aluminum sheets. Select metal compatible with connected ducts.
- B. Extra-Wide Metal-Edged Connectors: Factory fabricated with a strip of fabric 5-3/4 inches (146 mm) wide attached to two strips of 2-3/4-inch- (70-mm-) wide, 0.028-inch- (0.7-mm-) thick, galvanized, sheet steel or 0.032-inch (0.8-mm) aluminum sheets. Select metal compatible with connected ducts.
- C. Transverse Metal-Edged Connectors: Factory fabricated with a strip of fabric 3-1/2 inches (89 mm) wide attached to two strips of 4-3/8-inch- (111-mm-) wide, 0.028-inch- (0.7-mm-) thick, galvanized, sheet steel or 0.032-inch (0.8-mm) aluminum sheets. Select metal compatible with connected ducts.
- D. Conventional, Indoor System Flexible Connector Fabric: Glass fabric double coated with polychloroprene.
 - 1. Minimum Weight: 26 oz./sq. yd. (880 g/sq. m).
 - 2. Tensile Strength: 480 lbf/inch (84 N/mm) in the warp, and 360 lbf/inch (63 N/mm) in the filling.
- E. Conventional, Outdoor System Flexible Connector Fabric: Glass fabric double coated with a synthetic-rubber, weatherproof coating resistant to the sun’s ultraviolet rays and ozone environment.
 - 1. Minimum Weight: 26 oz./sq. yd. (880 g/sq. m).
 - 2. Tensile Strength: 530 lbf/inch (93 N/mm) in the warp, and 440 lbf/inch (77 N/mm) in the filling.

2.8 FLEXIBLE DUCTS

- A. General: Comply with UL 181, Class 1.
- B. Flexible Ducts, Insulated: Factory-fabricated, insulated, round duct, with an outer jacket enclosing 1-1/2-inch- (38-mm-) thick, glass-fiber insulation around a continuous inner liner.
 - 1. Reinforcement: Steel-wire helix encapsulated in inner liner.
 - 2. Outer Jacket: Glass-reinforced, silver Mylar with a continuous hanging tab, integral fibrous-glass tape, and nylon hanging cord.
 - 3. Outer Jacket: Polyethylene film.
 - 4. Inner Liner: Polyethylene film.
- C. Pressure Rating: 6-inch wg (1500 Pa) positive, 1/2-inch wg (125 Pa) negative.

2.9 LAGGING

- A. Vinyl noise barrier with a scrim reinforced aluminum foil facing on one side bonded to 2", 4lb/sqft sound absorbing quilted fiberglass, STC (sound transmission class) 34, complying with UL 94.

<u>Sound Transmission Loss (dB)</u>		<u>Frequency (Hz)</u>			
<u>125</u>	<u>250</u>	<u>500</u>	<u>1000</u>	<u>2000</u>	<u>4000</u>
21	24	29	41	54	68

2.10 ACCESSORY HARDWARE

- A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments, and length to suit duct insulation thickness.
- B. Splitter Damper Accessories: Zinc-plated damper blade bracket; 1/4-inch (6-mm), zinc-plated operating rod; and a duct-mounted, ball-joint bracket with flat rubber gasket and square-head set screw.
- C. Flexible Duct Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action, in sizes 3 to 18 inches (75 to 450 mm) to suit duct size.
- D. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install duct accessories according to applicable details shown in SMACNA's "HVAC Duct Construction Standards--Metal and Flexible" for metal ducts and NAIMA's "Fibrous Glass Duct Construction Standards" for fibrous-glass ducts.
- B. Install volume dampers in lined duct; avoid damage to and erosion of duct liner.
- C. Provide test holes at fan inlet and outlet and elsewhere as indicated.
- D. Install fire and smoke dampers according to manufacturer's UL-approved written instructions.
 - 1. Install fusible links in fire dampers.
- E. Install duct access panels for access to both sides of duct coils. Install duct access panels downstream from volume dampers, fire dampers, turning vanes, and equipment.
 - 1. Install duct access panels to allow access to interior of ducts for cleaning, inspecting, adjusting, and maintaining accessories and terminal units.
 - 2. Install access panels on side of duct where adequate clearance is available.
 - 3. Install fire damper duct access panels within reach of fusible links.
- F. Label access doors according to other Sections.
- G. Flexible ducts shall be a maximum length of 4 feet. Provide a rigid elbow at connection to ceiling mounted registers, diffusers, and grilles. Flexible ducts shall only be used on supply air ductwork systems. Flexible ducts shall not be used on return and exhaust air systems.
- H. Install duct lagging from roof curb duct connection to downstream termination of duct silencers, on supply and return ductwork associated with rooftop units RTU-11, 13, 14 and 15. For RTU-12 supply ductwork, install duct lagging from building wall penetration to downstream termination of both duct silencers. Comply with manufacturer's written instructions using types of mounting accessories indicated. Lagging provides duct insulation, additional insulation over lagging is not required.

3.2 ADJUSTING

- A. Adjust duct accessories for proper settings.
- B. Adjust fire and smoke dampers for proper action.
- C. Final positioning of manual-volume dampers is specified in other Sections.

END OF SECTION 233300

SECTION 237200 AIR-TO-AIR ENERGY RECOVERY UNITS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Packaged energy recovery units.
- B. Related Sections:
 - 1. Division 01, High Performance Buildings Requirements Section 018113.13 for credits 16a-38k-4(b)4, 16a-38k-4(b)5, 16a-38k-3(d).
 - a. The above listed HPB credits are related to this section. Other HPB credits may apply and shall be reviewed for their potential applicability and conformed with as though listed.

1.2 ACTION SUBMITTALS

- A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR - SUBMITTALS
- B. Product Data for each energy recovery unit specified, including the following:
 - 1. Certified supply and exhaust fans performance curves with system operating conditions indicated.
 - 2. Certified fans sound power ratings.
 - 3. Certified heat recovery component (i.e., heat exchangers, etc.) rated capacities for inlet and outlet operating conditions, and operating efficiencies indicated.
 - 4. Certified coil-performance ratings with system operating conditions indicated.
 - 5. Motor ratings and electrical characteristics plus motor and fan accessories.
 - 6. Material gages and finishes.
 - 7. Filters with performance characteristics.
 - 8. Dampers, including housings, linkages, and operators.
 - 9. Weights (shipping, installed, and operating).
 - 10. Furnished specialties.
 - 11. All required accessories.
 - 12. Installation and startup instructions.
- C. Shop Drawings: From manufacturer detailing equipment assemblies and indicating dimensions, weights, loadings, required clearances, method of field assembly, components, and location and size of each field connection.

1. Wiring diagrams detailing wiring for power and control systems and differentiating between manufacturer-installed and field-installed wiring.

1.3 QUALITY ASSURANCE SUBMITTALS

- A. Field test reports indicating and interpreting test results relative to compliance with specified requirements.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For air-to-air energy recovery units to include in the operation and maintenance manuals specified in Form 816 Article 1.20-1.08.14 subsection 2 and described in NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS.
- B. Warranty: For air-to-air energy recovery units specified in Form 816 Article 1.20-1.06.08 and described in NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS.

1.5 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with provisions of the following codes:
 1. ASHRAE Compliance: Provide capacity ratings for energy recovery devices according to ASHRAE 84, “Method of Testing Air-to-Air Heat Exchangers.”
 2. NRCA Compliance: Provide roof curbs for roof-mounted equipment constructed according to recommendations of NRCA.
- B. Testing Requirements: The following factory tests are required:
 1. Sound Power Level Ratings: Comply with AMCA 301, “Methods for Calculating Fan Sound Ratings from Laboratory Test Data.” Test fans according to AMCA 300, “Reverberant Room Method for Sound Testing of Fans.” Fans shall bear AMCA-certified sound ratings seal.
 2. Fan Performance Ratings: For fans product data submitted, establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings in accordance with AMCA Standard 210/ASHRAE Standard 51 - Laboratory Methods of Testing Fans for Rating.
- C. NFPA Compliance: Central-station air-handling units and components shall be designed, fabricated, and installed in compliance with NFPA 90A, “Installation of Air Conditioning and Ventilating Systems.”
- D. UL Standard: Provide units complying with UL 1812, “Ducted Heat Recovery Ventilators”; or UL 1815.
- E. UL and NEMA Compliance: Provide ancillary electrical components, such as motors, required as part of energy recovery units that are listed and labeled by UL and that comply with applicable NEMA standards.

- F. Comply with NFPA 70 for components and installation.
- G. AHRI Compliance: Air to air energy recovery components shall comply with AHRI 1060.
- H. ARI Compliance: Coils shall be rated in accordance with ARI standard 410 and bear the ARI seal.
- I. Listing and Labeling: Provide electrically operated components specified in this Section that are listed and labeled.
 - 1. The Terms “Listed” and “Labeled”: As defined in the National Electrical Code, Article 100.
- J. Coordination: Coordinate layout and installation of energy recovery units with piping and ductwork and with other installations.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Deliver energy recovery unit as a factory-assembled module with protective crating and covering.
- B. Lift and support units with manufacturer’s designated lifting or supporting points.

1.7 SEQUENCING AND SCHEDULING

- A. Coordinate installation of roof curbs, equipment supports, and roof penetrations. .

1.8 ENVIRONMENTAL REQUIREMENTS

- A. Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings lubricated, and fan has been test run under observation.

1.9 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed, are packaged with protective covering for storage, and are identified with labels describing contents.
- B. Filters: Furnish one set of each type of filter specified.
- C. Fan Belts: Furnish one set of belts for each belt-driven fan in energy recovery units.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis of design manufacturer: XETEX series XHR energy recovery rooftop units; XETEX Inc.

2.2 PACKAGED ENERGY RECOVERY UNITS (RTU-1 THRU RTU-10)

- A. Double Wall Construction: Cabinet frame exterior and panels (fixed and access) shall be formed of minimum 18 gauge galvanized steel, primed with industrial universal primer, moisture and corrosion resistant, and acrylic top coat. Frame and panels to be double-walled construction with 2" thick insulation, 3# density hardboard, composed of glass fibers bonded with a thermoset resin and faced with an adhered black non-woven mat surface. Frame and panels to have an internal liner of minimum 22 gauge galvanized steel and shall be sealed with silicone sealant. Perforated panels shall be provided on the walls of all blower sections for acoustical insulation. Sloped roof panels with rain gutters shall overhang the sidewalls. Provide outside air shut-off damper, exhaust air shut-off damper, and intake and exhaust weather hoods with bird-screens. Outside air hoods shall be sized for 250 feet/minute velocity and configured to minimize capture of snow into rooftop unit.
1. Insulation shall have a thermal resistance R factor of 8.7 (2" thick). Insulation shall comply with ASTM 612, Type 1A and 1B. Per ASTM E 84 it shall have a maximum flame spread index of 25 and a maximum smoke developed index of 50, and under NFPA 259 its limited combustibility rating shall be less than or equal to 3,500 Btu/lb.
- B. Structural Steel Base Frame and Floor: Unit shall have an all-welded base frame constructed from structural steel. The frame shall include formed supports constructed from welded structural steel under blowers and other components. A minimum 16 gauge galvanized steel interior floor shall be installed on the base frame. The floor shall be insulated with 2" thick load-bearing, rigid, closed-cell polyisof foam core insulation, with a minimum 22 gauge galvanized steel sub-floor under the insulation. All base frame seams shall be sealed and the frame shall be coated with a rust inhibiting paint. The perimeter of the frame shall be insulated.
1. Floor insulation shall comply with ASTM C1289, Type II, Class 1 and UL Classified; FM Class 1 Approved.
- C. Drain Pans: 304 stainless steel, double sloped drain pans with all welded seams and MPT connections shall be provided in all heat exchanger sections. Heat exchanger sections shall have a minimum of two separate, full width, double sloped drain pans; one in the supply air plenum and one in the exhaust air plenum. Each drain pan shall be a minimum 3" deep with its own MPT drain. The heat exchanger shall be removable from the unit without requiring that the drain pans be removed or deconstructed.
- D. Hinged Access Doors: Access to all exchanger surfaces, blowers, motors, filters, and other components requiring regular maintenance shall be provided through access doors. Access doors shall have double-wall construction with a minimum 18 gauge galvanized steel inner and outer walls, and 3# density hardboard fiberglass insulation. Access doors shall be held closed by a minimum of two roller cam latches. Door hinges shall be galvanized steel. Doors shall be removable from the unit frame. Access door frames shall be made from galvanized steel. Continuous hollow rubber gasket shall be applied to all access openings to provide water and airtight seals.
- E. Air-to-Air Flat Plate Heat Exchangers: Air-to-air heat exchanger shall be aluminum, flat-plate type. Heat transfer surface shall be a minimum 0.008" thick formed aluminum plates. Heat exchanger frame profiles and corners shall be all aluminum. End plates shall be galvanized steel, capable of withstanding a pressure difference between airflows of up to 7.2" w.c.

without deforming air passages. Unit shall be capable of operating in temperatures up to 190 degrees F. Cell construction shall have a maximum cross contamination between airflows of 0.1% of total airflow. The entire cell shall be capable of being visibly inspected and cleaned as required.

- F. Plenum Blowers: Supply and exhaust air blowers shall be a backward inclined airfoil centrifugal plenum type without scroll housing arranged in a draw-through configuration. Fans shall incorporate a wheel; heavy gauge reinforced steel inlet plate shaft, and bearings in AMCA Arrangement 3 configuration to form a heavy-duty integral unit. Blowers shall be tested to AMCA standard 210 and bear the AMCA certified ratings seal for performance. The fan blades shall continuously welded, die-formed airfoil type, designed for maximum efficiency and quiet operation. Impellers shall be statically and dynamically balanced, non-overloading, and complete fan assembly shall be test balanced at the operating speed prior to shipment. Fan motors shall be premium efficient ODPT-frame. Motor and blower shall be mounted on common frame and isolated from unit case with restrained spring isolators with a minimum of 1" deflection flexible duct connections. For each fan provide low leak manual locking dampers to be closed in the event a fan is taken out of service.
- G. Coils: Coil shall be designed for use with a water-based heat transfer fluid containing 30 % propylene glycol. Complete coil core shall be tested with 315 pounds air pressure under warm water and guaranteed for 250 psig working pressures. Headers shall be of non-ferrous materials using seamless copper tubing with intruded tube holes to permit expansion and contraction without creating undue stress or strain.
- H. Dampers: Parallel blade outside air dampers shall be mounted on the inlet of the unit. and operated by a spring return, direct-coupled on-off actuator with an end switch to be interlocked with the supply air motor relay. Parallel blade exhaust air damper shall be mounted on the outlet of the unit and operated by a spring return, direct-coupled on-off actuator with an end switch to be interlocked with the return air motor relay. Opposed blade face-and-bypass dampers shall be mounted flush to the face of the exchanger and operated by a spring return, direct-coupled, modulating proportional actuator. Dampers shall be interlocked so that when the face damper is open the bypass damper shall be closed.
1. Coordinate provision of controls and control devices with project controls contractor.
- I. Filters: Outside and Return air filters shall be MERV 8 pleated panels consisting of cotton and synthetic media, media support grid and enclosing frame with integral channel for side-access application. Filters shall be mounted within unit in galvanized holding frames upstream of exchanger and accessible through access panels or doors.
- J. Electrical: Electrical controls shall include variable frequency drives, fused branch circuit breakers, control transformer for low voltage controls, service switch, and terminal points/blocks all contained in a NEMA 3R, unit-mounted control panel. A single main disconnect switch for single point power connection shall be provided. The disconnect switch shall be mounted through the access panel so that power will have to be shut-off before the access door can be opened. The unit wiring diagram shall be provided in the panel. All provided wiring and controls shall be factory tested before shipment.
- K. Manufacturer's Energy Recovery Control: The manufacturer's energy recovery control system shall use remote temperature sensors mounted in the entering and leaving sides of both airstreams to monitor exchanger performance. Setpoints shall be adjustable through the

building control system.

1. The manufacturer provided controls shall prevent frost build-up. The controller shall monitor the temperature in the exhaust airstream leaving the exchanger and open the bypass side of the Face-and-Bypass damper enough to prevent the temperature from dropping below an adjustable, pre-programmed setpoint.
2. The manufacturer provided controls shall control heat recovery for economizer mode. The controller shall monitor the temperature of the supply air leaving the exchanger and open the bypass side of the Face-and-Bypass damper enough to prevent the temperature from rising above an adjustable, pre-programmed setpoint.
3. The manufacturer provided controls shall switch to maximum heat recovery for cooling mode. The controller shall monitor both indoor and outdoor temperatures. When outdoor temperature is higher than indoor temperature, the Face-and-Bypass damper shall open to full face mode.
4. Coordinate operation, adjustment and signal requirements with project controls contractor.

L. Variable Frequency Drives

1. VFD Certifications and Ratings: VFD's shall be UL listed as complete assemblies and be enclosed in enclosures that are UL listed as plenum rated. VFDs shall also have seismic certification. The tolerated voltage window shall allow the VFD to operate from a line of +30% to -35% of nominal voltage range. VFDs shall be rated for continuous operation to 104 °F with full current without being compromised by temperature variations within any 24 hour period; at 122 °F only 10% de-rating shall be required.
2. VFD Features: Drive-mounted digital displays and keypads shall allow operator interface. The keypad shall be removable, capable of remote mounting and allow for uploading and downloading of parameter settings as an aid for start-up of multiple VFDs. Built in timers that use a real-time clock shall be included and eliminate the need for external timing circuits. VFDs shall have serial communication ports with BACnet MS/TP, Modbus, Johnson Controls N2, and Siemens Building Technologies FLN standard protocols and shall not require any third-party gateways. VFD shall have a programmable time delay for motor start. VFDs shall also include Electromagnetic Interference / Radio Frequency Interference (EMI/RFI) filters that meet product standard EN 61800-3 for the First Environment and therefore eliminate the need for any external filtering hardware. VFDs shall have internal 5% impedance reactors to reduce the harmonics to the power line and to add protection for AC line transients. VFD shall transmit energy usage (kW and kWh) to the building controls system.
3. VFD Control Features: VFDs shall also incorporate two PID Set Point controllers allowing space pressure or flow signals to be connected to the VFD using the microprocessor in the VFD for closed-loop control. The second independent PID loop shall be capable of using an analog input to modulate an analog output to maintain the set point of an independent process (valve, damper, etc.). It shall be possible to monitor and control these processes through the serial communication

port.

- 4. VFD Safety Features: VFDs shall provide a programmable loss-of-load relay/serial communication output to indicate a broken belt or coupling. A run permissive circuit shall delay motor operation until a dry contact has been closed indicating that the appropriate dampers are open. A minimum of two separate safety interlock inputs shall also be provided that, when opened, will cause the VFD to command the motor to stop and the damper to close.

- M. Roof Curbs: Roof curb shall be minimum 16 gauge galvanized steel with additional supports and cross members as needed. Curb shall have wood nailer and 1.5" thick fiberglass insulation of the same type used to insulate the unit floor

- N. Weights: Units shall not exceed the maximum weights listed below:
 - 1. RTU-1 thru 6: 22,000 lbs
 - 2. RTU-7: 25,000 lbs
 - 3. RTU-8: 25,000 lbs
 - 4. RTU-9: 14,000 lbs
 - 5. RTU-10: 5,000 lbs

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to receive energy recovery units for compliance with requirements for installation tolerances and other conditions affecting performance of energy recovery units. Examine roughing-in of condensate drainage piping and electrical to verify actual locations of connections before installation. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Provide the services of the manufacturer’s factory-authorized service representative to instruct installing contractors on field assembly, system controls and devices, and provide startup services.

- B. Install outdoor energy recovery units level and plumb, according to manufacturer’s written instructions.
 - 1. Roof Mounted Units: Support roof mounted units on prefabricated roof curbs furnished by equipment manufacturer. Secure units to roof curbs per manufacturer’s installation instructions. Coordinate roof curb and curb flashing with roofing contractor. Ensure that roof curbs and units are watertight.

- C. Arrange installation of units to provide access space around equipment for service and maintenance.

- D. Install new filters at completion of equipment installation and before testing, adjusting, and

balancing.

3.3 CONNECTIONS

- A. Drawings indicate the general arrangement of ducts and duct accessories. Make final duct connections with flexible connections.
- B. Drawings indicate the general arrangement of piping, fittings, and specialties. The following are specific connection requirements:
 - 1. Install piping adjacent to unit to allow service and maintenance.
 - 2. Connection piping to energy recovery units with flexible connectors.
 - 3. Connect condensate drain pans using minimum 1-1/4-inch NPS (DN32), Type M copper tubing. Extend to nearest equipment or floor drain. Construct deep trap at connection to drain pan and install cleanouts at changes in direction.
 - 4. Hot Water Piping: Connect to supply and return coil tapings with shutoff or balancing valve and union or flange at each connection.

3.4 CLEANING

- A. After completing system installation, including outlet fittings and devices, inspect and clean exposed finishes. Remove burrs, dirt and construction debris, and repair damaged finishes including chips, scratches and abrasions
- B. Clean fan interiors to remove foreign material and construction dirt and dust. Vacuum clean fan wheels, cabinets, and heat recovery equipment air face areas.

3.5 COMMISSIONING

- A. Manufacturer's Field Inspection: Engage a factory-authorized service representative to perform the following:
 - 1. Inspect field assembly of components and installation of equipment including piping, ductwork, and electrical connections.
 - 2. Prepare a written report on findings and recommended corrective actions.
- B. Final Checks before Startup: Perform the following before startup:
 - 1. Verify that shipping, blocking, and bracing are removed.
 - 2. Verify that unit is secure on curbs, mountings and supporting devices and that connections for piping, ductwork, and electrical are complete. Verify that proper thermal overload protection is installed in motors, starters and disconnects.
 - 3. Perform cleaning and adjusting specified in this Section.
 - 4. Disconnect heat recovery wheel drives from motors and verify heat recovery wheel

rotation and smooth bearings operations. Reconnect wheel drive system, align belts, and install belt guards.

5. Lubricate bearings, pulleys, belts, and other moving parts with factory-recommended lubricants.
 6. Set zone dampers to fully open position for each zone.
 7. Set outside-air and return-air mixing dampers to minimum outside-air setting.
 8. Inspect energy recovery component and confirm there is no damage or operational issues.
 9. Install clean filters.
 10. Verify that manual and automatic volume control, and any fire and smoke dampers in connected ductwork systems are in fully open position.
- C. Startup Services: Engage a factory-authorized service representative to commission units as specified below.
1. Energize and verify correct rotation of heat wheels and fans.
 2. Adjust seals and purge.
 3. Test and adjust controls and safeties. Replace damaged or malfunctioning controls and equipment.
 4. Prepare a written report on commissioning checklists and startup procedures.

3.6 DEMONSTRATION

- A. Train Owner's maintenance personnel on procedures and schedules related to startup and shutdown, troubleshooting, servicing, and preventive maintenance.
- B. Review data in the operation and maintenance manuals.
- C. Schedule training with Owner with at least 7 days' advance notice.

END OF SECTION 237200

SECTION 237523 ROOFTOP HEATING AND COOLING UNITS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes packaged rooftop heating and cooling units.
- B. Related Sections:
 - 1. Division 01, High Performance Buildings Requirements Section 018113.13 for credits 16a-38k-4(b)4, 16a-38k-4(b)5, 16a-38k-3(d), 16a-38k-3(k).
 - a. The above listed HPB credits are related to this section. Other HPB credits may apply and shall be reviewed for their potential applicability and conformed with as though listed.

1.2 ACTION SUBMITTALS

- A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.
- B. Product Data: For each type of product.
 - 1. Submit manufacturer's technical product data, including rated capacities of selected model clearly indicated, dimensions, required clearances, weights, furnished specialties and accessories; and installation and start-up instructions.
- C. Shop Drawings:
 - 1. Submit shop drawings detailing the manufacturer's electrical requirements for power supply wiring for rooftop heating and cooling units. Submit manufacturer's ladder-type wiring diagrams for interlock and control wiring. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.
 - 2. Submit shop drawings detailing the mounting, securing, and flashing of the roof curb to the roof structure. Indicate coordinating requirements with roof membrane system.

1.3 INFORMATION SUBMITTALS

- A. Product certificates signed by manufacturers of meters and gages certifying accuracies under specified operating conditions and products' compliance with specified requirements.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For each type of rooftop heating and cooling unit include in the operation and maintenance manuals specified in Form 816 Article 1.20-1.08.14 subsection 2 and described in NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS.
- B. Warranty: For each type of rooftop heating and cooling unit specified in Form 816 Article 1.20-1.06.08 and described in NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS.

1.5 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of rooftop heating and cooling units, of types and capacities required, whose products have been in satisfactory use in similar service for not less than 5 years.
- B. Regulatory Requirements:
 - 1. Refrigerating system construction of rooftop units shall be in accordance with ASHRAE 15 "Safety Code for Mechanical Refrigeration."
 - 2. Energy Efficiency Ratio (EER) of rooftop units shall be equal to or greater than prescribed by ASHRAE 90.1 "Energy Standard for Buildings except Low-Rise Residential Buildings."
 - 3. Rooftop units shall be listed by UL and have UL label as a unit.

1.6 SCHEDULING AND SEQUENCING

- A. Coordinate installation of roof mounting curb as follows:
 - 1. Furnish manufacturer's standard roof curb for each piece of equipment.
 - 2. Curb shall be installed and flashed by the Division 07 Contractor.
 - 3. Installation of roof mounted equipment on the curb shall be by the Division 23 Contractor.
 - 4. All flashing and roofing shall be by the Division 07 Contractor.
- B. Coordinate roof opening with the Division 07 Contractor.

1.7 SPECIAL WARRANTY

- A. Warranty on Compressors: Provide written warranty, signed by manufacturer, agreeing to replace/repair, within warranty period, compressors with inadequate and defective materials and workmanship, including leakage, breakage, improper assembly, or failure to perform as required; provided manufacturer's instructions for handling, installing, protecting, and maintaining units have been adhered to during warranty period. Replacement is limited to component replacement only, and does not include labor for removal and reinstallation.
 - 1. Warranty Period: 5 years from date of substantial completion.

1.8 MAINTENANCE

- A. Extra Materials: Furnish to Owner, with receipt, the following spare parts for each rooftop heating and cooling unit:
 - 1. One set filters for each unit.

PART 2 - PRODUCTS

2.1 ROOFTOP HEATING AND COOLING UNITS

- A. Manufacturers: Subject to compliance with requirements, provide rooftop units of one of the following:
1. Aaon
 2. Trane (The) Co; Div of American Standard Inc.
 3. Daikin, McQuay.
- B. General Description: Units shall be factory-assembled and tested, designed for roof installation, and consisting of compressors, condensers, evaporator coils, condenser and evaporator fans, refrigeration and temperature controls, filters, and dampers. Capacities and electrical characteristics are scheduled on the Drawings.
- C. Casing: Manufacturer's standard casing construction, having corrosion protection coating, and exterior finish. Casings shall have removable panels or access doors for inspection and access to internal parts, a minimum of 1/2" thick thermal insulation, knockouts for electrical and piping connections and an exterior condensate drain connection and lifting lugs.
- D. Roof Curbs: Factory fabricated, heavy gauge galvanized steel, 1 1/2" thick 18" high fiberglass insulated curb with solid bottom acoustic curb with spring isolated seismic restrained rail system; openings sized to respective duct size. Curb shall be fabricated to match roof pitch. Provide supply and return duct flexible connector support hardware. Construction shall be in accordance with NRCA Standards. Provide 2" fiberglass isolation matt in bottom of curb. Provide flex pipe connections to unit..
- E. Supply Fans:
1. Unit shall include direct drive, unhooded, backward curved, plenum supply fans.
 2. Blowers and motors shall be dynamically balanced and mounted on rubber isolators.
 3. Motors shall be premium efficiency ODP with ball bearings rated for 200,000 hours service with external lubrication points.
 4. Variable frequency drivers shall be factory wired, mounted in the units, and shall transmit energy usage (kW and kWh) to the building controls system; coordinate with controls contractor. Where multiple fans serve supply or exhaust airflow, a single variable frequency drive shall operate all fan motors. Fan motors shall be premium efficiency.
- F. Exhaust Fans:
1. Exhaust dampers shall be sized for 100% relief.
 2. Fans and motors shall be dynamically balanced.
 3. Motors shall be premium efficiency ODP with ball bearings rated for 200,000 hours service with external lubrication points.
 4. Access to exhaust fans shall be through double wall, hinged access doors with quarter turn lockable handles.
 5. Units shall include belt driven, unhooded, backward curved, plenum exhaust fans.
 6. Variable frequency drives shall be factory wired, mounted in the unit, and shall transmit energy usage (kW and kWh) to the building controls system; coordinate with controls

contractor. Where multiple fans serve supply or exhaust airflow, a single variable frequency drive shall operate all fan motors. Fan motors shall be premium efficiency.

G. Condenser Fans:

1. Propeller-type, direct-driven fans with permanently lubricated bearings.

H. Motors: Motors shall be Premium efficiency as manufactured by Baldor, Toshiba, or Reliance. Motors for use with VFD's are premium efficiency inverter rated only. Motor bearings are ball bearing and have external lubrication connections.

I. Coils:

1. General: Aluminum plate fin and seamless copper tube type. Fins shall have collars drawn, belled and firmly bonded to the tubes by means of mechanical expansion of the tubes. No soldering or tinning shall be used in the bonding process. Coils shall have a galvanized steel casing. Coils shall be mounted in the coil casing with same end connections accessible for service. Coils shall be removable from the unit through the roof or through the piping enclosure. Coil section shall be completely insulated.
2. Water heating coils: pitched in the unit casing for proper drainage.
 - a. Coils shall have metering orifices and a supply header to ensure distribution of hot water to each tube. Coils shall be proof (300 psig) and leak (200 psig) tested with air pressure under water.
3. Refrigerant cooling coils: have an equalizing type vertical distributor to ensure each coil circuit receives the same amount of refrigerant. Coils shall be proof (450 psig) and leak (300 psig) tested with air pressure under water, then cleaned, dehydrated, and sealed with a holding charge of nitrogen.

K. Refrigeration System:

1. Unit shall be factory charged with R-410A refrigerant.
2. Compressors shall be scroll type with thermal overload protection and carry a 5 year non-prorated warranty, from the date of original equipment shipment from the factory.
3. Compressors shall be mounted in an isolated service compartment which can be accessed without affecting unit operation. Lockable hinged compressor access doors shall be fabricated of double wall, rigid polyurethane foam injected panels to prevent the transmission of noise outside the cabinet.
4. Compressors shall be isolated from the base pan with the compressor manufacturer's recommended rubber vibration isolators, to reduce any transmission of noise from the compressors into the building area.
5. Each refrigeration circuit shall be equipped with thermostatic expansion valve type refrigerant flow control.
6. Each refrigeration circuit shall be equipped with automatic reset low pressure and

fittings
replaceable

manual reset high pressure refrigerant safety controls, Schrader type service on both the high pressure and low pressure sides and a factory installed core liquid line filter driers.

7. Unit shall include a variable capacity scroll compressor on the refrigeration circuit which shall be capable of modulation from 10-100% of its capacity.
- J. Safety controls: manual reset type for:
1. Low pressure cutout;
 2. High pressure cutout;
 3. Compressor motor overload protection.
- K. Economizer: return and outside air dampers, outside air filter. System shall have 100 percent outside air capability. .
- L. Accessories: Units shall include the following accessories as indicated or scheduled:
1. Low ambient control: head pressure control, designed to operate at temperatures down to 0°F (-18°C).
 2. Provide electrical disconnect switch sized per manufacturer.
- M. Weights: Units shall not exceed the maximum weights listed below:
1. RTU-11: 2,200 lbs
 2. RTU-12: 6,200 lbs
 3. RTU-13: 6,200 lbs
 4. RTU-14: 1,000 lbs
 5. RTU-15: 1,000 lbs

2.2 ENERGY RECOVERY HEATING AND COOLING (RTU-11, RTU-12, RTU&-13)

- A. Unit shall contain a factory mounted and tested energy recovery - wheel. The energy recovery wheel shall be mounted in a rigid frame containing the wheel drive motor, drive belt, wheel seals and bearings. Frames shall slide out for service and removal from the cabinet.
- B. The energy recovery component shall incorporate a rotary when in an insulated cassette frame complete with seals, drive motor and drive belt.
- C. Wheel(s) shall be wound continuously with one flat and one structured layer in an ideal parallel plate geometry providing laminar flow and minimum pressure drop-to-efficiency ratios. The layers shall be effectively captured in stainless steel wheel frames or aluminum and stainless steel segment frames that provide a rigid and self-supporting matrix.
- D. Wheel(s) shall be provided with removable energy transfer matrix. Wheel frame construction shall be welded hub, spoke and rim assembly of stainless, plated and/or coated steel and shall be self-supporting without matrix segments in place. Segments shall be removable without the use of tools to facilitate maintenance and cleaning. Wheel bearings shall be selected to provide an L-10 life in excess of 400,000 hours. Rim shall be continuous rolled stainless steel and the wheel shall be connected to the shaft by means of taper locks.
- E. All diameter and perimeter seals shall be provided as part of the cassette assembly and shall be factory set. Drive belts of stretch urethane shall be provided for wheel rim drive without the need

for external tensioners or adjustment.

- F. The energy recovery cassette shall be an Underwriters Laboratories Recognized Component for electrical and fire safety. The wheel drive motor shall be an Underwriters Laboratory Recognized Component and shall be mounted in the cassette frame and supplied with a service connector or junction box. Thermal performance shall be certified by the manufacturer in accordance with ASHRAE Standard 84, Method of Testing Air-to-Air Heat Exchangers and AHRI Standard 1060, rating Air-to-Air Energy Recovery Ventilation Equipment. Cassettes shall be listed in the AHRI certified products.
- G. Unit shall include 4 inch thick, pleated panel outside air filters with MERV rating of 8, upstream of the wheels.
- H. Hinged service access doors shall allow access to the wheel(s).
- I. Total energy recovery wheels shall be coated with silica gel desiccant permanently bonded by a process without the use of binders or adhesives, which may degrade desiccant performance. The substrate shall be lightweight polymer and shall not degrade nor require additional coatings for application in marine or coastal environments. Coated segments shall be washable with detergent or alkaline coil cleaner and water. Desiccant shall not dissolve not deliquesce in the presence of water or high humidity.
- J. Unit shall include energy recovery wheel rotation detection sensors and a set of normally open and normally closed contacts for field indication of wheel rotation.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions under which rooftop units are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.2 INSTALLATION

- A. General: Install rooftop units in accordance with manufacturer's installation instructions. Install units plumb and level, firmly anchored in locations indicated, and maintain manufacturer's recommended clearances.
- B. Support: Installation of roof curbs shall be by the Division 07 Contractor.
- C. Electrical Connections: Refer to Division 26 for final electrical connections to equipment and installation of loose shipped electrical components.

3.3 DEMONSTRATION

- A. Start-Up Services:
 - 1. Provide the services of a factory-authorized service representative to start-up rooftop units, in accordance with manufacturer's written start-up instructions. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.

B. Operating and Maintenance Training:

1. Provide services of manufacturer's service representative to instruct Owner's personnel in operation and maintenance of rooftop units. Training shall include start-up and shut-down, servicing and preventative maintenance schedule and procedures, and troubleshooting procedures plus procedures for obtaining repair parts and technical assistance. Review operating and maintenance data contained in the Operating and Maintenance Manuals.
 - a. Schedule training with Owner, provide at least 7-day prior notice to the Engineer.

END OF SECTION 237523

SECTION 238316 - HYDRONIC RADIANT FLOOR HEATING SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Related Sections:

- 1. Division 01, High Performance Buildings Requirements Section 018113.13 for credits 16a-38k-4(b)4, 16a-38k-4(b)5.
 - a. The above listed HPB credits are related to this section. Other HPB credits may apply and shall be reviewed for their potential applicability and conformed with as though listed.

1.3 SCOPE

- A. Each radiant floor heating system, per zone, shall include, but no limited to, all (PEX) tubing, piping, manifolds, valves, pumps, slab sensors and enclosures. Coordinate provision of pre-pipes enclosures with manufacturer.

1.4 REFERENCES

- A. American Society for Testing and Materials (ASTM) Standard ASTM F-876; Standard Specification for Cross-linked Polyethylene (PEX) Tubing.
- B. American Society for Testing and Materials (ASTM) Standard ASTM F-877; Standard Specification for Cross-linked Polyethylene (PEX) Plastic Hot-and-Cold Water Distribution Systems.
- C. Canadian Standards Association (CSA) Standard CAN/CSA B137.5; Cross-linked Polyethylene (PEX) Tubing Systems for Pressure Applications.
- D. International Conference of Building Officials (ICBO) Evaluation Services; Evaluation Report No.4407.
- E. Plastic Pipe Institute (PPI) Technical Report TR-3: Policies and Procedures for Developing Recommended Hydrostatic Design Stresses for Thermoplastic Pipe Materials.
- F. Plastic Pipe Institute (PPI) Technical Report TR-4: Recommended Hydrostatic Strengths and Design Stresses for Thermoplastic Piping and Fitting Compounds.
- G. Housing and Urban Development (HUD): Material Release 1269
- H. National Mechanical Code (BOCA).
- I. Standard Mechanical Code (SBCCI).

- J. Uniform Mechanical Code (ICBO).

1.5 ACTION SUBMITTALS

- A. Submit the following in accordance with Form 816 Article 1.20-1.05.02 and NOTICE TO CONTRACTOR – SUBMITTALS.
- B. Product Data: For each type of product.
 - 1. Include product data including certified performance of system components indicating pump operating point, enclosure weights, furnished components and specialties, and accessories.
- C. Shop Drawings: Showing dimensions and layout of enclosures packages.
- D. Wiring Diagrams: Detailed wiring for power, signal, and control systems, differentiating between manufacturer-installed wiring and field-installed wiring.
- E. Tubing Schedule: radiant floor tubing schedule that lists the manifolds and their respective loops. Tubing on center distances, flow rates per loop and identification for zones will also be included in the schedule information.
- F. Manufacturer's Construction Drawings: For actual construction, installation drawings of the radiant floor design tubing layout to include all required detail notes to aid in the installation of the system shall be submitted for approval as specified under terms and condition of the Contract Document. No fabrication shall be performed until approval is obtained.

1.6 INFORMATION SUBMITTALS

- B. Submit verification of Standard Grade Hydrostatic Design Stresses and Pressure Ratings on the PEX tubing from Plastic Pipe Institute in accordance with TR-3. The following standard grade ratings are required: 200 ° F at 80 psi; 180 ° F at 100 psi; 73.4 ° F at 160 psi.
- C. Submit third party verification that the PEX tubing manufacturing process is peroxide method (PEX-a). Acceptable third party agencies are: Hauser Laboratories, Boulder, Co.; Canadian Standards Association (CSA), Toronto, Ontario; National Sanitation Foundation (NSF), Ann Arbor, MI.

1.7 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For radiant equipment to include in the operation and maintenance manuals specified in Form 816 Article 1.20-1.08.14 subsection 2 and described in NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS.
- B. Warranty: For radiant equipment manuals specified in Form 816 Article 1.20-1.06.08 and described in NOTICE TO CONTRACTOR – CLOSEOUT DOCUMENTS.

1.8 QUALITY ASSURANCE

- A. All components of the hydronic radiant floor heating distribution system shall be provided through one manufacturer including, but no limited to, tubing, fittings, manifolds, and other ancillary components required to complete the installation.

- B. The installing contractor shall provide, in writing, to the project engineer that the PEX tubing furnished under this specification conforms to the material and mechanical requirements specified herein.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. All radiant floor heating system products shall be kept clean and dry during delivery and storage.
- B. All PEX tubing shall be stored in its carton or under cover to avoid dirt or foreign material from being introduced into the tubing.
- C. PEX tubing shall not be exposed to direct sunlight for more than 30 days during installation. If construction delays are encountered, the installing contractor is responsible to provide cover to all portions of the exposed tubing.

1.10 WARRANTY

- A. PEX tubing shall carry a twenty-five (25) year non-prorated limited warranty against failure due to defects in quality or workmanship when installed by a licensed contractor.

PART 2 - PRODUCTS

2.1 TUBING

- A. The peroxide method PEX (PEX-a) tubing is to be manufactured in accordance with ASTM F876.
- B. Tubing shall not be manufactured using Siloxane material during the cross-linking process.
- C. The PEX tubing shall be homogeneous throughout and essentially uniform in color, opacity, density and other properties. The inside and outside surfaces shall be matte or glossy in appearance. The tubing wall shall be free of cracks, holes, blisters, voids, foreign inclusions, or other defects that are apparent to the naked eye and that may affect the wall integrity.
- D. Mild surface abrasions are acceptable. Gouges or notches in the tubing wall greater than 10% of the minimal wall thickness are not acceptable and are subject to rejection of that tubing loop (refer to ASTM F876 for additional information).
- E. The tubing shall have an integral oxygen diffusion barrier applied at time of manufacturing that does not exceed an oxygen diffusion rate of 1.10 grams per cubic meter per day at 104E F water temperature in accordance with German DIN 4726.
- F. The tubing shall be issued a Standard Grade Hydrostatic Design Stresses and Pressure Rating in accordance with all three temperatures and pressures listed in Table 1 of ASTM F876. Tubing shall be tested in accordance with PPI TR-3 and listed in PPI TR-4.
- G. Tubing manufacturing process shall be certified by an ICBO approved independent third party testing laboratory and verification agency.
- H. The PEX tubing shall be manufactured in the United States of America.

2.2 MANIFOLDS

- A. Manifolds can be manufactured of High Density Polyethylene (HDPE), copper or brass material and shall be supplied by the respective tubing manufacturer for system compatibility.
- B. Manifolds shall be constructed of HDPE material when a non-barrier PEX distribution tubing is used in the design. Copper or brass manifolds shall be installed when PEX distribution tubing with an oxygen diffusion barrier is used in the design.
- C. HDPE manifolds must arrive from the PEX tubing manufacturer with fittings installed on the outlet nipples of the manifolds. Copper manifolds will have fittings sweated on the outlet nipples of the manifolds.
- D. Each manifold location shall have the ability to vent air manually from the system when installed at a higher elevation than the radiant panel area.
- E. Manifolds installed above ground shall be isolated from supply and return piping with valves that are suitable for isolation and balancing.

2.3 FITTINGS

- A. Fittings to attach the PEX tubing to the manifold shall be supplied by the tubing manufacturer.
- B. The fitting shall consist of a PEX ring marked to the respective tube size and the applicable fitting.
- C. All fittings installed on HDPE manifolds are to be machined from 303 stainless steel material. All fittings installed on copper manifolds are to be machined from 360 brass material.
- D. All fittings used as splice connections shall be of suitable material and in accordance with the manufacturer's recommendations.
- E. Fittings shall be certified to comply with the requirements of ASTM F877.
- F. The fittings shall be manufactured in the United States of America.

2.4 SUPPLY AND RETURN PIPING TO MANIFOLDS

- A. Provide piping per Section 230060 - HVAC Piping.

2.5 RADIANT FLOOR HEATING ENCLOSURES

- A. Manufacturer's wall mounted lockable enclosures, each containing pre-piped manifolds, pump, 3-way mixing valve and pipe main shutoff valves. Provide suitable space for mounting controls devices provided by controls contractor. Provide skirt below enclosures (mounted 18" above floor) to conceal tubing.
 - 1. Enclosures RZ-1,2 & 3 shall contain pump and 3-way mixing valve with connections to pipe mains and pre-insulated piping routed to manifolds in Maintenance Pits. Lockable Maintenance Pit enclosures shall contain manifolds with pre-insulated piping shutoff valves and capped drain valves with hose end connections within recesses. Coordinate enclosure dimensions with pit wall recesses. There shall be no electronic devices within pit enclosures.

PART 3 - INSTALLATION

3.1 GENERAL

- A. During the installation, all tubing shall be capped on each end to prevent foreign materials from entering the tubing.
- B. All tubing shall be checked for abrasions prior to installation. Tubing embedded in the slab shall be installed without joints or splices unless authorized by the tubing manufacturer.
- C. The tubing shall be installed in such a manner as to effectively address the heat loss of the space. Tubing shall not be placed near heat sensitive materials.
- D. PEX tubing shall be properly pressure tested, in accordance with the tubing manufacturer's guidelines, prior to burial of the tubing in concrete. The tubing system shall maintain an air pressure test, under a minimum pressure of 80 psi, for a period of twenty-four (24) hours prior to the concrete pour. Tubing shall be pressured prior to and during the concrete pour to ensure system integrity.
- E. All pressure tests shall be accomplished with air pressure. If the installing contractor prefers the use of water for pressure testing, then the installing contractor is responsible for the removal of all water from the system if ambient air temperatures approach 32E F or less. If freezing temperatures are likely, then the system shall be pressurized with air only.
- F. After the system has been filled, air shall be vented from the system. Provisions should be made for components in the mechanical room to allow system purging of air.
- G. Mount bottom of enclosures 18" above finished floor.

3.2 CONCRETE SLAB ON GRADE INSTALLATION

- A. The tubing shall be fastened to the flat mesh or reinforcing bar in accordance with the tubing manufacturer's installation recommendations.
- B. Tubing on center distance(s) and loop lengths shall be specified in the submitted radiant floor design tubing layout.
- C. Tubing will be installed no closer than six (6) inches from all walls.
- D. If under slab insulation is required by the design, the vertical compressive strength of the high density extruded board insulation will be determined by the Architect. Required insulation resistance value @ value) to be determined by the radiant floor design.
- E. Tubing shall be installed at a consistent depth below the surface elevation as determined by the project engineer. Tubing installation will ensure sufficient clearance of all control joint cuts.
- F. In areas where tubing must cross metal expansion joint that occur in the concrete; the tubing shall be installed below the metal expansion joints. Fibrous expansion joints may be penetrated depending on the tubing manufacturer's and Architect's recommendations. Provide PVC sleeves crossing expansion joints per manufacturer's instructions.
- G. Metal or PVC bend supports will be used to support the tubing departing from the slab at a 90E bend.

END OF SECTION 238316

SECTION 262413 SWITCHBOARDS

PART 1 - GENERAL

1.1 SUMMARY

- A. Description of Work: Provide switchboard(s) as indicated.

1.2 SUBMITTALS

- A. Product Data: Manufacturers descriptive literature for type of switchboard.
- B. Shop Drawings including:
 1. Identification: All shop drawings shall use designations to identify components and switchboards as shown on the Contract Documents.
 2. Elevation/Plan: Floor plan and front elevation to scale, with all dimensions and entry locations, and each section, compartment and device clearly indicated. Identify equipment which exceeds allotted space.
 3. Equipment Data: Separate manufacturers data sheets for switchboard, all components such as switches, overcurrent devices, etc., and all accessories (metering, relays indicating lights, etc.) highlighted to specifically describe the exact equipment being provided including all options. Each sheet shall be labeled as indicated on the Contract Documents and all component locations shall be referenced to the elevation provided. Information to be indicated shall include voltage, phasing, bracing, ampacity, types, interrupting ratings, trip description with all adjustment ranges and factory settings, etc.
 4. Time Current Curves: Provide logarithmic time/current currents for all overcurrent devices with the curve depicting the factory settings highlighted.
 5. Wiring Diagrams: A complete single line, elementary, schematic wiring diagrams showing all switches, overcurrent devices, and accessories which will distinguish between field and factory wiring. Diagrams shall be specifically developed for this project, standard drawings are not acceptable.
- C. Shop drawings for Service Entrance switchboards to be approved by serving electric utility company, prior to submission for final Engineer approval. Refer to 262100 - Electrical Service.
- D. Manufacturer Certification: Provide certification signed by manufacturer that the equipment meets the requirements of the contract documents.
- E. Test Reports: Provide test reports documenting tests required in Part 3.

1.3 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Manufacturer shall have regularly engaged in the manufacture of similar equipment with successful in-service performance for at least the last 5 years.
- B. Reference Standards: Equipment shall meet the applicable requirements, be installed and tested per

NEMA, ANSI and NEC.

- C. Listing and Labeling: Equipment shall be UL listed and labeled. If used as service entrance the switchboard shall be so labeled.

1.4 DELIVERY STORAGE AND HANDLING

- A. Delivery: Deliver in shipping splits of dimensions that can be moved past obstructions in delivery path at the time of installation.
- B. Storage: Store in original packing until ready for installation. Provide protection from condensation and apply temporary heat as required by equipment manufacture.
- C. Handling: Handle switchgear according to manufacturers instructions.

1.5 SPARE EQUIPMENT

- A. Spare Fuses: Six of each type and rating used for power and/or control systems.
- B. Spare Indicating Lights: Six of each type.
- C. Touchup Paint: Three 1/2 pint containers matching enclosure finish.
- D. Undercoating Touchup: One 1/2 pint.
- E. Contact Lubricant: One pint.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Manufacturer: Subject to compliance with requirements in the contract documents provide equipment from the following:
 - 1. General Electric
 - 2. Siemens
 - 3. Square D

2.2 SWITCHBOARD TYPES/CONFIGURATIONS

- A. General: Factory assembled consisting of a self supporting structure, with bussing, overcurrent protection devices, and other auxiliary equipment and wiring as indicated.
- B. Type: Front accessible with group mounted mains and feeders suitable for mounting against a wall.
- C. Type: Front accessible with individually mounted mains and group mounted feeders.
- D. Line Up: Align rear surfaces.
- E. Compartmentation: Provide individual compartments for all devices.

- F. Spares: Provide 25% spare spaces.

2.3 ENCLOSURES AND STRUCTURES

- A. Construction: Totally enclosed, free-standing, self-supporting, floor mounted lineup composed of bolted steel frame vertical sections bolted together to form a unitized assembly, with sections having adequate lifting means and sufficient structural rigidity for rolling, jacking, or leveling into place.
- B. Enclosures: NEMA-1, code gauge cold rolled steel finished with phosphatizing primer and ANSI #61 gray finish. Include ventilation openings as required to maintain minimum temperatures. All covers to be removable.
- C. Maximum Overall Dimensions: As indicated.

2.4 BUSSING

- A. Material: Copper or electrical grade aluminum alloy, electroplated with tin or silver.
- B. Joints and Connections: Welded or bolted using washers and lock washers (with spring cup washers used for aluminum bus).
- C. Phase Rotation: A-B-C to be left-to-right, front-to-rear, and/or top-to-bottom, as seen when facing the load terminal section.
- D. Neutral Bus: Insulated from ground bus.
- E. Ground Bus: Continuous through all sections, and connected to each section by welding or bolting.
- F. Service Entrance Switchboards: Connect neutral bus to ground bus at single point with removable bolted link.

2.5 BUS AMPACITY

- A. General: As indicated, 100 percent rated, with bus ampacity rating determined by UL-891 heat rise testing, with a 65°C rating above 40°C ambient temperature. Main bussing to be full size throughout all distribution sections. Do not telescope main bus. Distribution section bussing to be equal to or greater than the sum of the frame ratings of the overcurrent devices served, but not larger than the main bus rating. Branch bussing to be equal to or greater than the frame rating(s) of the overcurrent device(s) connected.
- B. Neutral Bus: Ampacity to be the same as main phase bus rating.
- C. Ground Bus: Rating to be minimum 25% of main phase bus rating, larger if so indicated.

2.6 LOAD CONNECTIONS

- A. Lugs for outgoing feeders to be positive pressure bolted clamp type.

2.7 SHORT CIRCUIT RATING

- A. Each switchboard shall be suitable for operation at a fault current of at least 65,000 RMS symmetrical amperes. The switchboard shall be so labeled, indicating the maximum available fault current rating,

taking into account the structure, bus bracing, and overcurrent protective device interrupting ratings. All devices shall be fully rated.

2.8 OVERCURRENT PROTECTIVE DEVICES, GENERAL

A. General:

1. Voltage rating equal to or larger than the system voltage.
2. Provisions for locking each device in either open or closed positions by padlock. Locking provisions shall not interfere with overcurrent protection.
3. Each overcurrent or switching device clearly indicates open or closed position by handle position or by indicating target.
4. Overcurrent Protective Device Spaces: All overcurrent protective device spaces shall be "fully prepared" including branch bussing and connectors, barriers, front cover, mounting hardware, etc., so that the device may be added without additional parts, kits, etc.

B. Molded Case Circuit Breakers:

1. General: Fixed mounted, molded-case type, with quick make, quick break, mechanically trip-free, over-center switching mechanism, with clear indication for ON, OFF and TRIP positions. Ratings, poles and sizes as indicated and listed.
2. Tripping:
 - a. Below 200A: Thermal magnetic trip providing inverse time delay overload and instantaneous short circuit protection.
 - b. 200A - 400A: Same as 200A except trips are interchangeable.
 - c. Above 400A: Field adjustable solid state tripping device and required supporting equipment with the following displayed accessible settings:
 - 1.) Current Setting.
 - 2.) Long-time Delay.
 - 3.) Long-time pickup, with indicating lights.
 - 4.) Short-time pickup.
 - 5.) Short-time delay.
 - 6.) Instantaneous pickup.
 - d. Ground Fault Protection: Provide ground fault protection with field adjustable pickup and delay settings.
 - e. Trip Indicators: Provide trip indicating lights with push to reset for the following:
 - 1.) Overload.
 - 2.) Short circuit.
 - 3.) Ground fault.
 - f. Short Trip: Provide necessary components and equipment to allow remote

operation of breaker.

- g. Ambient Compensation: Mechanisms shall be ambient compensated.
3. Auxiliary Contacts: For interlocking or remote indication of breaker position, with spare auxiliary switches in addition to other auxiliary switches required for normal breaker operation, quantity as indicated. Each consists of 2 Type “a” and 2 Type “b” stages (contacts) wired through secondary disconnecting devices to a terminal block in the stationary housing.
 4. Arc Chutes: Readily removable from the associated circuit breaker when it is in the DISCONNECTED position and arranged to permit inspection of the contacts without removing the breaker from the switchgear.
 5. Padlocking Provisions: For installing at least 3 padlocks on each breaker to secure its enclosure and prevent movement of the drawout mechanism.
 6. Operating Handle: One for each breaker capable of manual operation.
 7. Electric Close Button: One for each electrically operated breaker.
 8. Mechanical Interlocking of Breakers: Uses a mechanical tripping lever or equivalent design in addition to electrical interlocks.
 9. Key Interlocks: Arranged so keys are held captive at the devices indicated. Mountings and hardware are included where future installation of key interlock devices is indicated.
 10. Undervoltage Trip Devices: Instantaneous, with adjustable pickup voltage.
 11. Undervoltage Trip Devices: Adjustable time-delay and pickup voltage.
 12. Shunt-Trip Devices: Where indicated.
 13. Indicating Lights: BREAKER OPEN and CLOSED, for main and bus tie circuit breakers interlocked either with each other or with external devices.
 14. Accessories:
 - a. Accessory Set: Tools and miscellaneous items required for circuit breaker and switchgear test, inspection, maintenance, and operation. Includes racking handle to manually move the breaker between CONNECTED and DISCONNECTED positions. Portable test set permits testing of all functions of circuit breaker solid-state trip devices without removal from switchgear. Relay and meter test plugs are suitable for testing switchgear meters and switchgear class relays.

2.9 OWNER’S METERING COMPARTMENT

- A. General: With hinged door, captive screws or latch, cable supports, and with all devices (including instrument transformers) identified as to function and circuit. Include the following instruments:
 - B. Ammeter: Flush mounted with 5 amp full scale movement, 1% accuracy, minimum 4-1/2” scale marked to the primary rating of the respective current transformers.

- C. Ammeter Switch: 4-position, cam type, with position indicators, mounted below ammeter.
- D. Current Transformers: With primary rating equal to or greater than the circuit ampacity, 5 amp secondary, and shorting switch.
- E. Voltmeter: Flush mounted with 1% accuracy, minimum 4 1/2" scale marked 0-300 or 0-600 volts, as required for system voltage.
- F. Voltmeter Switch: 7-position, cam type, with position indicators, mounted below voltmeter.
- G. Potential Transformers (if required by the manufacturer): With primary protected by current limiting fuses.
- H. Kilowatt-Hour Meter: Semi-flush mounted, 2-1/2" or 3-element for 4-wire system, with 15-minute interval resettable demand register.

2.10 NAMEPLATES

- A. General: Permanently label all cubicles, switches, lights, devices, terminals, wire as per 16195 - Electrical Identification.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General: Set switchboards on 3-1/2" high concrete pad and anchor to building structure as recommended by the manufacturer. Protect switchboards during construction with covering to keep all sections clean and dry at all times. Provide heat necessary to eliminate condensation.
- B. Raceway Entries: Coordinate raceway entries into switchboards so that sections having spare devices or spaces for future devices have adequate accessible space in raceway entry areas for future raceway. Ground all raceways entering switchboards to the main ground bus using grounding bushings and bonding jumpers.
- C. Connections: Tighten switchboard bus joint bolts and electrical connector and terminal bolts in accordance with manufacturer's published torque-tightening values. Where manufacturer's torque values are not stated, use those specified in UL 486A and UL 486B.

3.2 FIELD QUALITY CONTROL

- A. Quality Control Testing Program: Conform to the following:
 1. Program Objectives: To assure switchboard installation meets specified requirements, is operational within specified tolerances, provides appropriate protection for systems and equipment, and is suitable for energizing.
 2. Procedures: Make field tests and inspections and prepare switchboard for satisfactory operation in accordance with manufacturer's recommendations and these specifications.
 3. Schedule tests and notify Engineer at least one week in advance of test commencement.

4. Reports: Prepare written reports of test results and observations. Report defective materials and workmanship. Include complete records of adjustments and remedial efforts.
 5. Labeling: Upon satisfactory completion of tests and related effort. Apply a label to tested components indicating test results, person responsible, and date.
 6. Protective Device Ratings and Settings: Verify indicated ratings and settings and make the final system adjustments of overcurrent protective devices in accordance with this Section "Overcurrent Protection Devices, General".
- B. Visual and Mechanical Inspections: Include the following inspections and related work:
1. Inspect for defects and physical damage, testing laboratory, labels, and nameplate compliance with up-to-date circuit connections.
 2. Verify that potential transformers, including their overcurrent protection and current transformers, meet specified requirements.
 3. Perform operational test and exercise of mechanical components and other operable devices in accordance with manufacturer's instruction manual.
 4. Check switchboard anchorage, area clearances, and alignment and fit of components.
 5. Check tightness of bolted electrical connections with calibrated torque wrench. Refer to manufacturer's instructions for proper torque values.
 6. Clean switchboard interior and exterior using manufacturer's approved methods and materials, as required.
 7. Perform visual and mechanical inspection and related work for OCPDs as specified in Section "Overcurrent Protective Devices."
- C. Electrical Tests: Perform all tests in accordance with the International Electrical Testing Associations (NETA) Acceptance Testing Specifications ATS-1999.
- D. Ground Fault Protection System Testing: Perform all tests in accordance with NEC 230-95.

END OF SECTION 262413