

MAINE TURNPIKE AUTHORITY

MAINE TURNPIKE

CONTRACT DOCUMENTS

CONTRACT 2019.04

INTERCHANGE 103 BARRIER TOLL PLAZA
OPEN ROAD TOLLING CONVERSION
MILE 103.0

NOTICE TO CONTACTORS

PROPOSAL

CONTRACT AGREEMENT

CONTRACT BOND

FINAL LIEN AND CLAIM WAIVER AND AFFIDAVIT

SPECIFICATIONS

MAINE TURNPIKE AUTHORITY
SPECIFICATIONS

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

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

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MAINE TURNPIKE AUTHORITY

NOTICE TO CONTRACTORS

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

CONTRACT 2019.04

INTERCHANGE 103 BARRIER TOLL PLAZA

OPEN ROAD TOLLING CONVERSION

MILE 103.0

at the office of the Maine Turnpike Authority, 2360 Congress Street, Portland, ME, until 11:00 a.m., prevailing time as determined by the Authority on April 18, 2019 at which time and place the Proposals will be publicly opened and read. Bids will be accepted from Contractors **prequalified** by the Maine Department of Transportation for Bridge Construction Projects. All other bids will be rejected. In addition, contractors submitting bids must be themselves or utilize a highway subcontractor pre-qualified by the Maine Department of Transportation for Highway, a building subcontractor prequalified by the Maine Department of Transportation for Buildings and an electrical subcontractor prequalified by the Maine Department of Transportation for Traffic Signals and Lighting Projects.

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

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

The work consists of replacing the existing toll plaza; construction of two northbound and two southbound open road tolling (ORT) lanes, and three northbound and three southbound cash/E-ZPass lanes; construction of a precast pedestrian tunnel for employee access and utilities; construction of an Administration Building and access road; reconfiguration of Exit 51 ramps and I-295 Northbound ramp; and demolition of existing toll plaza and reconstruction of the mainline to accommodate approach and departure grade and alignment differentials at the modified plaza for the Maine Turnpike. The work includes earthwork, pavement, concrete, toll plaza demolition and modification, signing, bridge overpass-mounted, overhead sign structures, concrete barrier, guardrail, electrical work, lighting and lightning suppression systems. The work also includes the installation of tolling provisions in the tunnel, canopy, and toll booth, maintenance of traffic, and all other work incidental thereto in accordance with the Plans and Specifications.

Plans and Contract Documents may be examined by prospective Bidders weekdays between 8:00 a.m. and 4:30 p.m. at the office of the Maine Turnpike Authority, 2360 Congress Street,

Portland, Maine. **The half size Plans** and Contract Documents may be obtained from the Authority upon payment of Two Hundred Fifty (\$250.00) Dollars for each set, which payment will not be returned. Checks shall be made payable to: Maine Turnpike Authority. The Plans and Contract Documents may also be downloaded from a link on our website at <http://www.maineturnpike.com/project-and-planning/Construction-Contracts.aspx>.

For general information regarding Bidding and Contracting procedures, contact Nate Carll, Purchasing Manager, at (207)482-8115. For information regarding Schedule of Items, plan holders list and bid results, visit our website at <http://www.maineturnpike.com/project-and-planning/Construction-Contracts.aspx>. For Project specific information, fax all questions to Nate Carll, Purchasing Manager, at (207) 871-7739 or email ncarll@maineturnpike.com. Responses will not be prepared for questions received by telephone. Bidders shall not contact any other Authority staff or Consultants for clarification of Contract provisions, and the Authority will not be responsible for any interpretations so obtained.

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

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

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

A pre-bid conference will be held on April 2, 2019 at 10:00 a.m. at the Maine Turnpike Authority, 2360 Congress Street, Portland, Maine.

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

MAINE TURNPIKE AUTHORITY

Nate Carll
Purchasing Manager
Maine Turnpike Authority
Portland, Maine

Maine Turnpike Authority

MAINE TURNPIKE

PROPOSAL

CONTRACT 2019.04

INTERCHANGE 103 BARRIER TOLL PLAZA
OPEN ROAD TOLLING CONVERSION
MILE 103.0

MAINE TURNPIKE AUTHORITY

PROPOSAL

CONTRACT 2019.04

INTERCHANGE 103 BARRIER TOLL PLAZA
OPEN ROAD TOLLING CONVERSION
MILE 103.0

TO MAINE TURNPIKE AUTHORITY:

The work consists of replacing the existing toll plaza; construction of two northbound and two southbound open road tolling (ORT) lanes, and three northbound and three southbound cash/E-ZPass lanes; construction of a precast pedestrian tunnel for employee access and utilities; construction of an Administration Building and access road; reconfiguration of Exit 51 ramps and I-295 Northbound ramp; and demolition of existing toll plaza and reconstruction of the mainline to accommodate approach and departure grade and alignment differentials at the modified plaza for the Maine Turnpike. The work includes earthwork, pavement, concrete, toll plaza demolition and modification, signing, bridge overpass-mounted, overhead sign structures, concrete barrier, guardrail, electrical work, lighting and lightning suppression systems. The work also includes the installation of tolling provisions in the tunnel, canopy, and toll booth, maintenance of traffic, and all other work incidental thereto in accordance with the Plans and Specifications.

This Work will be done under a Contract known as Contract 2019.04 according to the Plans and Specifications which are on file in the office of the Maine Turnpike Authority, 2360 Congress Street, Portland, Maine.

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

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

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

SCHEDULE OF BID PRICES

CONTRACT NO. 2019.04

Interchange 103 Barrier Toll Plaza Open Road Tolling Conversion (MM 103.0)

Item No	Item Description	Units	Approx. Quantities	Unit Prices in Numbers		Bid Amount in Numbers	
				Dollars	Cents	Dollars	Cents
201.11	CLEARING	Acre	4				
201.23	REMOVING SINGLE TREE TOP ONLY	Each	4				
201.24	REMOVING STUMP	Each	4				
202.071	REMOVING ASBESTOS CONTAINING MATERIALS, TOLL BOOTH LAB TOPS	Lump Sum	1				
202.081	REMOVING EXISTING BUILDING	Lump Sum	1				
202.15	REMOVING EXISTING MANHOLE OR CATCH BASIN	Each	6				
202.17	REMOVING EXISTING STRUCTURAL CONCRETE	Lump Sum	1				
202.202	REMOVING PAVEMENT SURFACE	Square Yard	27,850				
202.203	PAVEMENT BUTT JOINTS	Square Yard	1,910				
202.205	RUMBLE STRIPS	Each	29,850				
202.206	REMOVING RUMBLE STRIPS	Linear Foot	8,650				

CARRIED FORWARD:

Item No	Item Description	Units	Approx. Quantities	Unit Prices in Numbers		Bid Amount in Numbers	
				Dollars	Cents	Dollars	Cents
BROUGHT FORWARD:							
203.20	COMMON EXCAVATION	Cubic Yard	88,000				
203.21	ROCK EXCAVATION	Cubic Yard	200				
203.2310	UNDERGROUND STORAGE TANK REMOVAL	Lump Sum	1				
203.2312	DISPOSAL / TREATMENT OF SPECIAL EXCAVATION	Ton	50				
203.25	GRANULAR BORROW	Cubic Yard	28,325				
206.082	STRUCTURAL EARTH EXCAVATION - MAJOR STRUCTURES	Cubic Yard	2,350				
304.09	AGGREGATE BASE COURSE - CRUSHED	Cubic Yard	11,285				
304.10	AGGREGATE SUBBASE COURSE - GRAVEL	Cubic Yard	18,135				
403.207	HOT MIX ASPHALT, 19.0 MM NOMINAL MAXIMUM SIZE	Ton	16,150				
403.208	HOT MIX ASPHALT, 12.5 MM	Ton	900				
403.2081	HOT MIX ASPHALT, 12.5 MM (POLYMER MODIFIED) - RAP	Ton	9,110				
403.209	HOT MIX ASPHALT, 9.5 MM NOMINAL MAXIMUM SIZE (SIDEWALKS, DRIVES, ISLANDS & INCIDENTALS)	Ton	100				

CARRIED FORWARD:

Item No	Item Description	Units	Approx. Quantities	Unit Prices in Numbers		Bid Amount in Numbers	
				Dollars	Cents	Dollars	Cents
BROUGHT FORWARD:							
403.211	HOT MIX ASPHALT, 9.5 MM NOMINAL MAXIMUM SIZE (SHIMMING)	Ton	1,658				
403.213	HOT MIX ASPHALT, 12.5 MM NOMINAL MAXIMUM SIZE (BASE AND INTERMEDIATE BASE COURSE)	Ton	7,570				
409.152	BITUMINOUS TACK COAT NTSS - 1HM TRACKLESS - APPLIED	Gallon	15,700				
419.30	SAWING BITUMINOUS PAVEMENT	Linear Foot	5,760				
470.08	BERM DROPOFF CORRECTION - GRINDINGS	Ton	248				
470.081	BERM CORRECTION	Linear Foot	4,500				
502.231	STRUCTURAL CONCRETE, SPACE FRAME PEDESTALS & FOOTINGS	Cubic Yard	96				
502.232	STRUCTURAL CONCRETE, UTILITY PITS	Cubic Yard	145				
502.261	STRUCTURAL CONCRETE, ORT SLABS	Cubic Yard	210				
502.262	STRUCTURAL CONCRETE, CASH SLABS	Cubic Yard	280				
502.263	STRUCTURAL CONCRETE, PLAZA ISLANDS, BUMPERS, AND CURTAIN WALLS	Cubic Yard	200				
503.14	EPOXY-COATED REINFORCING STEEL, FABRICATED & DELIVERED	Pound	43,700				

CARRIED FORWARD:

Item No	Item Description	Units	Approx. Quantities	Unit Prices in Numbers		Bid Amount in Numbers	
				Dollars	Cents	Dollars	Cents
BROUGHT FORWARD:							
503.15	EPOXY-COATED REINFORCING STEEL, PLACING	Pound	43,700				
503.181	GLASS FIBER REINFORCED POLYMER (GFRP) REINFORCING BARS (#5), FABRICATED & DELIVERED	Linear Foot	83,500				
503.182	GLASS FIBER REINFORCED POLYMER (GFRP) REINFORCING BARS (#12), FABRICATED & DELIVERED	Linear Foot	180				
503.191	GLASS FIBER REINFORCED POLYMER (GFRP) REINFORCING BARS (#5), PLACING	Linear Foot	83,500				
503.192	GLASS FIBER REINFORCED POLYMER (GFRP) REINFORCING BARS (#12), PLACING	Linear Foot	180				
503.90	SYNTHETIC FIBER REINFORCEMENT	Pound	2,450				
504.50	TOLL PLAZA CANOPIES	Lump Sum	1				
504.80	SPACE FRAME CANOPIES, FABRICATED AND DELIVERED	Lump Sum	1				
504.81	SPACE FRAME CANOPIES, ERECTION	Lump Sum	1				
504.90	STEEL POST SUPPORT SYSTEMS	Lump Sum	1				
504.91	MOUNTING BRACKET ASSEMBLIES	Lump Sum	1				
504.96	METAL STAIRS	Lump Sum	1				

CARRIED FORWARD:

Item No	Item Description	Units	Approx. Quantities	Unit Prices in Numbers		Bid Amount in Numbers	
				Dollars	Cents	Dollars	Cents
BROUGHT FORWARD:							
508.14	HIGH PERFORMANCE WATERPROOFING MEMBRANE	Lump Sum	1				
511.091	TEMPORARY EARTH SUPPORT SYSTEMS	Lump Sum	1				
515.2011	PIGMENTED CONCRETE PROTECTIVE COATING - TUNNEL AND STAIRWAY WALLS & CEILING	Square Yard	750				
515.2012	PIGMENTED CONCRETE PROTECTIVE COATING - TUNNEL FLOOR	Square Yard	270				
515.202	CLEAR PROTECTIVE COATING FOR CONCRETE SURFACES	Square Yard	2,500				
515.23	EPOXY OVERLAY	Square Foot	225				
526.301	TEMPORARY CONCRETE BARRIER TYPE I (9,000 LF)	Lump Sum	1				
526.351	MEDIAN BARRIER TYPE I	Linear Foot	450				
526.3511	MEDIAN BARRIER TYPE IA - PRECAST	Linear Foot	2,806				
526.3513	MEDIAN BARRIER TYPE IB - PRECAST	Linear Foot	938				
526.3514	MEDIAN BARRIER TYPE IC - PRECAST	Linear Foot	170				
526.3515	MEDIAN BARRIER TYPE ID - PRECAST	Linear Foot	107				

CARRIED FORWARD:

Item No	Item Description	Units	Approx. Quantities	Unit Prices in Numbers		Bid Amount in Numbers	
				Dollars	Cents	Dollars	Cents
BROUGHT FORWARD:							
526.3516	MEDIAN BARRIER TYPE IE - PRECAST	Linear Foot	51				
526.352	MEDIAN BARRIER TYPE II	Linear Foot	134				
526.3611	MEDIAN BARRIER TRANSITION TYPE IA - PRECAST	Each	3				
526.3612	MEDIAN BARRIER TRANSITION TYPE IB - PRECAST	Each	1				
526.362	MEDIAN BARRIER TRANSITION TYPE II - PRECAST	Each	4				
526.371	MEDIAN BARRIER WITH MOUNTED LIGHT POLE TYPE I	Each	17				
527.306	CENTER BARRIER CRASH ATTENUATOR	Each	3				
527.342	WORK ZONE CRASH CUSHIONS - TL-2	Unit	5				
527.343	WORK ZONE CRASH CUSHIONS - TL-3	Unit	7				
535.70	PRECAST CONCRETE TUNNEL	Lump Sum	1				
602.30	FLOWABLE CONCRETE FILL	Cubic Yard	8				
603.155	12 INCH REINFORCED CONCRETE PIPE - CLASS III	Linear Foot	99				

CARRIED FORWARD:

Item No	Item Description	Units	Approx. Quantities	Unit Prices in Numbers		Bid Amount in Numbers	
				Dollars	Cents	Dollars	Cents
BROUGHT FORWARD:							
603.165	15 INCH REINFORCED CONCRETE PIPE - CLASS III	Linear Foot	95				
603.175	18 INCH REINFORCED CONCRETE PIPE - CLASS III	Linear Foot	603				
603.195	24 INCH REINFORCED CONCRETE PIPE - CLASS III	Linear Foot	73				
603.205	30 INCH REINFORCED CONCRETE PIPE - CLASS III	Linear Foot	40				
603.280	CONCRETE COLLAR FOR REINFORCED CONCRETE PIPE	Each	2				
604.072	CATCH BASIN TYPE A1-C	Each	2				
604.09	CATCH BASIN TYPE B1	Each	5				
604.097	60" CATCH BASIN TYPE B5-C	Each	1				
604.15	MANHOLE	Each	2				
604.18	ADJUSTING MANHOLE OR CATCH BASIN TO GRADE	Each	5				
604.245	CATCH BASIN TYPE F4-C	Each	1				
604.26	CATCH BASIN TYPE B5	Each	40				

CARRIED FORWARD:

Item No	Item Description	Units	Approx. Quantities	Unit Prices in Numbers		Bid Amount in Numbers	
				Dollars	Cents	Dollars	Cents
BROUGHT FORWARD:							
605.09	6 INCH UNDERDRAIN TYPE B	Linear Foot	1,729				
605.11	12 INCH UNDERDRAIN TYPE C	Linear Foot	236				
605.111	12 INCH UNDERDRAIN TYPE C - SDR	Linear Foot	600				
605.12	15 INCH UNDERDRAIN TYPE C	Linear Foot	236				
605.13	18 INCH UNDERDRAIN TYPE C	Linear Foot	140				
606.13	31" W-BEAM GUARDRAIL-MID-WAY SPLICE (7' STEEL POSTS, 8" OFFSET BLOCKS, SINGLE FACED)	Linear Foot	2,940.625				
606.1306	31" W-BEAM GUARDRAIL-MIDWAY SPLICE TANGENT TERMINAL	Each	7				
606.131	31" W-BEAM GUARDRAIL-MID-WAY SPLICE (8' STEEL POSTS, 8" OFFSET BLOCKS, SINGLE FACED)	Linear Foot	662.5				
606.132	31" W-BEAM GUARDRAIL-MID-WAY SPLICE (7' STEEL POSTS, 8" OFFSET BLOCKS, DOUBLE FACED)	Linear Foot	1,612.5				
606.1351	31" W-BEAM GUARDRAIL - MID-WAY SPLICE TERMINAL END - ANCHORED END	Each	12				
606.1724	BRIDGE TRANSITION - TYPE III, MODIFIED	Each	2				
606.2651	TERMINAL END - REMOVE AND RESET	Each	1				

CARRIED FORWARD:

Item No	Item Description	Units	Approx. Quantities	Unit Prices in Numbers		Bid Amount in Numbers	
				Dollars	Cents	Dollars	Cents
BROUGHT FORWARD:							
606.2652	TERMINAL END - REMOVE AND STACK	Each	9				
606.275	TERMINAL END - DOUBLE RAIL - GALVANIZED STEEL	Each	2				
606.352	REFLECTORIZED BEAM GUARDRAIL DELINEATOR	Each	130				
606.353	DELINEATOR POST	Each	94				
606.3561	DELINEATOR POST - REMOVE AND RESET	Each	102				
606.3605	GUARDRAIL - REMOVE, MODIFY, AND RESET SINGLE RAIL	Linear Foot	950				
606.3621	GUARDRAIL ADJUST, SINGLE RAIL	Linear Foot	3,400				
606.82	GUARDRAIL - REMOVE AND STACK EXISTING CRASH END	Each	1				
607.2326	AUTOMATIC ENTRY GATE	Each	1				
607.40	CHAIN LINK FENCE - 3' HIGH	Linear Foot	510				
607.41	POST ASSEMBLY FOR SIGN OR CHAIN LINK FENCE	Each	66				
607.4211	DUMPSTER ENCLOSURE	Lump Sum	1				

CARRIED FORWARD:

Item No	Item Description	Units	Approx. Quantities	Unit Prices in Numbers		Bid Amount in Numbers	
				Dollars	Cents	Dollars	Cents
BROUGHT FORWARD:							
608.08	REINFORCED CONCRETE SIDEWALK	Square Yard	110				
608.26	CURB RAMP DETECTABLE WARNING FIELD	Square Foot	36				
609.11	VERTICAL CURB TYPE 1	Linear Foot	1,000				
609.12	VERTICAL CURB TYPE 1 - CIRCULAR	Linear Foot	200				
609.234	TERMINAL CURB TYPE 1 - 4 FT	Each	4				
609.238	TERMINAL CURB TYPE 1 - 8 FT	Each	2				
610.08	PLAIN RIPRAP	Cubic Yard	34				
610.18	STONE DITCH PROTECTION	Cubic Yard	27				
610.181	TEMPORARY STONE CHECK DAM	Cubic Yard	325				
613.319	EROSION CONTROL BLANKET	Square Yard	13,750				
614.30	GEOCELL CONFINEMENT SYSTEM FOR SLOPE PROTECTION	Square Foot	16,000				
615.07	LOAM	Cubic Yard	7,690				

CARRIED FORWARD:

Item No	Item Description	Units	Approx. Quantities	Unit Prices in Numbers		Bid Amount in Numbers	
				Dollars	Cents	Dollars	Cents
BROUGHT FORWARD:							
618.13	SEEDING METHOD NUMBER 1	Unit	45				
618.14	SEEDING METHOD NUMBER 2	Unit	584				
619.1201	MULCH - PLAN QUANTITY	Unit	629				
619.1202	TEMPORARY MULCH	Lump Sum	1				
619.1401	EROSION CONTROL MIX	Cubic Yard	50				
620.58	EROSION CONTROL GEOTEXTILE	Square Yard	910				
621.043	EVERGREEN TREE (6' - 8') GROUP A	Each	2				
621.396	DWARF EVERGREEN (18" - 24") GROUP B	Each	8				
621.512	HYBRID RHODODENDRON (2' - 2.5')	Each	3				
621.553	DECIDUOUS SHRUB (3' - 4') GROUP B	Each	4				
625.106	WATER SERVICE SUPPLY LINE (<3 IN)	Linear Foot	2,400				
626.121	QUAZITE JUNCTION BOX (36X24)	Each	11				

CARRIED FORWARD:

Item No	Item Description	Units	Approx. Quantities	Unit Prices in Numbers		Bid Amount in Numbers	
				Dollars	Cents	Dollars	Cents
BROUGHT FORWARD:							
626.122	QUAZITE JUNCTION BOX (18X11)	Each	75				
626.13	4' X 6' SPLICE BOX WITH ACCESS DOOR	Each	5				
626.21	METALLIC CONDUIT	Linear Foot	310				
626.22	NON-METALLIC CONDUIT	Linear Foot	35,500				
626.223	HORIZONTAL DIRECTIONAL DRILLED CONDUIT	Linear Foot	530				
626.31	18 INCH DIAMETER FOUNDATION	Each	33				
626.32	24 INCH DIAMETER FOUNDATION	Each	94				
626.333	30 INCH DIAMETER FOUNDATION, 8 FEET OR LESS FOUNDATION	Each	8				
626.36	REMOVE OR MODIFY CONCRETE FOUNDATION	Each	66				
627.18	12 INCH SOLID WHITE PAVEMENT MARKING LINE	Linear Foot	9,100				
627.681	TEMPORARY 6 INCH PAINTED PAVEMENT MARKING LINE - YELLOW OR WHITE	Linear Foot	97,400				
627.73	TEMPORARY 6 INCH PAVEMENT MARKING TAPE	Linear Foot	7,050				

CARRIED FORWARD:

Item No	Item Description	Units	Approx. Quantities	Unit Prices in Numbers		Bid Amount in Numbers	
				Dollars	Cents	Dollars	Cents
BROUGHT FORWARD:							
627.731	TEMPORARY 6 INCH BLACK PAVEMENT MARKING TAPE	Linear Foot	7,050				
627.733	4" WHITE OR YELLOW PAINTED PAVEMENT MARKING LINE	Linear Foot	1,520				
627.744	6" WHITE OR YELLOW PAINTED PAVEMENT MARKING LINE	Linear Foot	51,900				
627.75	WHITE OR YELLOW PAVEMENT & CURB MARKING	Square Foot	1,220				
627.77	REMOVING EXISTING PAVEMENT MARKING	Square Foot	37,650				
627.812	TEMPORARY RAISED PAVEMENT MARKERS	Each	2,000				
627.94	PERMANENT PAVEMENT MARKING TAPE	Linear Foot	335				
627.941	PAVEMENT MARKING TAPE - DOTTED WHITE LANE LINE, 6-INCH WIDTH	Linear Foot	820				
627.944	PAVEMENT MARKING - RECESSED TAPE - WORDS, ARROWS AND STOP BARS	Square Foot	170				
629.05	HAND LABOR, STRAIGHT TIME	Hour	70				
631.10	AIR COMPRESSOR (INCLUDING OPERATOR)	Hour	70				
631.11	AIR TOOL (INCLUDING OPERATOR)	Hour	70				

CARRIED FORWARD:

Item No	Item Description	Units	Approx. Quantities	Unit Prices in Numbers		Bid Amount in Numbers	
				Dollars	Cents	Dollars	Cents
BROUGHT FORWARD:							
631.12	ALL PURPOSE EXCAVATOR (INCLUDING OPERATOR)	Hour	70				
631.14	GRADER (INCLUDING OPERATOR)	Hour	70				
631.171	TRUCK - SMALL (INCLUDING OPERATOR)	Hour	70				
631.18	CHAIN SAW RENTAL (INCLUDING OPERATOR)	Hour	30				
631.21	ROAD BROOM (INCLUDING OPERATORS AND HAULER)	Hour	10				
631.22	FRONT END LOADER (INCLUDING OPERATOR)	Hour	70				
631.32	CULVERT CLEANER (INCLUDING OPERATOR)	Hour	20				
631.36	FOREMAN	Hour	70				
631.50	JACKHAMMER (AIR TOOL INCLUDING OPERATOR)	Hour	60				
631.51	BUCKET TRUCK	Hour	60				
631.52	SCISSOR LIFT	Hour	60				
631.53	ELECTRICIAN	Hour	100				

CARRIED FORWARD:

Item No	Item Description	Units	Approx. Quantities	Unit Prices in Numbers		Bid Amount in Numbers	
				Dollars	Cents	Dollars	Cents
BROUGHT FORWARD:							
631.54	ELECTRICIAN'S APPRENTICE	Hour	100				
631.55	PLUMBER	Hour	60				
632.01	OVER HEIGHT VEHICLE DETECTION SYSTEM: EXIT 103 AREA	Lump Sum	1				
633.01	PROPANE SERVICE TRENCH	Linear Foot	66				
633.21	PROPANE TANK SUPPORTS (12' X 4')	Each	2				
633.31	PROPANE TANK PAD	Square Yard	27				
634.051	REMOVE AND STACK LIGHT STANDARD	Each	9				
634.052	REMOVE HIGH MAST LIGHT STANDARD	Each	2				
634.208	REMOVE AND RESET LIGHT STANDARD	Each	1				
634.231	CONVENTIONAL LIGHT STANDARD WITH LED FIXTURE	Each	81				
639.18	FIELD OFFICE, TYPE A	Each	1				
643.711	LANE USE SIGNAL INSTALLATION	Each	6				

CARRIED FORWARD:

Item No	Item Description	Units	Approx. Quantities	Unit Prices in Numbers		Bid Amount in Numbers	
				Dollars	Cents	Dollars	Cents
BROUGHT FORWARD:							
643.712	FLASHING BEACON - SOLAR POWERED	Each	2				
645.105	REMOVE AND STACK SIGN	Each	111				
645.107	REMOVE AND STACK CANOPY MOUNTED SIGN	Each	10				
645.109	REMOVE AND RESET SIGN	Each	7				
645.1092	CANOPY MOUNTED DYNAMIC MESSAGE SIGN	Each	4				
645.121	OVERHEAD GUIDE SIGN NB 2 (STA. 7450+00)	Lump Sum	1				
645.122	OVERHEAD GUIDE SIGN NB 3 (STA. 7463+00)	Lump Sum	1				
645.123	OVERHEAD GUIDE SIGN NB 5 (STA. 7477+25)	Lump Sum	1				
645.124	OVERHEAD GUIDE SIGN SB 1 (STA 4491+00)	Lump Sum	1				
645.125	OVERHEAD GUIDE SIGN SB 2 (STA 4508+75)	Lump Sum	1				
645.126	OVERHEAD GUIDE SIGN SB 3 (STA. 27+00)	Lump Sum	1				
645.127	OVERHEAD GUIDE SIGN SB 4 (STA. 43+00)	Lump Sum	1				

CARRIED FORWARD:

Item No	Item Description	Units	Approx. Quantities	Unit Prices in Numbers		Bid Amount in Numbers	
				Dollars	Cents	Dollars	Cents
BROUGHT FORWARD:							
645.14	CANOPY MOUNTED SIGN	Each	4				
645.151	CANTILEVER GUIDE SIGN NB 1 (STA. 7427+25)	Lump Sum	1				
645.152	CANTILEVER GUIDE SIGN NB 4 (STA. 7471+75)	Lump Sum	1				
645.155	VARIABLE SPEED LIMIT SIGN	Each	2				
645.161	BREAKAWAY DEVICE SINGLE POLE	Each	51				
645.162	BREAKAWAY DEVICE MULTI POLE	Each	24				
645.251	ROADSIDE GUIDE SIGNS, TYPE I	Square Foot	1,065				
645.271	REGULATORY, WARNING, CONFIRMATION AND ROUTE ASSEMBLY SIGN, TYPE I	Square Foot	1,440				
645.289	STEEL H-BEAM POLES	Pound	24,020				
645.501	REMOVE AND RESET MAINLINE SIGN STA. 7401+23 (2 SIGNS)	Lump Sum	1				
645.502	REMOVE AND RESET MAINLINE SIGN STA. 7440+50 (1 SIGN)	Lump Sum	1				
645.503	REMOVE AND RESET MAINLINE SIGN STA. 7467+00 (1 SIGN)	Lump Sum	1				

CARRIED FORWARD:

Item No	Item Description	Units	Approx. Quantities	Unit Prices in Numbers		Bid Amount in Numbers	
				Dollars	Cents	Dollars	Cents
BROUGHT FORWARD:							
645.504	REMOVE AND RESET MAINLINE SIGN STA. 7470+29 (1 SIGN)	Lump Sum	1				
645.505	REMOVE AND RESET MAINLINE SIGN STA. 3488+27 (1 SIGN)	Lump Sum	1				
645.506	REMOVE AND RESET MAINLINE SIGN STA. 4474+00 (1 SIGN)	Lump Sum	1				
645.507	REMOVE AND RESET MAINLINE SIGN STA. 789+50 (1 SIGN)	Lump Sum	1				
645.508	REMOVE AND RESET MAINLINE SIGN STA. 8492+00 (1 SIGN)	Lump Sum	1				
645.509	REMOVE AND RESET MAINLINE SIGN STA. 7515+00 (1 SIGN)	Lump Sum	1				
645.601	REMOVE AND STACK OVERHEAD SIGN STRUCTURE (NB ORT)	Lump Sum	1				
645.602	REMOVE AND STACK OVERHEAD SIGN STRUCTURE (SB CASH)	Lump Sum	1				
648.00	INSTALL FLAGPOLE	Each	1				
652.30	FLASHING ARROW	Each	1				
652.312	TYPE III BARRICADES	Each	21				
652.33	DRUM	Each	200				

CARRIED FORWARD:

Item No	Item Description	Units	Approx. Quantities	Unit Prices in Numbers		Bid Amount in Numbers	
				Dollars	Cents	Dollars	Cents
BROUGHT FORWARD:							
652.34	CONE	Each	50				
652.35	CONSTRUCTION SIGNS	Square Foot	4,100				
652.361	MAINTENANCE OF TRAFFIC CONTROL DEVICES	Lump Sum	1				
652.38	FLAGGERS	Hour	100				
652.41	PORTABLE-CHANGEABLE MESSAGE SIGN	Each	4				
652.45	TRUCK MOUNTED ATTENUATOR	Cal. Day	540				
652.451	AUTOMATED TRAILER MOUNTED SPEED LIMIT SIGN	Each	3				
652.46	TEMPORARY PORTABLE RUMBLE STRIP	Unit	50	\$150	00	\$7,500	00
655.01	INSTALLATION OF ORT LANE CONTROLLER CABINET	Each	2				
655.012	INSTALLATION OF CASH LANE CONTROLLER CABINET	Each	6				
655.02	DVAS MOUNT INSTALLATION	Each	10				
655.03	VCARS MOUNT INSTALLATION	Each	16				

CARRIED FORWARD:

Item No	Item Description	Units	Approx. Quantities	Unit Prices in Numbers		Bid Amount in Numbers	
				Dollars	Cents	Dollars	Cents
BROUGHT FORWARD:							
655.04	INSTALLATION OF SENSOR LOOPS	Lump Sum	1				
655.05	INSTALLATION OF AVI ANTENNAS	Each	20				
655.06	INSTALLATION OF AVI READERS	Each	4				
655.07	TRAFFIC CONTROL PEDESTAL PREPARATION WORK	Each	6				
655.08	OPUS MOUNT INSTALLATION	Each	18				
655.09	ARMORED CABLE - 10/3	Linear Foot	300				
655.1004	#4/0 AWG WIRE	Linear Foot	2,000				
655.100	#2/0 AWG WIRE	Linear Foot	2,900				
655.1001	#1/0 AWG WIRE	Linear Foot	1,600				
655.101	#1 AWG WIRE	Linear Foot	1,600				
655.102	#2 AWG WIRE	Linear Foot	1,000				
655.104	#4 AWG WIRE	Linear Foot	1,400				

CARRIED FORWARD:

Item No	Item Description	Units	Approx. Quantities	Unit Prices in Numbers		Bid Amount in Numbers	
				Dollars	Cents	Dollars	Cents
BROUGHT FORWARD:							
655.106	#6 AWG WIRE	Linear Foot	1,200				
655.108	#8 AWG WIRE	Linear Foot	600				
655.11	#10 AWG WIRE	Linear Foot	2,400				
655.12	#12 AWG WIRE	Linear Foot	45,600				
655.14	4PR/24 (CATEGORY 5E) CABLE	Linear Foot	31,200				
655.15	LMR 400 CABLE	Linear Foot	2,040				
655.161	MULTIMODE FIBER OPTIC CABLE - 6 FIBER	Linear Foot	2,000				
655.162	SINGLE MODE FIBER OPTIC CABLE - 6 FIBER	Linear Foot	3,500				
655.17	IVIS HOMERUN LOOP CABLE (IMSA 50-2 #14)	Linear Foot	7,140				
655.200	1 1/2" SCHEDULE 40 PVC CONDUIT	Linear Foot	300				
655.2001	3/4" SCHEDULE 40 PVC CONDUIT	Linear Foot	300				
655.2002	1" SCHEDULE 40 PVC CONDUIT	Linear Foot	300				

CARRIED FORWARD:

Item No	Item Description	Units	Approx. Quantities	Unit Prices in Numbers		Bid Amount in Numbers	
				Dollars	Cents	Dollars	Cents
BROUGHT FORWARD:							
655.2003	2" SCHEDULE 40 PVC CONDUIT	Linear Foot	300				
655.201	3" SCHEDULE 40 PVC CONDUIT	Linear Foot	240				
655.202	4" SCHEDULE 40 PVC CONDUIT	Linear Foot	360				
655.2021	1" SCHEDULE 80 PVC CONDUIT	Linear Foot	420				
655.203	1 1/2" SCHEDULE 80 PVC CONDUIT	Linear Foot	840				
655.2031	2" SCHEDULE 80 PVC CONDUIT	Linear Foot	480				
655.204	3" SCHEDULE 80 PVC CONDUIT	Linear Foot	2,550				
655.205	4" SCHEDULE 80 PVC CONDUIT	Linear Foot	360				
655.2051	6" SCHEDULE 80 PVC CONDUIT	Linear Foot	240				
655.2052	5" SCHEDULE 80 PVC CONDUIT	Linear Foot	240				
655.206	1" GALVANIZED RIGID METAL CONDUIT	Linear Foot	720				
655.2061	3/4" GALVANIZED RIGID METAL CONDUIT	Linear Foot	720				

CARRIED FORWARD:

Item No	Item Description	Units	Approx. Quantities	Unit Prices in Numbers		Bid Amount in Numbers	
				Dollars	Cents	Dollars	Cents
BROUGHT FORWARD:							
655.207	1 1/2" GALVANIZED RIGID METAL CONDUIT	Linear Foot	420				
655.2071	2" GALVANIZED RIGID METAL CONDUIT	Linear Foot	660				
655.208	3" GALVANIZED RIGID METAL CONDUIT	Linear Foot	720				
655.209	1/2" LIQUID TIGHT METALLIC FLEXIBLE CONDUIT	Linear Foot	480				
655.210	3/4" LIQUID TIGHT METALLIC FLEXIBLE CONDUIT	Linear Foot	360				
655.2101	1 1/2" LIQUID TIGHT METALLIC FLEXIBLE CONDUIT	Linear Foot	120				
655.2102	2" LIQUID TIGHT METALLIC FLEXIBLE CONDUIT	Linear Foot	120				
655.211	1 1/2" ELECTRICAL METALLIC TUBING CONDUIT	Linear Foot	120				
655.212	2" ELECTRICAL METALLIC TUBING CONDUIT	Linear Foot	120				
655.213	3" ELECTRICAL METALLIC TUBING CONDUIT	Linear Foot	120				
655.214	4" ELECTRICAL METALLIC TUBING CONDUIT	Linear Foot	120				
655.215	3/4" ELECTRICAL METALLIC TUBING CONDUIT	Linear Foot	120				

CARRIED FORWARD:

Item No	Item Description	Units	Approx. Quantities	Unit Prices in Numbers		Bid Amount in Numbers	
				Dollars	Cents	Dollars	Cents
BROUGHT FORWARD:							
655.221	TYPE A PULL BOX INSIDE	Each	20				
655.222	TYPE C PULL BOX IN TUNNEL/BOOTH PIT	Each	24				
655.223	TYPE D PULL BOX OUTDOOR CANOPY	Each	6				
655.224	TYPE E PULL BOX STEEL IN BOOTH	Each	12				
655.225	TYPE F PULL BOX OUTSIDE	Each	24				
655.30	12" X 12" X 6" GALVANIZED JUNCTION BOX	Each	90				
655.31	18" X 18" X 6" GALVANIZED JUNCTION BOX	Each	6				
655.40	18" X 24" X 12" JUNCTION BOX	Each	8				
655.42	36" X 30" X 20" NEMA 4X CABINET	Each	6				
655.431	60 AMP 3 PHASE PANELBOARD CABINET	Each	8				
655.44	100 AMP 3 PHASE PANELBOARD CABINET	Each	2				
655.45	150 AMP 3 PHASE PANELBOARD CABINET	Each	2				

CARRIED FORWARD:

Item No	Item Description	Units	Approx. Quantities	Unit Prices in Numbers		Bid Amount in Numbers	
				Dollars	Cents	Dollars	Cents
BROUGHT FORWARD:							
655.50	2" SCHEDULE 80 PVC CONDUIT CONDULETS	Each	10				
655.51	4" SCHEDULE 80 PVC CONDUIT CONDULETS	Each	10				
655.511	3/4" RIGID METAL CONDUIT CONDULETS	Each	10				
655.52	1" RIGID METAL CONDUIT CONDULETS	Each	20				
655.53	1½" RIGID METAL CONDUIT CONDULETS	Each	50				
655.54	2" RIGID METAL CONDUIT CONDULETS	Each	50				
655.55	3" ELECTRICAL METAL TUBING CONDULETS	Each	40				
655.56	2" ELECTRICAL METAL TUBING CONDULETS	Each	40				
655.57	1½" ELECTRICAL METAL TUBING CONDULETS	Each	40				
655.58	3/4" ELECTRICAL METAL TUBING CONDULETS	Each	40				
655.59	1" ELECTRICAL METAL TUBING CONDULETS	Each	40				
655.63	4-INCH X 4-INCH PVC NEMA 3R WIREWAY	Linear Foot	540				

CARRIED FORWARD:

Item No	Item Description	Units	Approx. Quantities	Unit Prices in Numbers		Bid Amount in Numbers	
				Dollars	Cents	Dollars	Cents
BROUGHT FORWARD:							
655.64	6-INCH X 6-INCH PVC NEMA 3R WIREWAY	Linear Foot	500				
655.65	8-INCH X 8-INCH PVC NEMA 3R WIREWAY	Linear Foot	300				
655.66	12-INCH X 12-INCH PVC NEMA 3R WIREWAY	Linear Foot	300				
655.75	CONCRETE ENCASED CONDUIT	Cubic Yard	135				
655.80	LIGHTNING SUPPRESSION SYSTEM	Lump Sum	1				
655.81	KEY SWITCH	Each	10				
655.82	DUPLEX RECEPTACLE	Each	20				
655.83	NEMA L5-20R RECEPTACLE	Each	10				
655.84	QUADPLEX RECEPTACLE	Each	10				
655.90	SPACE FRAME LIGHTING	Lump Sum	1				
655.92	LED CANOPY LIGHT FIXTURE	Each	12				
655.99	LED BUMPER BEACON	Each	6				

CARRIED FORWARD:

Item No	Item Description	Units	Approx. Quantities	Unit Prices in Numbers		Bid Amount in Numbers	
				Dollars	Cents	Dollars	Cents
BROUGHT FORWARD:							
656.41	GRAVEL WETLAND FILTER 1	Lump Sum	1				
656.42	GRAVEL WETLAND FILTER 2	Lump Sum	1				
656.50	BALED HAY, IN-PLACE	Each	140				
656.60	TEMPORARY BERMS	Linear Foot	3,000				
656.62	TEMPORARY SLOPE DRAINS	Linear Foot	500				
656.632	30" TEMPORARY SILT FENCE	Linear Foot	26,000				
659.10	MOBILIZATION	Lump Sum	1				
670.01	SEWAGE DISPOSAL SYSTEM	Lump Sum	1				
800.01	TOLL ADMINISTRATION BUILDING	Lump Sum	1				
800.10	ELECTRICAL DEMOLITION	Lump Sum	1				
800.20	MECHANICAL DEMOLITION	Lump Sum	1				
800.22	HVAC AND ELECTRICAL TUNNEL AND BOOTHS	Lump Sum	1				

CARRIED FORWARD:

Item No	Item Description	Units	Approx. Quantities	Unit Prices in Numbers		Bid Amount in Numbers	
				Dollars	Cents	Dollars	Cents
BROUGHT FORWARD:							
800.30	TOLL PLAZA & BRIDGE DEMOLITION	Lump Sum	1				
800.40	NEW TOLL BOOTH INSTALLATION	Lump Sum	1				
800.41	STAIR ENCLOSURE & INSTALLATION	Lump Sum	1				
800.90	GENERATOR PAD	Lump Sum	1				
800.91	TRANSFORMER PAD	Lump Sum	1				
803.01	TEST PITS	Each	3				
832.41	TYPE A STEEL SITE BOLLARD	Each	8				
TOTAL:							

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

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

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

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

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

_____ (SEAL)

_____ (SEAL)

*Affix Corporate Seal
or Power of Attorney
Where Applicable*

_____ (SEAL)

By: _____

Its: _____

Information below to be typed or printed where applicable:

INDIVIDUAL:

(Name)	(Address)
--------	-----------

PARTNERSHIP - Name and Address of General Partners:

(Name)	(Address)
--------	-----------

(Name)	(Address)
--------	-----------

(Name)	(Address)
--------	-----------

(Name)	(Address)
--------	-----------

INCORPORATED COMPANY:

(President)	(Address)
-------------	-----------

(Vice-President)	(Address)
------------------	-----------

(Secretary)	(Address)
-------------	-----------

(Treasurer)	(Address)
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MAINE TURNPIKE AUTHORITY

CONTRACT AGREEMENT

CONTRACT 2019.04
INTERCHANGE 103 BARRIER TOLL PLAZA
OPEN ROAD TOLLING CONVERSION
MILE 103.0

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

_____ herein termed the “Contractor”:

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

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

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

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

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

AUTHORITY -

MAINE TURNPIKE AUTHORITY

By: _____

Title: CHAIRMAN

Date of Signature: _____

ATTEST:

Secretary

CONTRACTOR -

CONTRACTOR

By: _____

Title: _____

Date of Signature: _____

WITNESS:

MAINE TURNPIKE AUTHORITY

CONTRACT BOND

CONTRACT 2019.04
INTERCHANGE 103 BARRIER TOLL PLAZA
OPEN ROAD TOLLING CONVERSION
MILE 103.0

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

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

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

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

Witnesses:

CONTRACTOR

_____ (SEAL)

SURETY

_____	_____ (SEAL)
_____	_____ (SEAL)
_____	_____ (SEAL)

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

MAINE TURNPIKE AUTHORITY

FINAL LIEN AND CLAIM WAIVER AND AFFIDAVIT

CONTRACT 2019.04
INTERCHANGE 103 BARRIER TOLL PLAZA
OPEN ROAD TOLLING CONVERSION
MILE 103.0

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

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

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

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

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

(Contractor)

By: _____

Title: _____

State of MAINE
County of _____

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

(Company Name)

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

(SEAL)

Notary Public

My Commission Expires: _____

MAINE TURNPIKE AUTHORITY

SPECIFICATIONS

PART I – SUPPLEMENTAL SPECIFICATIONS

(Rev. November 10, 2016)

CONTRACT 2019.04

INTERCHANGE 103 BARRIER TOLL PLAZA
OPEN ROAD TOLLING CONVERSION
MILE 103.0

The Supplemental Specifications are not included
in these contract documents but are available at
MaineTurnpike.com for download.

MAINE TURNPIKE AUTHORITY

SPECIFICATIONS

PART II – SPECIAL PROVISIONS

CONTRACT 2019.04

INTERCHANGE 103 BARRIER TOLL PLAZA
OPEN ROAD TOLLING CONVERSION
MILE 103.0

PART II - SPECIAL PROVISIONS

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MAINE TURNPIKE AUTHORITYSPECIFICATIONSPART II - SPECIAL PROVISIONS

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

General Description of Work

The work consists of replacing the existing toll plaza; construction of two northbound and two southbound open road tolling (ORT) lanes, and three northbound and three southbound cash/E-ZPass lanes; construction of a precast pedestrian tunnel for employee access and utilities; construction of an Administration Building and access road; reconfiguration of Exit 51 ramps and I-295 Northbound ramp; and demolition of existing toll plaza and reconstruction of the mainline to accommodate approach and departure grade and alignment differentials at the modified plaza for the Maine Turnpike.

The work includes earthwork, pavement, concrete, toll plaza demolition and modification, signing, bridge overpass-mounted, overhead sign structures, concrete barrier, guardrail, electrical work, lighting and lightning suppression systems. The work also includes the installation of tolling provisions in the tunnel, canopy, and toll booth, maintenance of traffic, and all other work incidental thereto in accordance with the Plans and Specifications.

Plans

The drawings included in these Contract Documents, and referred to as the Plans, show the general character of the work to be done under this Contract. They bear the general title "Maine Turnpike – Contract 2019.04 – Interchange 103 Barrier Toll Plaza Open Road Tolling Conversion – Mile 103.0". The right is reserved by the Resident to make such minor corrections or alterations in the Plans as he deems necessary without change in the unit prices on the Schedule of Prices of the Proposal.

101.2 DefinitionHolidays

The following is added after Memorial Day in the General Provisions:

Independence Day 2019
(Fourth of July)

12:01 p.m. (Noon) preceding Wednesday to
6:00 a.m. the following Friday.

Christmas Day 2019

12:01 p.m. (Noon) preceding Friday to
6:00 a.m. the following Thursday.

New Year's Day 2020	12:01 p.m. (Noon) preceding Friday to 6:00 a.m. the following Thursday.
Independence Day 2020 (Fourth of July)	12:01 p.m.(Noon) preceding Thursday to 6:00 a.m. the following Monday.
Christmas Day 2020	12:01 p.m. (Noon) preceding Wednesday to 6:00 a.m. the following Monday.
New Year's Day 2021	12:01 p.m. (Noon) preceding Wednesday to 6:00 a.m. the following Monday.
Independence Day 2021 (Fourth of July)	12:01 p.m.(Noon) preceding Friday to 6:00 a.m. the following Monday.

103.4 Notice of Award

The following sentence is added:

The Maine Turnpike Authority Board is scheduled to consider the Contract Award on April 18, 2019.

104.3.8 Wage Rates and Labor Laws

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

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

THIS DOCUMENT MUST BE CLEARLY POSTED AT THE PERTAINING STATE FUNDED PREVAILING WAGE CONSTRUCTION SITE

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

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

Title of Project -----MTA 2019.04 Interchange 103 Conversion

Location of Project –West Gardiner, Kennebec County

**2019 Fair Minimum Wage Rates
Highway & Earth Kennebec County**

<u>Occupation Title</u>	<u>Minimum Wage</u>	<u>Minimum Benefit</u>	<u>Total</u>	<u>Occupation Title</u>	<u>Minimum Wage</u>	<u>Minimum Benefit</u>	<u>Total</u>
Asphalt Raker	\$15.88	\$1.04	\$16.92	Line Erector - Power/Cable	\$31.00	\$5.32	\$36.32
Backhoe Loader Operator	\$22.00	\$5.08	\$27.08	Loader Operator - Front-End	\$18.88	\$2.97	\$21.85
Bulldozer Operator	\$20.33	\$4.74	\$25.07	Mechanic- Maintenance	\$20.50	\$2.96	\$23.46
Carpenter	\$19.75	\$3.18	\$22.93	Millwright	\$24.25	\$8.80	\$33.05
Carpenter - Rough	\$19.00	\$1.88	\$20.88	Oil/Fuel Burner Serv.& Install	\$23.00	\$3.51	\$26.51
Cement Mason/Finisher	\$17.00	\$1.34	\$18.34	Painter	\$17.50	\$0.42	\$17.92
Concrete Mixing Plant Operator	\$22.11	\$4.89	\$27.00	Paver Operator	\$20.25	\$0.89	\$21.14
Crane Operator =>15 Tons)	\$26.80	\$4.74	\$31.54	Pipe-layer	\$22.00	\$1.49	\$23.49
Crusher Plant Operator	\$17.00	\$3.86	\$20.86	Re-claimer Operator	\$21.58	\$1.80	\$23.38
Driller - Well	\$19.83	\$2.66	\$22.49	Roller Operator - Earth	\$21.28	\$1.27	\$22.55
Electrician - Licensed	\$21.78	\$14.26	\$36.04	Roller Operator - Pavement	\$18.53	\$2.63	\$21.16
Electrician Helper/Cable Puller	\$17.00	\$1.34	\$18.34	Screed/Wheelman	\$19.50	\$2.87	\$22.37
Excavator Operator	\$21.00	\$3.10	\$24.10	Sider	\$16.75	\$1.38	\$18.13
Fence Setter	\$17.13	\$1.50	\$18.63	Stone Mason	\$21.00	\$0.95	\$21.95
Flagger	\$13.00	\$0.00	\$13.00	Truck Driver - Light	\$17.00	\$3.38	\$20.38
Grader/Scraper Operator	\$18.00	\$1.62	\$19.62	Truck Driver - Medium	\$19.00	\$3.36	\$22.36
Highway Worker/Guardrail	\$17.50	\$1.76	\$19.26	Truck Driver - Heavy	\$17.00	\$1.53	\$18.53
Ironworker - Reinforcing	\$22.11	\$2.79	\$24.90	Truck Driver - Tractor Trailer	\$18.00	\$3.51	\$21.51
Laborers (Incl. Helpers & Tenders)	\$15.00	\$0.88	\$15.88	Truck Driver - Mixer (Cement)	\$17.19	\$1.07	\$18.26
Laborer - Skilled	\$18.00	\$1.61	\$19.61				

The Laborer classifications include a wide range of work duties. Therefore, if any specific occupation to be employed on this project is not listed in this determination, call the Bureau of Labor Standards at the above number for further clarification.

Welders are classified in the trade to which the welding is incidental.

Apprentices - The minimum wage rate for registered apprentices are those set forth in the standards and policies of the Maine State Apprenticeship and Training Council for approved apprenticeship programs.

Posting of Schedule - Posting of this schedule is required in accordance with 26 MRSA §1301 et. seq., by any contractor holding a State contract for construction valued at \$50,000 or more and any subcontractors to such a contractor.

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

Determination No: HI-046-2019

A true copy

Filing Date: February 5, 2019

Attest: 

Expiration Date: 12-31-2019

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

THIS DOCUMENT MUST BE CLEARLY POSTED AT THE PERTAINING STATE FUNDED PREVAILING WAGE CONSTRUCTION SITE

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

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

Title of Project -----MTA 2019.04 Interchange 103 Conversion

Location of Project –West Gardiner, Kennebec County

**2019 Fair Minimum Wage Rates
Heavy & Bridge Kennebec County**

<u>Occupation Title</u>	<u>Minimum Wage</u>	<u>Minimum Benefit</u>	<u>Total</u>	<u>Occupation Title</u>	<u>Minimum Wage</u>	<u>Minimum Benefit</u>	<u>Total</u>
Backhoe Loader Operator	\$26.48	\$4.96	\$31.44	Laborer - Skilled	\$19.50	\$5.72	\$25.22
Boilermaker	\$24.00	\$9.00	\$33.00	Line Erector - Power/Cable	\$31.00	\$5.49	\$36.49
Bulldozer Operator	\$20.00	\$3.71	\$23.71	Loader Operator - Front-End	\$21.50	\$3.17	\$24.67
Carpenter	\$23.50	\$4.16	\$27.66	Mechanic- Maintenance	\$22.25	\$3.97	\$26.22
Carpenter - Rough	\$22.00	\$7.20	\$29.20	Mechanic- Refrigeration	\$25.71	\$5.09	\$30.80
Communication Equip Installer	\$23.00	\$1.63	\$24.63	Millwright	\$25.10	\$9.55	\$34.65
Comm Transmission Erector	\$20.13	\$3.83	\$23.96	Painter	\$19.50	\$3.58	\$23.08
Concrete Mixing Plant Operator	\$22.11	\$4.92	\$27.03	Paver Operator	\$20.00	\$0.00	\$20.00
Crane Operator =>15 Tons)	\$27.00	\$6.79	\$33.79	Pipe/Steam/Sprinkler Fitter	\$27.00	\$5.61	\$32.61
Crusher Plant Operator	\$17.38	\$3.12	\$20.50	Pipelayer	\$23.00	\$1.14	\$24.14
Diver	\$32.00	\$6.91	\$38.91	Plumber (Licensed)	\$25.00	\$4.26	\$29.26
Driller - Well	\$19.83	\$2.66	\$22.49	Plumber Helper/Trainee	\$19.00	\$3.10	\$22.10
Earth Auger Operator	\$25.84	\$5.78	\$31.62	Rigger	\$22.50	\$6.57	\$29.07
Electrician - Licensed	\$29.25	\$9.44	\$38.69	Roller Operator - Earth	\$22.11	\$2.77	\$24.88
Electrician Helper/Cable Puller	\$18.00	\$3.38	\$21.38	Roller Operator - Pavement	\$19.00	\$1.06	\$20.06
Excavator Operator	\$24.00	\$2.91	\$26.91	Sheet Metal Worker	\$20.00	\$4.11	\$24.11
Fence Setter	\$15.00	\$2.00	\$17.00	Stone Mason	\$21.00	\$0.95	\$21.95
Flagger	\$13.00	\$0.00	\$13.00	Truck Driver - Light	\$17.00	\$1.17	\$18.17
Ironworker - Reinforcing	\$28.71	\$0.00	\$28.71	Truck Driver - Medium	\$19.00	\$3.37	\$22.37
Ironworker - Structural	\$20.50	\$2.50	\$23.00	Truck Driver - Heavy	\$18.50	\$2.06	\$20.56
Laborers (Helpers & Tenders)	\$17.00	\$1.38	\$18.38	Truck Driver - Tractor Trailer	\$21.13	\$4.07	\$25.20

The Laborer classifications include a wide range of work duties. Therefore, if any specific occupation to be employed on this project is not listed in this determination, call the Bureau of Labor Standards at the above number for further clarification.

Welders are classified in the trade to which the welding is incidental.

Apprentices - The minimum wage rate for registered apprentices are those set forth in the standards and policies of the Maine State Apprenticeship and Training Council for approved apprenticeship programs.

Posting of Schedule - Posting of this schedule is required in accordance with 26 MRS §1301 et. seq., by any contractor holding a State contract for construction valued at \$50,000 or more and any subcontractors to such a contractor.

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

Determination No: HB-002-2019

A true copy

Filing Date: February 5, 2019

Attest: Scott R. Cotnoir

Expiration Date: 12-31-2019

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

BLS(Heavy & Bridge Kennebec)

THIS DOCUMENT MUST BE CLEARLY POSTED AT THE PERTAINING STATE FUNDED PREVAILING WAGE CONSTRUCTION SITE

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

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

**Title of Project -----MTA 2019.04 Interchange 103 Conversion
Location of Project –West Gardiner, Kennebec County**

**2019 Fair Minimum Wage Rates
Building 2 Kennebec County
(other than 1 or 2 family homes)**

<u>Occupation Title</u>	<u>Minimum Wage</u>	<u>Minimum Benefit</u>	<u>Total</u>	<u>Occupation Title</u>	<u>Minimum Wage</u>	<u>Minimum Benefit</u>	<u>Total</u>
Asbestos/Lead Removal Worker	\$13.25	\$0.82	\$14.07	Ironworker - Structural	\$22.50	\$3.00	\$25.50
Backhoe Loader Operator	\$22.00	\$5.08	\$27.08	Laborers (Helpers & Tenders)	\$16.00	\$1.04	\$17.04
Boilermaker	\$24.00	\$9.00	\$33.00	Laborer - Skilled	\$18.05	\$2.79	\$20.84
Bricklayer	\$24.25	\$2.04	\$26.29	Loader Operator - Front-End	\$19.00	\$3.00	\$22.00
Bulldozer Operator	\$20.00	\$3.71	\$23.71	Mechanic- Maintenance	\$25.00	\$3.94	\$28.94
Carpenter	\$21.50	\$3.79	\$25.29	Mechanic- Refrigeration	\$26.00	\$5.16	\$31.16
Carpenter - Acoustical	\$19.50	\$2.03	\$21.53	Millwright	\$29.47	\$10.77	\$40.24
Carpenter - Rough	\$20.00	\$1.03	\$21.03	Oil/Fuel Burner Serv& Installer	\$23.00	\$3.51	\$26.51
Cement Mason/Finisher	\$19.50	\$2.11	\$21.61	Painter	\$16.50	\$0.00	\$16.50
Communication Equip Installer	\$22.20	\$3.67	\$25.87	Pipe/Steam/Sprinkler Fitter	\$25.25	\$5.95	\$31.20
Concrete Mixing Plant Operator	\$22.11	\$4.92	\$27.03	Plumber (Licensed)	\$25.00	\$4.04	\$29.04
Crane Operator =>15 Tons)	\$28.00	\$8.45	\$36.45	Plumber Helper/Trainee	\$21.00	\$3.37	\$24.37
Dry-Wall Applicator	\$22.00	\$0.00	\$22.00	Propane/Natural gas serv/inst	\$26.00	\$4.03	\$30.03
Dry-Wall Taper & Finisher	\$22.91	\$1.08	\$23.99	Pump Installer	\$16.13	\$3.14	\$19.27
Electrician - Licensed	\$27.00	\$4.53	\$31.53	Rigger	\$22.25	\$6.60	\$28.85
Electrician Helper/Cable Puller	\$17.00	\$1.24	\$18.24	Roofer	\$15.00	\$2.79	\$17.79
Excavator Operator	\$20.50	\$2.91	\$23.41	Sheet Metal Worker	\$19.52	\$3.12	\$22.64
Fence Setter	\$15.00	\$2.00	\$17.00	Sider	\$16.75	\$1.38	\$18.13
Flagger	\$13.00	\$0.00	\$13.00	Stone Mason	\$21.00	\$0.95	\$21.95
Floor Layer	\$20.00	\$3.06	\$23.06	Truck Driver - Light	\$17.00	\$1.17	\$18.17
Glazier	\$17.25	\$0.89	\$18.14	Truck Driver - Medium	\$19.00	\$3.37	\$22.37
HVAC	\$24.88	\$2.71	\$27.59	Truck Driver - Heavy	\$17.00	\$1.09	\$18.09
Insulation Installer	\$20.25	\$2.88	\$23.13	Truck Driver - Tractor Trailer	\$17.15	\$1.08	\$18.23
Ironworker - Reinforcing	\$16.00	\$2.79	\$18.79	Truck Driver - Mixer (Cement)	\$17.88	\$3.15	\$21.03

The Laborer classifications include a wide range of work duties. Therefore, if any specific occupation to be employed on this project is not listed in this determination, call the Bureau of Labor Standards at the above number for further clarification.

Welders are classified in the trade to which the welding is incidental.

Apprentices - The minimum wage rate for registered apprentices are those set forth in the standards and policies of the Maine State Apprenticeship and Training Council for approved apprenticeship programs.

Posting of Schedule - Posting of this schedule is required in accordance with 26 MRS §1301 et. seq., by any contractor holding a State contract for construction valued at \$50,000 or more and any subcontractors to such a contractor.

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

Determination No: B2-023-2019

A true copy

Filing Date: February 5, 2019

Attest: 

Expiration Date: 12-31-2019

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

BLS 424BU (R2019) (Building 2 Kennebec)

104.4.6 Utility Coordination

This Subsection is amended by the addition of the following:

These Special Provisions outline the arrangements which have been established by the Authority for coordination of the work to be accomplished by the utilities. The scope and schedule of utility relocation work is noted herein. The Contractor shall plan and conduct his work accordingly.

General

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

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

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

AERIAL AND UNDERGROUND UTILITIESCOMMUNICATION:

FairPoint/Consolidated Communications
5 Davis Farm Road
Portland, ME 04103
(207) 626-2007
(207) 272-7538
ATTN: Matt Free

MAINE DOT:

Maine DOT
16 State House Station
Augusta, ME 04333-0016
(207) 446-2305
ATTN: Ron Cote

ELECTRIC:

Central Maine Power Company
83 Edison Drive
Augusta, ME 04336
(207) 626-9443
ATTN: Tim Robbins

WATER:

Gardiner Water District
246 Water St.
Gardiner, ME 04345
(207) 582-5500
ATTN: Paul Gray

SPECTRUM/CHARTER COMMUNICATIONS

83 Anthony Ave
Augusta, ME 04330
(207) 620-3411
ATTN: Dave Bouchard

CENTRAL MAINE POWER (CMP)

CMP will be setting new pole, service and transformer for the proposed Administration Building. The contractor shall be responsible for the conduit, junction boxes, and transformer pad from the new pole to the new administration building. CMP will de-energize service to the existing toll plaza.

The contractor shall notify CMP ten (10) working days prior to the utility coordination meeting. The coordination effort is to relay contractor's construction schedule, determine possible covering of aerial conductors and schedule of the new service.

FAIRPOINT/CONSOLIDATED COMMUNICATIONS

FairPoint/Consolidated Communications will be providing a new service to the new administration building.

The contractor shall notify FairPoint/Consolidated Communications ten (10) working days prior to the utility coordination meeting. The coordination effort is to relay contractor's construction schedule, determine possible covering of aerial conductors and schedule of the new service.

GARDINER WATER DISTRICT

The contractor will coordinate and install the water service to the Administration building with the Gardiner Water District.

The contractor shall notify Gardiner Water District ten (10) working days prior to the utility coordination meeting. The coordination effort is to relay contractor's construction schedule and schedule of extending the service.

MAINE TURNPIKE AUTHORITY

There is an existing primary electrical service from the existing Administration Building to the transformer on the I-95 Northbound On-Ramp at Sta. 7528+50 Rt. This powers the eleven (11) LED luminaires with a voltage of 120/208V (Contractor to verify). Contractor will coordinate the disconnection of this primary with the MTA.

104.4.6.1 Temporary Utilities

The Contractor will be required to maintain all services and utilities to the existing facility throughout construction of the new toll plaza area. Existing services and utilities include, but are not necessarily limited to, power, telephone, water, sewer, propane, heat and site/roadway lighting. The Contractor shall be responsible for all temporary connections, service runs, relocation, disconnections, reconnections, etc. required to maintain these services due to phasing of construction and constraints of the site and work area. This includes any needed temporary services for the new toll plaza and the existing I-95 Northbound On-Ramp lighting. In order to maintain power to the transformer and lighting along the I-95 Northbound On-Ramp, the contractor may have to provide temporary power to the existing lights. Temporary power can be provided on wooden poles located outside the clear zone or protected. The contractor shall coordinate with the

Resident and MTA on a temporary service. This item shall be incidental to Item 800.30 Existing Toll Plaza Demolition.

Prior to start of construction, the Contractor shall submit a plan and schedule for maintaining existing services and utilities. The plan shall identify all proposed temporary connections, service runs, relocations, disconnections, reconnections, etc. and shall reflect construction phasing and the Contractor's proposed sequence of work. Maintaining existing services and utilities and all temporary utility work, including proposed temporary connections, service runs, relocations, disconnections, reconnections, etc. shall be incidental to Item 800.30 Existing Toll Plaza Demolition.

104.4.7 Cooperation With Other Contractors

This Subsection is amended by the addition of the following:

Adjacent contracts currently scheduled for the 2019, 2020 and 2021 construction season include:

- MTA Contract 2018.05 – Exit 103 I-295 Southbound Underpass Bridge Rehabilitation (2019-2020)
- MTA Contract 2018.15 – Bridge Rehabilitation Cobbossee Stream Overpass MM 99.2 (2018-2020)
- MTA Contract 2019.11 – Plains Road Underpass Bridge Repairs MM 95.6 (2019)
- MaineDOT WIN 02237.00 Bridge Painting Pond Rd/I-295 Bridge (2019)
- MaineDOT WIN 18735.00, 18736.00, 18736.10 and 22684.00 Bridge Street and Maine Avenue Bridges, Gardiner (2019-2020)

The construction of the 2018.05 Exit 103 I-295 Southbound Underpass Bridge Rehabilitation project is currently underway, and its construction will overlap with this contract. The 2019.04 Contractor's Superintendent or Project Manager shall attend coordination meetings with the Resident and the 2018.05 Exit 103 I-295 Southbound Underpass Bridge Rehabilitation Contractor at least once every two weeks. The 2019.04 Contractor shall perform necessary adjustments to the Maintenance of Traffic Plan to conform with construction phase changes at the Exit 103 I-295 Southbound Underpass Bridge Rehabilitation. Payment for moving devices shall be incidental to Item 651.361 Maintenance of Traffic Control Devices.

Contractor shall not begin installation of the overhead sign structure at Sta. 7450+00 and associated guardrail until the painting of Pond Road Bridge project (WIN 02237.00) has been completed.

The following Subsection is added:

105.2.4.2 Lead Paint

The Contractor shall note that the existing toll booths and bridge structure contain lead based paint. A copy of the Lead Determination Report is attached as Appendix A. The Contractor shall institute every precaution when working with materials coated with lead based paints.

Lead Paint Removal

The Contractor is required to remove and dispose of lead based paint and paint residue before cutting, grinding, drilling and sandblasting existing materials in preparation of completing the work except as provided under the Drilling of Lead Based Paint subsection in this Special Provision. All lead based paint and paint residue shall be removed, handled, stored and disposed of in conformance with all local, State and Federal laws and regulations governing lead based paint. The Contractor may use his own properly trained employees to abate the lead based paint in accordance with applicable regulations and requirements; or he may hire a licensed lead abatement subcontractor to abate the lead based paint in accordance with applicable regulations and requirements.

The Contractor, or licensed lead abatement subcontractor, shall submit a Project specific Health and Safety (OSHA) Plan and a Hazardous Waste Management Plan (EPA/DEP) a minimum of two (2) weeks prior to undertaking the removal of lead based paint.

Drilling of Lead Based Paint

The Contractor may drill lead based painted steel, without lead based paint removal, provided the Contractor collects and recycles the drill cuttings at a licensed metal recycling facility. If the Contractor chooses not to collect and recycle the drill cuttings at a licensed metal recycling facility he will be required to abate the area where drilling is to occur in full accordance with the lead based paint removal, storage and disposal requirement of this Special Provision.

The Authority will require a signed statement from the Contractor stating the drill cuttings were collected and recycled at a licensed metal recycling facility and the name the recycling facility.

Health and Safety Plan

The Health and Safety Plan submittal shall describe how the Contractor/licensed lead abatement subcontractor intends to remove the lead based paints; and shall outline how the Contractor/licensed lead abatement subcontractor will adhere to all Federal, State and local ordinances which govern worker (including authorized representatives of the Authority) exposure to lead based paints, and ensure the safety of the workers performing lead removal. Copies of current worker training certificates (OSHA), medical screenings, and respirator fit up shall be included in the submittal.

Hazardous Waste Management Plan

The Hazardous Waste Management Plan submittal shall describe how the Contractor/licensed lead abatement subcontractor intends to manage the hazardous waste that will be generated, temporarily accumulated, stored, transported off-site and disposed; adhere to ordinances associated with the management of hazardous wastes; and ensure protection of the environment.

The Hazardous Waste Management Plan shall:

- Be signed by the Contractor;

- State whether Contractor or licensed lead abatement subcontractor will be undertaking the work; and,
- State whether abated lead materials will be accumulated and stored on-site (required if Contractor is not licensed by DEP/EPA to transport and temporarily store lead based hazardous waste), or be removed in HEPA vacuums daily to the removal Contractor's licensed waste storage facility (permitted only if Contractor is licensed by DEP/EPA to transport and temporarily store lead based hazardous waste).

If abated lead materials are to be accumulated and stored on-site, the Hazardous Waste Management Plan shall include (at a minimum) the following:

- Container size and labeling standards:
 - Containers must be 55 gallons or less
 - Containers must have the labeled "HAZARDOUS WASTE"
- Accumulation requirements:
 - Labels will include accumulation start date and container full date
 - On-site storage will not exceed 180 days from full date
 - Total on-site storage shall not exceed 55 gallons or 220 pounds
- Inspections (including frequency and checklist):
 - Inspections shall be performed each day the Contractor works
 - Inspection checklist shall be similar to MaineDEP format (Refer to Appendix A1 of MaineDEP Handbook for Hazardous Waste Generators – January 2003)
- Transport and DOT "pre-transport requirements":
 - Specify the licensed hazardous waste transporter to be used
 - Obtain Generator's EPA ID No. (typically a provisional ID # is obtained through the licensed hazardous waste transporter)
 - USDOT – approved containers must be used for shipment
 - Schedule MTA for signing Hazard Waste Manifest
- Recordkeeping requirements:
 - Describe where at the jobsite the required records (e.g., inspection logs, training records, Lead Determination report/hazardous waste characterization, etc.) will be maintained
 - Describe how and when copies of the required documents specified above will be transferred to the MTA Environmental Services Coordinator's office

The Contractor/licensed lead abatement subcontractor, shall provide documentation to the MTA that the employees who will be removing, handling, managing and/or directly supervising the hazardous waste operations have received required Resource Conservation and Recovery Act (RCRA) hazardous waste management training, and all training is current.

The lead based hazardous waste must remain on-site, unless the removal is being performed by a licensed lead abatement subcontractor that collects the paint residue in HEPA vacuums and is licensed by DEP/EPA to transport and temporarily store lead based hazardous waste at the removal Contractor's licensed waste storage facility. Both on-site and licensed off-

site lead based hazardous waste storage facilities require secure storage and daily inspection of the stored waste.

If the removal Contractor is not licensed by DEP/EPA to transport and temporarily store lead based hazardous waste off-site, then an EPA licensed Hazardous Waste transporter(s) shall be used to remove hazardous waste from the site. All removal and disposal documentation will be required when the hazardous waste leaves the site. As the Generator, only the Authority's Environmental Services Coordinator or his trained designee shall sign waste manifests when material is removed from the Project site.

The removal, storage, handling, transporting, and disposal of lead based paint and lead based paint residue will not be measured separately for payment, but shall be incidental to the various Contract work items.

The following Subsection is added:

105.2.4.3 Asbestos

The Contractor shall note that the existing structure(s) have undergone Asbestos Containing Material Determination Survey(s), and have tested positive for asbestos containing materials. A copy of the Asbestos Demolition Impact Assessment report is attached as Appendix A. The removal and disposal of the asbestos containing materials is specified in Special Provision 202, Removing Structure and Obstructions (Removing Asbestos Containing Materials).

Whereas no Asbestos Containing Material Determination Survey is 100 percent accurate, building demolition activities shall be accomplished under the supervision of a "competent person", as defined by OSHA, to evaluate whether materials uncovered/exposed are asbestos containing materials. If the "competent person" observes, or believes he has observed, asbestos containing materials while demolition is underway, the "competent person" shall immediately stop the demolition, secure the site and notify the Project Resident/Inspector.

The Owner shall have the area sampled and analyzed for asbestos containing materials. No work will be permitted in the area until samples show that no asbestos containing materials exists, or if asbestos containing materials are present, the conditions are abated. Compensation for delays resulting from stopping the demolition, testing for asbestos containing materials, and abating asbestos containing materials, if they exist, shall be limited to a time extension.

105.8.2 Permit Requirements

The Project is being constructed under the Maine Department of Environmental Protection (DEP) Natural Resources Protection Act Permit by Rule (PBR) Regulations Section 11 – State Transportation Facilities, updated July 8, 2012. A copy of Section 11 – State Transportation Facilities Permit by Rule regulations are attached in Appendix B.

The Project is being permitted under Section 404 of the Clean Water Act, through the US Army Corps of Engineers Programmatic General Permit, Category 2 Pre-Construction Notification (PCN). The Project is subject to the General Conditions of the Category 2 Authorization dated October 13, 2015 through October 13, 2020. A copy of the General Permit shall be provided on the MTA website. A signed copy of the Category 2 PCN form and DEP PBR form will be sent to the Corps Maine Project Office at least two weeks before work commences. All tree cutting shall occur between October 16 and April 19 of any year to maximum extent practicable and no tree cutting shall occur between June 1 and July 31 of any year in order to minimize potential impacts to federally listed northern long eared bats.

The Project is subject to the requirements of the Maine Pollutant Discharge Elimination System (MPDES) General Permit for Stormwater Discharge from Construction Activity, as promulgated by the US Environmental Protection Agency (US EPA) and Administrated by the Maine Department of Environmental Protection (DEP).

A Notice of Intent (NOI), accompanied by a preliminary Limit of Disturbance (LOD) plan was submitted by the Authority to the DEP for coverage under the Maine Construction General Permit (MCGP). Compliance with the erosion and sedimentation control requirements outlined in this Contract is required by the Contractor.

The Contractor shall prepare a LOD plan illustrating the Contractor's proposed limit of earthwork disturbance. The LOD plan shall show all construction access locations, field office locations, material and temporary waste storage locations, as well as include the Contract limits of earthwork disturbance. All applicable erosion and sedimentation control devices needed shall be detailed on the Contractor's LOD plan and are not limited to those devices shown on the Contract LOD plan. **This Plan shall be submitted for review and approval, to the Resident within 14 days of Contract award.** Payment for creating, revising, and completing this plan shall be incidental to Item 659.10, Mobilization.

The LOD for this Contract, which were submitted as part of the NOI, has been estimated to be **38.68 acres.**

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

- If the cumulative area of disturbance exceeds the estimated LOD noted above, by less than one acre, the Resident shall have a minimum of five (5) working days to approve the revised LOD plan.
- If the cumulative area of disturbance exceeds the estimated LOD noted above, by over one acre, the Resident shall first approve of the plan and then possibly resubmit the NOI for MaineDEP approval. The approval may take a minimum of 21 working days.

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

The Contractor shall comply with the conditions outlined in the Army Corps General Permit, Maine Department of Environmental Protection NRPA Permit by Rule, the US Army Corps of Engineers General Permit, and the Maine Pollutant Discharge Elimination System General Permit for stormwater discharge associated with construction activity. The Contractor shall indemnify and hold harmless the Maine Turnpike Authority or its agents, representatives and employees against any and all claims, liabilities or fines arising from or based on the violation of the above noted permits.

107.1 Contract Time and Contract Completion Date

This Subsection is amended by the addition of the following:

All work shall be completed on or before November 14, 2021.

107.4.6 Prosecution of Work

The following is a summary of the Construction Phases and Key Dates:

Phases 1 and 2: Roadway Widening, Access Road, Admin Building and ORT Lanes:

The Contractor shall complete the excavation, tunnel installation, drainage, subbase, pavement, ORT slabs, Access Road, Admin Building, and tunnel work associated with the new ORT facility. The Contractor shall maintain access to existing booths, employee parking areas and existing admin building for MTA employees and their existing operations.

Phases 3: Northbound and Southbound Cash Lane Construction and Cash Lane Commissioning

The contractor shall complete the excavation, drainage, subbase, pavement, toll booths, concrete slabs, canopies and electrical work associated with the three (3) Northbound and the three (3) Southbound cash lanes in a condition suitable for commissioning and testing of the cash lanes by the System Integrator and Authority. With the Phase 3 traffic control in place, and the new cash lane facilities complete, the System Integrator shall commence commissioning testing once the cash lanes are in a suitable condition and complete the testing no later than 14 calendar days for each lane following. The commissioning and testing on the Northbound and Southbound cash lanes can be done separately to facilitate the construction schedule. Within 3 days of the System Integrator notifying the contractor the commissioning testing of the three (3) Northbound and the three (3) Southbound cash lanes is completed and operational, the Contractor shall deactivate the existing toll plaza and begin the demolition associated with Phase 4 work as indicated on the Maintenance of Traffic Plans. Contractor shall provide access to the MTA to the existing administrative building for one week for MTA to salvage building contents.

Once the three (3) Northbound and the three (3) Southbound cash lanes are commissioned and operational, and the operation of the existing plaza is no longer needed, the Contractor can deactivate the existing toll plaza and administration building and begin its demolition. The contractor shall maintain at least the minimum number of lanes through the existing toll booths as indicated in Section 652.

The Contractor shall maintain access to existing booths, employee parking areas and existing admin building for MTA employees and their existing operations.

Phase 4, 5, and 6: Demolition of Existing Toll Plaza and Administration Building and Commissioning of ORT Lanes

With the Phase 4 traffic control in place, and the new ORT facilities complete, the System Integrator shall commence ORT lane commissioning testing and will complete the testing no later than 126 calendar days from the Authority's acceptance that the ORT facilities are complete and the traffic control for Phase 4 is in place. ORT testing may also occur during Phase 5 if necessary. Contractor shall provide and maintain traffic control associated with the testing of ORT equipment including providing sufficient roadway approaches to ORT facilities to properly test the operation at highway speeds. Contractor shall coordinate traffic control requirements with the tolling engineer and system integrator. This shall include setting up and taking down the temporary traffic control measures needed for the ORT testing.

It is the Contractor's responsibility to maintain long-term lane closures of the ORT zones and cash lanes and maintain all proposed ORT and cash lane signage covers until the ORT and cash lanes are operational. At the Authority's discretion, operation may be accelerated if all required work is complete, but any such acceleration is still subject to the schedule terms in these Specifications.

Winter Lane Requirements

The Contractor shall sufficiently complete construction on I-295 Northbound and Southbound prior to November 16, 2019, and November 16, 2020 so as all right side temporary concrete barrier is removed or the temporary concrete barrier is relocated to provide a right shoulder 8 feet wide or greater, from November 15, 2019 to April 15, 2020 and from November 16, 2020 through April 15, 2021, except for the areas as noted on the maintenance of traffic plans.

Supplemental Liquidated Damages

Supplemental liquidated damages of Two Thousand (\$2,000.00) Dollars per calendar day shall be assessed for each calendar day during the periods from November 16, 2019 through April 15, 2020 and from November 16, 2020 through April 15, 2021 that the winter lane requirements activities listed above are not complied with.

The "day" begins at 12:01 a.m. and ends at 12:00-midnight.

Overheight Truck Pull Off Areas

The contractor shall provide overheight truck pull off areas during construction Phases 1, 2, and 3 as shown on the Maintenance of Traffic plans.

107.4.7 Limitations of Operations

Wide loads will be allowed to pass through the Project area during daylight hours as authorized by the Authority with the exception of Phase 3 and 4. During Phase 3, the Exit 51 Northbound On Ramp is allowed to be closed to wide loads for a consecutive 155 calendar day period when travelway and shoulder width is restricted to a total of 15 feet. During Phase 4 once toll plaza demo begins, the Northbound and Southbound wide load toll lanes are allowed to be closed to wide loads for a consecutive 130 calendar day period. The Exit 51 Northbound On Ramp and Exit 51 Southbound Off Ramp are allowed to be closed to wide loads for a consecutive 130

calendar day period. Wide loads are restricted from moving on the turnpike from a half hour after sunset until a half hour before sunrise. Wide loads must be able to safely pass all daytime work areas.

Care shall be taken when working near catch basins to ensure foreign material and contaminants do not enter the basin. If foreign material and/or contaminants enter the basin, it shall be removed prior to the material exiting the basin into a waterway. Removal shall be completed to the satisfaction of the Resident and payment shall be incidental to the Contract.

The Contractor shall submit his proposed staging and storage areas for approval by the Resident. All stored equipment must be outside of the clear zone. Proposed equipment storage locations shall be selected based on (1) proximity to UIS/Protected Natural Resources; (2) minimizing rutting or other actions that may hinder sheet flow from roadway; and (3) spill control and prevention, in the event of a fluid release from the equipment.

SPECIAL PROVISIONS

SECTION 201
CLEARING RIGHT-OF-WAY

(Clearing)

201.01 General

The following paragraphs are added:

A proposed clearing limit is also shown on the Plans. The Contractor is advised, that pursuant to Maine State law, the sale of harvested forest products must be reported to the Maine Forest Service at the end of each year. The Contractor is designated as the Authority's agent for reporting such harvesting. The Contractor shall prepare and submit the appropriate forms to the Maine Forest Service.

There shall be no clearing operations (tree cutting and removal) in June or July.

201.02 Clearing

The following is added at the end of the second paragraph:

Stumps that remain in areas not grubbed shall be cut flush with the ground. The stumps shall be treated with a herbicide, covered with two inch loam and seeded.

Vegetation within the clearing limit that has a height greater than the distance measured from the edge of existing pavement to the base of the tree shall be cleared by a means that assures that the tree will not fall onto the pavement. The Contractor shall submit his method of clearing to the Resident for approval.

The Contractor shall flag the clearing limits at 50 foot intervals two feet beyond the clearing limit line such that the flags remain in place at the completion of the clearing operation. This work shall be completed a minimum of one (1) week prior to the clearing. The flags shall be removed by the Contractor prior to the completion of the Contract. This work will be incidental to Clearing.

201.03 Disposal

The second paragraph is deleted and replaced with the following:

All clearing materials must be disposed of off-site by an approved method. Materials chipped on-site must be transported off-site for disposal. The Contractor will not be permitted to bury any brush or logs in the embankment slopes or within the turnpike right-of-way.

The loading of chips and logs for transport off the Project site shall not be conducted on the existing pavement. This activity shall be located at least 20 feet from the edge of pavement. The Resident may increase the required offset distance if it is determined that chips are spraying onto the pavement.

201.10 Basis of Payment

Payment will be made under:

<u>Pay Item</u>		<u>Pay Unit</u>
201.11	Clearing	Acre

SPECIAL PROVISIONSECTION 202REMOVING STRUCTURES AND OBSTRUCTIONS

(Removing Asbestos Containing Materials)
(Removing Buildings)

202.01 Description

The following paragraphs are added:

The work shall also consist of removing and disposing of all asbestos containing materials (ACM) identified in the Asbestos Demolition Impact Assessment in Appendix A prior to the demolition of the existing administrative building and the existing toll plaza booths and canopies. The licensed asbestos abatement Contractor shall meet the asbestos abatement requirements outlined in Appendix A.

The work shall also consist of removing the existing service building as specified herein.

All asbestos containing materials shall be removed by a licensed asbestos abatement Contractor prior to the general demolition of the identified buildings. All asbestos containing materials shall be disposed of at licensed asbestos containing material disposal sites in compliance with current EPA and MaineDEP regulations. The Contractor shall submit to the Resident the original disposal receipts acknowledging proper disposal of asbestos containing materials prior to the payment of Removing Asbestos Containing Material pay items.

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

202.02 Removing Buildings

The following paragraphs are added:

The following items/equipment will be removed and stacked at the Authority's Sign Shop MM 58.3 Northbound by the Contractor. The exact stacking location will be as approved by the Resident. Items include: propane tanks, picnic table, UPS, electrical panels and emergency lights in the generator room, all shelves and brackets in various locations, stove, microwave, safe, wire rack next to safe, overhead cabinets and their attached tracking, gray storage shelving in the tunnel, lockers, counter tops, desk, and three drawer file cabinets, wall clock, paper towel and toilet paper dispenser, mop sink and stainless steel broom holder above it, bathroom sink and toilet with handicap hand hold bars, wall mounted stainless steel trash bin, and 2 way radio. The contractor shall coordinate with the propane supply company to empty the tanks prior to removal.

The following items/equipment will be removed by the Authority prior to the buildings being released to the Contractor for subsequent demolition. The contractor shall provide the Authority a 4 week notice prior to beginning demolition. The demolition may not commence until the new toll plaza is tested and operational and approval is provided by the Authority. Items to be removed by the Authority include: bulletin boards, MSDS box, Needle stick box, lunch table and chairs.

The septic tank(s) shall be pumped out to remove waste material and shall be broken up as approved by the Resident to preclude accumulation of water. Tank(s) shall then be backfilled with gravel as required under the provisions regarding excavations below.

The foundations, including floor slabs, shall be completely removed. Concrete shall be disposed of off-site. The foundation shall then be filled to surrounding levels as required under the provisions regarding excavations below. Construction activities will disturb the connection to the leachfield. Contractor shall assume that the septic tank will require pumping at least every four (4) days. Contractor shall monitor tank levels.

All steps, walks, slabs, piers, posts, decks, and associated debris shall be completely removed.

Excavations shall be filled to ground level with two foot layers of good grade common borrow that meets the requirements of Subsection 703.18 of the Standard Specifications except in locations that are designated to receive special fill material, such as under proposed footings, concrete slabs and pavement. In this process, the contour and grades of site plan and sections are to be followed.

All buildings and materials contained therein after the Authority provides approval for demolition and any items connected with the property of a personal property nature shall become the property of the Contractor and shall be completely removed from the Exit 103 building. The Authority will require one (1) week to remove equipment from the existing building. Ownership of the buildings reverts to the Contractor upon the approval to demolish issued by the Maine Turnpike Authority. All debris and unusable materials shall be removed to an approved transfer station or approved landfill. Under no circumstances shall any material or debris be disposed of by burning on the premises nor shall the debris be burned at an off-premise site.

The Contractor shall provide and maintain all temporary barricades, signs or other safety measures necessary.

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

The new toll plaza and toll system shall be completely operating and, prior to the Authority providing approval to demolish the building and disconnecting the electric, water and utility services.

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

The following Subsection is added:

202.021 Removing Asbestos Containing Materials

The Maine Turnpike Authority had an Asbestos Demolition Impact Assessment performed at the Exit 103 Toll Plaza and building facilities in June 2018. All areas, except concealed spaces and components internal to mechanical devices, have been tested for asbestos. The location of asbestos is documented in Appendix A - Asbestos Demolition Impact Assessment, MTA Exit 103, Gardiner, Maine, dated June 14, 2018. The Inspection and bulk sample analysis indicates that there are Materials that do contain asbestos within the toll plaza booths tested and must be removed by a State of Maine certified asbestos abatement contractor. Should any additional suspect building materials be found during any of the demolition/renovation work, the work shall immediately stop until additional sampling can be conducted.

The asbestos determination investigation did not include demolition of the structure or equipment to locate asbestos containing materials.

A licensed asbestos abatement Contractor shall properly abate and dispose of all asbestos containing materials identified in the Asbestos Demolition Impact Assessment Report and as specified in this Special Provision.

The General Contractor may sub-contract the removal of the asbestos containing material (ACM) to a licensed asbestos abatement Contractor or use his own trained and licensed personnel. The licensed asbestos abatement Contractor must prepare a work plan for the removal of the ACM and submit a copy to the Resident for approval prior to commencing with the removal of ACM.

Disposal of all ACM shall comply with current EPA and Maine DEP regulations. The Contractor shall submit to the Resident the original disposal receipts acknowledging proper disposal of ACM prior to the payment of Removing Asbestos Containing Material pay items.

The licensed asbestos abatement Contractor will be responsible for all work associated with the asbestos removal, including the Asbestos Removal Plan, MaineDEP Notification, demolition, final clearances, legal disposal and Abatement Certification.

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

202.05 Method of Measurement

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

Removing Asbestos Containing Materials will be measured as one lump sum.

Removing the buildings will be measured as one lump sum per building.

202.06 Basis of Payment

This Subsection is amended by the addition of the following:

Removing Asbestos Containing Materials will be paid for at the Contract lump sum price which price shall be full compensation for the legal removal and disposal of all asbestos containing meeting materials, and shall include all materials, labor, tools and equipment necessary to complete this work.

Removing Buildings will be paid for at the Contract lump sum price per building which price shall be full compensation for the legal removal and disposal of all building materials, including removal of reinforced concrete floor, walls and foundations, termination of utilities, removing and stacking of equipment and items, and shall include all materials, labor, tools and equipment necessary to complete this work. Removing Building shall also include monitoring and pumping of the existing septic system. The demolition and removal of the underground fuel tank, Toll Plaza Booths, Canopies/Bridge and Tunnel are paid for under a separate item and are not in this lump sum price.

Payment will be made under:

<u>Pay Item</u>		<u>Pay Unit</u>
202.071	Removing Asbestos Containing Materials, Toll Booth Lab Tops	Lump Sum
202.081	Removing Existing Building	Lump Sum

SPECIAL PROVISIONS

SECTION 202

REMOVING STRUCTURES AND OBSTRUCTIONS

(Removing Existing Manhole or Catch Basin)

202.05 Removing Manholes or Catch Basins

The following sentence is added:

Frames and grates shall be removed, transported and stacked at the Crosby Maintenance Area located at Mile 45.8 Southbound.

202.07 Method of Measurement

The last paragraph is deleted and replaced with the following:

Removing Manholes or Catch Basins will be measured by each unit satisfactorily removed.

202.08 Basis of Payment

The following is added after the first sentence of the fourth paragraph:

Removing, transporting and stacking the frames and grates will not be paid for separately, but shall be incidental to the Removing Existing Manholes or Catch Basin item.

Payment will be made under:

<u>Pay Item</u>		<u>Pay Unit</u>
202.15	Removing Existing Manhole of Catch Basin	Each

SPECIAL PROVISIONS

SECTION 202

REMOVING STRUCTURES AND OBSTRUCTIONS

(Removing Existing Structural Concrete)

202.01 Description

The following paragraphs are added:

This work shall include removal and disposal of portions of the existing pavement, toll island slabs including bumpers and booth enclosures, as well as the tunnel and hatches as shown on the Plans. Only a portion of the tunnel is to be removed as shown in the Plans.

The Contractor may not dispose of demolition concrete within the Project Limits. All materials shall become the property of the Contractor and shall be removed from the site at the completion of the project. The Contractor shall provide the Resident with an affidavit stating the final location of all disposed material and that the material was disposed of in accordance with the Maine Department of Environmental Protection Solid Waste Regulations.

202.07 Method of Measurement

The following paragraphs are added:

Any excavation required to remove existing concrete will not be measured separately for payment, but shall be incidental to Item 202.17, Removing Existing Structural Concrete.

202.08 Basis of Payment

Payment will be made under:

<u>Pay Item</u>		<u>Pay Unit</u>
202.17	Removing Existing Structural Concrete	Lump Sum

SPECIAL PROVISIONSSECTION 202REMOVING STRUCTURES AND OBSTRUCTIONS

(Removing Pavement Surface)

202.01 Description

The following sentences are added:

This work shall also consist of removing the surface of the bituminous concrete pavement in all locations to the depth, width, grade, and cross section on the mainline as shown on the Plans or as directed by the Resident.

Removal of approach pavement shall be completed through the use of a milling machine. The milling machine(s) shall be capable of accurately establishing profile grades by referencing from a floating straight edge, a minimum of 30 feet.

Areas requiring shim pavement to reach final pavement grade shall not be milled.

This work shall also consist of construction of temporary ramps at all butt joints as shown in the MaineDOT Standard Details, November 2014 Edition – Pavement Overlay Butt Joint Detail (Roadways), Page 202(01) or as approved by the Resident. The length of the temporary ramp shall be at least 1/2 L.

202.061 Removing Pavement Surface

This Subsection is deleted and replaced with the following:

The equipment for removing the bituminous surface, excluding bridge decks, shall be a power-operated milling machine or planer capable of removing the bituminous concrete pavement to the required depth, transverse cross slope, and profile grade by use of an automated grade and slope control system. The controls shall automatically increase or decrease the pavement removal depth as required, and readily maintain desired cross slope to compensate for surface irregularities in the existing pavement course. The mill head on the machine shall have a maximum 8mm tooth spacing pattern and a minimum triple wrap configuration. The milling machine shall be capable of accurately establishing profile grades by referencing from a floating straight edge, minimum of 30± feet. The equipment shall also have an effective means for removing excess material from the surface and preventing flying material in compliance with Subsections 105.2.5 Compliance with Health and Safety Laws and 105.2.6 Convenience of the Public, of the Specification.

The contractor shall operate the milling machine such that the forward operating speed of the machine in feet per minute (fpm) does not exceed 65% of the mill head in revolutions per minute (rpm). i.e. 100 rpm head speed equals maximum forward operating speed of 65 fpm. The contractor shall avoid stopping the milling operation during truck exchanges by staging the haul units accordingly.

The Contractor shall locate, identify and remove all objects in the pavement through the work area that would be detrimental to the milling machine.

The Contractor shall be responsible for the layout of the longitudinal centerline between the travel lane and passing lane.

The finished milled surface will be inspected before being accepted, and any deviations in the profile exceeding 3/8 inch under a 16 foot string line or straightedge placed parallel to the centerline will be corrected. Any deviations in the cross slope that exceed 3/8 inch under a 10 foot string line or straightedge placed transversely to the centerline will be corrected. In no case shall the cross slope in a single lane width be inverted resulting in a depression as measured transverse to the direction of travel. Any cross slope inversions or depressions shall be corrected by spot shimming the area with HMA as directed by the resident prior to installing any leveling or wearing course. These corrections shall be done with no additional expense to the Authority.

All surplus pavement grindings shall be disposed of by the Contractor off the Turnpike right-of-way. All grindings shall be disposed of in accordance with the Maine Department of Environmental Protection Solid Waste Management Requirements.

202.07 Method of Measurement

The removal of existing bituminous concrete pavement – will be measured by the square yard of material removed to the required depth.

The following sentences are added:

Transporting and stockpiling of the pavement grindings at the maintenance facilities will not be measured separately for payment, but shall be incidental to the Removing Pavement Surface items.

Installation of temporary bituminous ramps for maintenance of traffic will not be measured separately for payment, but shall be incidental to the Contract.

Removal of temporary bituminous ramps for maintenance of traffic will not be measured separately for payment, but shall be incidental to the Contract.

202.08 Basis of Payment

Removing Pavement Surface will be paid for at unit price per square yard which price shall be full compensation for removing and disposing of the bituminous and gravel materials.

Payment will be made under:

<u>Pay Item</u>		<u>Pay Unit</u>
202.202	Removing Pavement Surface	Square Yard

SPECIAL PROVISION

SECTION 202

REMOVING STRUCTURES AND OBSTRUCTIONS

(Rumble Strips)

202.01 Description

The following sentences are added after the first paragraph:

This work shall consist of cutting a pattern of rumble strips from 1-295 Pond Road Bridge to Turnpike jug handle at Sta. 5281+00 for the northbound roadways and from the I-295 Exit 51 NB On Ramp to the Exit 103 SB Off Ramp for the southbound roadways. Rumble strips shall not be placed across ramp opening or on bridges. Rumble strips shall be placed on both edges of the painted gores approaching the northbound and southbound cash barriers separating traffic from the ORT lanes.

The following Subsections are added:

202.065 Rumble Strips

The rumble strips shall not be cut until the Contractor has placed the permanent pavement markings at the required locations.

At proposed rumble strip locations, the bituminous concrete paved surface shall be removed by milling in strips as detailed on the Plans and as directed by the Resident. The pattern will be 80 feet of rumble strips followed by a 20 foot space repeated along the entire length on the outside shoulder. The inside shoulder shall be continuous. The rumble strips shall be normal to the baseline of the roadway on tangent sections and radial on curves. The Contractor shall be responsible for the layout of the rumble strips. The milling machines for this type of rumble strip are designed by:

Surface Preparation Technology
81 Texaco Road
Mechanicsburg, PA 17055
Tel. (717) 697-1450

L&C Flashing Barricades
60 Walpole Street
Canton, MA 02021
Tel. (508) 580-6700

Thomas Grinding
110 Fox Lane Southwest
Moore Haven, FL 33471
Tel. (863) 946-1461

The milling machine shall be equipped with a 20 foot pointer to provide longitudinal grade control.

202.07 Method of Measurement

The following paragraph is added:

Rumble Strips will be measured by the actual number cut, completed and accepted.

Layout of rumble strips, disposal of milled bituminous pavement and roadway cleanup will not be measured separately for payment, but shall be incidental to this item.

202.08 Basis of Payment

The following sentences are added:

Rumble Strips will be paid for at the Contract unit price per each, which price shall be full compensation for all labor, materials, equipment and incidental items of work for a complete installation.

Payment will be made under:

<u>Pay Item</u>		<u>Pay Unit</u>
202.205	Rumble Strips	Each

SPECIAL PROVISION

SECTION 202

REMOVING STRUCTURES AND OBSTRUCTIONS

(Removing Rumble Strips)

202.01 Description

The following paragraph is added:

This work shall consist of grinding existing rumble strip locations to a depth of 1-1/2 inches, coating vertical and horizontal surfaces with bituminous tack coat, and installing 1-1/2 inches of hot mix asphalt, 9.5 mm over the entire milled area. Locations and lengths of removal shall be as shown on the Plans or as approved by the Resident.

The following Subsections are added:

202.011 Materials

Grinding shall be done in accordance with Section 202. Bituminous tack coat shall conform to Section 409.

Hot mix asphalt, 9.5 mm shall conform to Section 401.

202.025 General

Existing rumble strips are approximately 16 inches long, seven inches wide, 1/2 inch deep, and spaced approximately every five inches.

202.07 Method of Measurement

The following paragraph is added:

Removing Rumble Strips shall be measured by the linear foot removed and accepted. Measurement shall be parallel to the baseline.

202.08 Basis of Payment

The following sentences are added:

Removing Rumble Strips shall be paid for at the Contract unit price per linear foot which includes all grinding, bituminous tack coat, pavement, equipment and labor necessary to satisfactorily complete the work.

Payment will be made under:

Pay Item

Pay Unit

202.206 Removing Rumble Strips

Linear Foot

SPECIAL PROVISION

SECTION 203

EXCAVATION AND EMBANKMENT

203.01 Description

The following paragraph is added:

This work shall consist of cutting, removing and disposing of the full depth of existing bituminous concrete pavement at the approaches to the bridge structures within the limits of work as shown on the Plans or as approved by the Resident. The pavement shall be sawcut to the full depth of pavement at the limits of the excavation to provide a clean, vertical cut surface.

203.04 General

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

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

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

203.10 Embankment Construction - General

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

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

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

203.16 Winter Construction of Embankments

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

203.18 Method of Measurement

The following paragraphs are added:

There will be no additional payment for the required excavation plan, and costs shall be incidental to the Excavation items.

203.19 Basis of Payment

Payment will be made under:

Pay Item

Pay Unit

203.20 Common Excavation

Cubic Yard

SPECIAL PROVISIONSECTION 203EXCAVATION AND EMBANKMENT

(Contaminated Soil and Groundwater Management)

203.01 Description

This work consists of removing the #2 fuel oil underground storage tank (UST) and all associated tank appurtenances located at the Exit 103 West Gardiner ORT project site. Work under this Special Provision shall include all earthwork, tank work, piping work, electrical work, and paving work required for the complete removal of the #2 fuel oil UST system at the site.

The UST is an active 2,500-gallon capacity #2 fuel oil UST located on the south side of the Administration Building as shown on the contract plans. The vent pipe for the UST runs up the southern exterior wall of the Administration Building. Based on available information, the UST, which was installed on August 7, 1991, is of fiberglass construction, has flexible double-walled piping, and has secondary containment and spill monitoring. The UST is registered as Tank #5165 with the Maine Department of Environmental Protection (MeDEP) and was last inspected on November 8, 2017.

The UST closure shall be conducted in accordance with MeDEP Chapter 691 – *Rules for Underground Oil Storage Facilities* including, but not limited to, Appendices J, P, Q, and S therein; MeDEP’s Standard Operating Procedure (SOP) TS004 *Compendium of Field Testing of Soil Samples for Gasoline and Fuel Oil*; American Petroleum Institute (API) Recommended Practices 2015, 2015A, 2217, and 1631; applicable Occupational Safety and Health Association (OSHA) standards; Petroleum Equipment Institute (PEI) Recommended Practices; and all State and local fire codes. While Chapter 691 does not specifically require that a site assessment be conducted in accordance with Appendix P (since they are not required for consumptive use heating oil tanks), for this project, as a best management practice, it is required that the Contractor conduct a site assessment per Chapter 691, Appendix P.

While not specifically required by Chapter 691 (as the subject tank does not contain a Class I liquid), for this project, as a best management practice, it is required that all tasks described herein shall be completed under the supervision of a Maine-certified Underground Oil Tank Installer per Chapter 691. If the removal occurs after July 1, 2019, the Certified Underground Oil Storage Tank Installer overseeing the tank removal must also be trained in best management practices for erosion and sedimentation control by the MeDEP or through an equivalent program approved by the MeDEP. Within no less than 30 days prior to the tank removal, the Contractor must provide documentation to the Engineer that the Contractor’s tank removal supervisor has the necessary certifications.

203.04 General

The Contractor shall submit a site-specific Health and Safety Plan (HASP) to the Resident at least two weeks in advance of any excavation work on the project. The Contractor shall not

proceed with work until MTA has reviewed the plan and notified the Contractor that it is acceptable.

The Contractor shall be responsible for the disposal of fuel, sludge, water, and any other waste associated with the tank removal. The Contractor shall dispose of waste as the least restrictive category allowed by regulation. For example, when allowed, wastes shall be disposed for recycle, not regulated hazardous waste, and wastes shall be documented with bills of lading, not hazardous waste manifests. In any case, the Contractor shall dispose of waste for recycling where possible. The Contractor shall provide the Engineer with the name and address of the selected waste disposal facility(s) along with documentation of the facility's approval to accept the waste. No waste shall be disposed of until the Engineer reviews the facility documentation and accepts the location as an appropriate disposal facility.

The Contractor shall be responsible for any laboratory testing required by the disposal facility to accept the waste. Any laboratory reports generated as part of any waste characterization process shall be provided to the Engineer along with the documentation noted above.

When managing these wastes, the Contractor shall confirm with the Engineer their schedule for waste generation and disposal.

If waste must be disposed of under a hazardous waste manifest, the Contractor must activate the site's EPA ID Number by contacting the MeDEP Hazardous Waste Program (207-287-7688) no later than 30-days prior to waste generation activities. Specify that the waste generation activities are for a non-recurrent one-time fuel oil tank removal event. If an EPA ID number does not exist for the site, the Contractor shall obtain a temporary EPA ID number for the work. Specify that the waste generation activities are for a non-recurrent one-time tank removal event. Once an EPA ID number has been activated for the site, the Contractor shall contact the Engineer to report that the number has been activated.

Coordinate the hazardous waste removal schedule with the Engineer and Maine Turnpike Authority (MTA) so an MTA representative, or another designated representative, can be present to sign and assist the transporter in the proper distribution of any waste manifest(s) when the waste is transported off site. The Contractor shall ensure that the generator name and mailing address on all manifests appears as follows:

Maine Turnpike Authority
Attn: John Branscom
2360 Congress Street
Portland, ME 04102

If appropriate and with the approval of the Engineer and MTA, deactivate the site's EPA ID number by contacting MeDEP Hazardous Waste Program (207-287-7688) immediately after the waste has been removed from the site, notifying them that the waste has been successfully removed from the site and that, as the Contractor, you will no longer be generating waste from the project site. Once the EPA ID number has been deactivated, the Contractor shall contact the Engineer to report that the number has been deactivated.

The UST shall be closed as follows:

- All electrical service to the tank system shall be turned off and locked out;
- All product, liquid, and wastes shall be removed from the UST system (including all piping) and transferred to another tank owned by the MTA or properly disposed of off-site, at the discretion of the MTA. The Contractor shall assume that the tank will contain a maximum of 1,000 gallons of residual fuel and three 55-gallon drums of sludge. The Contractor shall be responsible for the disposal of all wastes generated as part of tank cleaning activities (e.g. wash water, rags, coveralls, etc.), the costs for which shall be included in the UST removal price.
- All piping shall be disconnected and removed to the greatest extent possible. Piping that cannot be removed must be drained of fuel and capped such that leaks of any *de minimis* levels of fuel remaining in the lines is prevented.
- The tank shall be tested by the Contractor for hazardous and explosive vapors and rendered vapor free or inerted of such vapors. The tank shall be tested periodically during removal and handling to ensure safe conditions are maintained at all times;
- The tank and all additional appurtenances shall be removed; and
- The excavation shall be backfilled and repaired to match existing site conditions.

The Contractor must take the following precautions during the UST removal project:

- Document that all underground utilities have been clearly marked. The Contractor is responsible for maintaining the utility mark-out with DigSafe for the duration of the project;
- Eliminate all potential sources of ignition from the project limits (i.e., smoking materials, non-explosion proof electrical and internal combustion equipment);
- Prevent discharge of static electricity during venting of flammable vapors by minimizing agitation and static producing movement, if possible, by providing a conductive path for the continuous, “safe” discharge of electricity by either bonding or grounding equipment and vehicles;
- Secure the work area from all pedestrians and vehicular traffic; and
- Prevent the accumulation of vapors at ground level and in the excavations.

Refer to API Publication 2015 and Recommended Practice 2003 for required precautionary measures to ensure vapor-free working conditions.

The Contractor shall use a combustible gas indicator (CGI) to periodically check for hazardous vapor concentrations in the work area. All CGI readings shall be recorded and provided to the Engineer’s on-site representative. Open flame and spark-generating equipment shall NOT be used in the vapor hazard area. Electrical equipment used in this area must be explosion-proof and approved for use in potentially explosive atmospheres. **SMOKING WILL STRICTLY BE PROHIBITED AT ALL TIMES.**

The location of the tank is in an unpaved, landscaped area so removal of existing pavement and/or concrete from within the work area where excavation is required is not expected. **The Contractor shall excavate with extreme caution and avoid puncturing the tank, its associated**

pipng, and any tank hold-down straps. If necessary, the Contractor shall remove fill materials directly above the tank top by hand using spark-free tools.

Prior to tank removal, all piping and wiring shall be disconnected from the tank. The Contractor shall avoid spillage when disconnecting and draining product piping. All exposed piping ends shall be capped after draining. Any soil impacted by spillage shall be excavated immediately and properly disposed of at a certified disposal facility at the Contractor's expense.

The Contractor shall remove all liquids and solids encountered in the tank and its interstitial space prior to handling the tank. Explosion-proof or air driven pumps shall be used when removing product and residues from the tank. If a vacuum truck is used, the truck should be located outside the vapor hazard area and shall be properly grounded. Plastic (PVC) pick-up tubes shall NOT be used on the stripping lines of vacuum trucks, as they are prone to accumulating static charges. Use a hand pump to remove the bottom few inches of liquid, if necessary, while observing appropriate grounding and bonding procedures. Tank bottoms, sludges, and materials used to clean the tank shall be disposed of at the Contractor's expense, as discussed in Section 3.2.1. Residual fuel and waste disposal documentation shall be submitted to the Engineer in the Closeout package.

Tank purging, if conducted, should be completed in accordance with Chapter 691, Appendix J.

Maintain sides, slopes, and shoring of excavations in a safe condition until completion of backfilling. All excavations shall comply with Code of Federal Regulations Title 29-Labor, Part 1926 (OSHA).

Structures and utilities located within the excavated area shall not be disturbed without prior approval by MTA. The Contractor shall protect all structures and utilities to remain so as to prevent disruption of facility operations.

The Contractor will maintain utility clearances during the work.

Clean, uncontaminated soils removed from the existing tank excavation during the tank removal, as identified by Contractor's environmental consultant can be reused to fill the excavation up to a level six (6) inches below finished grade during restoration. The Contractor shall take steps to keep the removed fill identified for reuse dry while awaiting replacement into the open excavation, such that fill materials shall not be wet, frozen, or otherwise unsuitable for reuse.

Place backfill materials in layers not more than 12 inches thick in loose lifts (6 inches for confined areas such as trenches) unless otherwise specified or approved. Before compaction, moisten or aerate each layer as necessary to facilitate compaction to the required density. Do not place backfill or fill material on surfaces that are muddy, frozen, or covered with ice.

Any additional material necessary to fill the excavation to the subgrade depth of six (6) inches shall be certified clean Granular Borrow without excessive fines, organics, or any other deleterious material. Acceptance of the Granular Borrow will be at the discretion of the Engineer.

Compact each layer of backfill using a pan compactor or other suitable device to prevent future settlement.

It is the Contractor's responsibility to maintain a safe and stable excavation in accordance with all requirements, including applicable OSHA standards. Engineered excavation support shall be required when necessary to maintain stable slopes and protect structures when excavating for underground storage tank removals. If the Contractor determines, based on site conditions, that engineered excavation support is necessary to complete the scope of work described herein, Contractor is to provide engineer-sealed excavation support plans to Engineer a minimum of five (5) business days in advance of initiating excavation work at the site.

It is not expected that dewatering will be necessary to complete the required work. However, if it is deemed necessary based on site conditions, the Contractor is responsible for obtaining required permits, equipment and materials, and completing dewatering, as necessary, to safely complete the scope of work described herein.

It is not expected that a liner is present around the tank. However, if a liner is present surrounding the tank, water contained within the liner must be pumped and containerized prior to removing the tank and/or disturbing the liner.

Unless authorized by the Engineer, bulk transportation and disposal of excavation water at an off-site facility will not be allowed.

If dewatering is required, the Contractor shall be responsible for obtaining all permits to allow groundwater discharges to surface or groundwater. If the Contractor determines, based on site conditions, that dewatering is necessary to complete the scope of work described herein, the Contractor is to provide a dewatering plan to the Engineer in advance of initiating dewatering activities.

The UST shall be properly disposed of regardless of its condition unless otherwise directed by the Engineer. Sufficient holes shall be made in the tank to render it unfit for future use. Reuse of the tank, or the sale of the tank for reuse, is prohibited. The Contractor shall provide the Engineer with a minimum of six (6) photographs of the tank, in its disposal condition, for verification within two (2) weeks of tank removal.

The Contractor is responsible for removing and disposing of all tank appurtenances (unless otherwise directed by the Engineer), as listed below. None of the listed materials should be disposed of in the tank excavation.

- Tank;
- Piping (including vent);
- Cover pad/drive pad, if present;
- Bottom pad or dead men, if present;
- Liner surrounding the tank, if present;
- Electrical wiring and conduit (to breaker); and
- Monitoring equipment.

The Contractor shall be responsible for checking current Federal, State, and local regulations and applicable consensus codes for special procedures or preparations that are required before the transport and disposal of any tank or appurtenances.

A written receipt or disposal documentation shall be submitted to the Engineer in the Closeout Documents. The receipt shall include the name (printed/signed), facility, phone/address, and list all tank appurtenances disposed of.

While Chapter 691 does not specifically require that a site assessment be conducted in accordance with Appendix P (since they are not required for consumptive use heating oil tanks), for this project, as a best management practice, it is required that the Contractor conduct a site assessment per Chapter 691, Appendix P.

The Contractor shall retain a qualified environmental consultant to conduct a site assessment as part of the tank removal project in accordance with Chapter 691, Appendix P *Requirements for a Site Assessment at Facility Closure or Tank Abandonment*. The Contractor shall provide the name of the environmental consultant to the Engineer within no less than 15 days prior to initiation of the tank removal.

Within 30 days of the completion of the site assessment, the Contractor shall provide the Engineer with a copy of the site assessment report that includes, at a minimum, all information specified in Sections 2-5, as appropriate, of Chapter 691, Appendix P.

If a site assessment finds evidence of a discharge or contamination above a notification level provided in Chapter 691, Appendix Q, the Engineer and MTA must be notified immediately so proper notification to the MeDEP can be made.

If, after consultation with MeDEP, it is determined that impacted soil requires excavation and off-site disposal, the Contractor will coordinate with Engineer and MTA to identify a stockpile location. Excavated impacted soil will be stockpiled on and under 2 layers 6-mil polyethylene sheeting to prevent water infiltration. The sheeting will be secured to prevent stockpile damage due to wind, rain, snow, or other adverse weather conditions. The Contractor will be responsible for maintaining the stockpile in an acceptable condition.

The Contractor and their environmental consultant shall conduct any necessary characterization of the soil stockpile to allow for completion of a disposal profile and its acceptance by a licensed facility for off-site disposal. The Contractor shall submit documentation of facility acceptance of soil to the Engineer.

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

203.18 Method of Measurement

Measurement for the Underground Storage Tank Removal shall be by lump sum and shall consist of all materials, equipment, and labor required for a site assessment per Chapter 691, Appendix P that includes identification and environmental screening of contaminated soil material, a health and safety plan, complete tank system removal including, but not limited to, removal and disposal of 2500-gal #2 Fuel Oil UST system (includes transfer to another tank owned by the MTA or properly disposed of off-site, at the discretion of the MTA up to 1,000 gallons of residual fuel, off-site disposal of up to three drums of tank cleaning waste, and any waste characterization

analysis necessary for waste disposal, excavation, removal of the tank, piping, related appurtenances, excavation support and backfill and site grading.

Measurement for Disposal/Treatment of Special Excavation shall be by the Ton. This shall include soil characterization excavation plan, excavation, temporary secured stockpile, off site treatment and/or disposal, disposal facility fees, mobilization, labor, equipment, and tipping fees.

203.19 Basis of Payment

Payment removal and disposal of the Underground Storage Tank Removal shall be by the lump sum.

Payment for off-site disposal or treatment of contaminated soils at a MeDEP licensed facility shall be by the ton of disposal/treatment of Special Excavation.

Payment for the following items shall be according to Subsection 109:03 (“Extra Work”): any necessary dewatering; and treatment or disposal of any contaminated groundwater.

<u>Pay Item</u>		<u>Pay Unit</u>
203.2310	Underground Storage Tank Removal	Lump Sum
203.2312	Disposal/Treatment of Special Excavation	Ton

SPECIAL PROVISION

SECTION 206

STRUCTURAL EXCAVATION

206.02 Construction Methods

The following paragraphs are added:

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

206.05 Basis of Payment

Payment will be made under:

<u>Pay Item</u>		<u>Pay Unit</u>
206.082	Structural Earth Excavation – Major Structure	Cubic Yard

SPECIAL PROVISIONSECTION 401HOT MIX ASPHALT PAVEMENT

Section 401 of the Maine Turnpike Authority 2016 Supplemental Specifications is modified as follows:

401.01 Description

The following paragraph is added:

A Quality Control Plan (QCP) is required.

401.02 Materials

Section 401.02 is deleted in its entirety and replaced with the following:

Aggregates for HMA Pavements Coarse Aggregate and fine aggregate for HMA pavements shall be graded such that when combined in the proper proportions, including filler if required, the resultant blend will meet the composition of mixture for the type of pavement specified. Materials shall meet the requirements specified in Section 700 – Materials:

Asphalt Cement	702.01
Aggregates for HMA Pavement	703.07
RAP for HMA Pavement	703.08
HMA Mixture Composition	703.09

Mainline Surface HMA Coarse aggregate: The material retained on the No. 4 sieve, shall consist of angular fragments obtained from crushed quarry stone and be free of dirt or other objectionable materials. Coarse aggregate shall have a Micro-Deval value of 15.0 percent or less as determined by AASHTO T 327. The crushed stone shall have a maximum of 1.5% material finer than the No. 200 mesh when tested in accordance with AASHTO T-11. Flat and elongated particles shall not exceed a maximum of 8% at a 5:1 ratio in accordance with ASTM D-4791. Coarse aggregate angularity shall be a minimum of 95/90 in accordance with AASHTO T-335.

Mainline Surface HMA Fine aggregate: The material passing the No. 4 sieve, shall be crushed manufactured sand free from dirt, clay balls, or other objectionable material. Natural sand may be incorporated into the mix at a rate no greater than 10 percent by weight of total aggregate. The unconfined void content of the fine aggregate blend shall be a 45 minimum value when tested in accordance with AASHTO T-304, method A. AASHTO T-176 sand equivalent value shall be 45 minimum.

Asphalt Low Modulus Joint Sealer: Asphalt Low Modulus Joint Sealer shall be a modified asphalt and rubber compound designed for sealing and improving the strength and performance of the base asphalt cement and shall conform to ASTM D6690 Type IV and the following specifications:

Cone Penetration	90-150
Flow @ 60°C [140°F]	3.0mm [1/8 in] max
Bond, non-immersed	Three 12.7mm [½ in] specimens pass 3 cycles @ 200% extension @ -29°C [-20°F]
Resilience, %	60 min
Asphalt Compatibility, ASTM D5329	pass*

* There shall be no failure in adhesion, formation of any oily exudate at the interface between the sealant and asphaltic concrete or other deleterious effects on the asphaltic concrete or sealant when tested at 60°C [140°F].

The contractor shall provide the Resident or authorized representative with a copy of the material manufacturer's recommendations pertaining to heating, application, and reheating prior to the beginning of operations or the changing of materials.

Section 401.03 Composition of Mixtures

Section 401.03 is deleted in its entirety and replaced with the following:

HMA pavement mixtures for base, intermediate, shim and local road bridge projects shall be a currently approved MDOT design unless otherwise noted. A maximum of 20% RAP may be used. VMA shall meet the requirements listed in Table 1.

HMA pavement mixtures for Mainline surface paving projects shall conform to the following requirements:

The Contractor shall compose the Hot Mix Asphalt Pavement with aggregate, Performance Graded Asphalt Binder (PGAB), and mineral filler if required. HMA shall be designed and tested according to AASHTO R35 and the volumetric criteria in Table 1. The Contractor shall size, uniformly grade, and combine the aggregate fractions in proportions that provide a mixture meeting the grading requirements of the Job Mix Formula (JMF). The Contractor may use a maximum of 15 percent reclaimed asphalt pavement (RAP) in any mainline surface course.

The Contractor shall submit a job mix formula (JMF) developed for each specified mixture at least 30 days prior to placement.

The JMF shall establish a single percentage of aggregate passing each sieve size within the limits shown in Subsection 703.09. The mixture shall be designed and produced, including all production tolerances, to comply with the allowable control points for the particular type of mixture as outlined in Subsection 703.09. The JMF shall state the original source, gradation, and percentage to be used of each portion of the aggregate and mineral filler if required. It shall also state the proposed PGAB content, the name and location of the refiner, the supplier, the source of PGAB submitted for approval, the type of PGAB modification if applicable, and the location of the terminal if applicable.

In addition, the Contractor shall provide the following information with the proposed JMF:

- Properly completed JMF indicating all mix properties (Gmm, VMA, VFB, etc.).
- Stockpile Gradation Summary.
- Test reports for individual aggregate consensus properties
- Design Aggregate Structure Consensus Property Summary.
- Design Aggregate Structure Trial Blend Gradation Plots (0.45 power chart).
- Trial Blend Test Results for at least three different aggregate blends.
- Selected design aggregate blend.
- Test results for the selected design aggregate blend at a minimum of three binder contents.
- Test results for final selected blend compacted to N_{max} .
- Specific Gravity for the PGAB to be used.
- Recommended mixing and compaction temperatures from the PGAB supplier.
- Data Sheets (SDS) For PGAB.
- Asphalt Content vs. Air Voids trial blend curve.
- Test report for Contractor's Verification sample.
- Summary of RAP test results (if used), including count, average and standard deviation of binder content and gradation.

At the time of JMF submittal, the Contractor shall identify and make available the stockpiles of all proposed aggregates at the plant site. There must be a minimum of 150 ton for coarse aggregate stockpiles, 75 ton for fine aggregate stockpiles before the JMF may be submitted. The Authority shall obtain samples for laboratory testing. The Contractor shall also make available to the Authority the PGAB proposed for use in the mix in enough quantity to test the properties of the asphalt and to produce samples for testing of the mixture. Before the start of paving, the Contractor and the Authority's representative shall test a production sample in the Contractor's laboratory for evaluation. If the Authority finds the mixture acceptable, an approved JMF will be forwarded to the Contractor. The Authority will then notify the Contractor that paving may commence. The first day's production shall be monitored, and the approval may be withdrawn if the mixture exhibits undesirable characteristics such as checking, shoving or displacement. The Contractor shall be allowed to submit aim changes within 24 hours of receipt of the first Acceptance test result for an individual JMF. Adjustments will be allowed of up to 2% on the percent passing the 2.36 mm sieve through the 0.075 mm and 3% on the percent passing the 4.75

mm or larger sieves. Adjustments will be allowed on the %PGAB of up to 0.2 percent. Adjustments will be allowed on GMM of up to 0.010.

Approved mix designs from the previous calendar year may be carried over, however no mix changes will be granted for a carryover mix design and the initial design must not be older than the previous paving season.

The Contractor shall submit a new JMF for approval each time a change in material source or materials properties is proposed. The same approval process shall be followed. The cold feed percentage of any aggregate except natural sand may be adjusted up to 10 percentage points from the amount listed on the JMF, however no aggregate listed on the JMF shall be eliminated. Natural sand may be adjusted up to 5 percent from the amount listed on the JMF but shall not exceed 10% by weight of total aggregates. The cold feed percentage for RAP may be reduced up to five percentage points from the amount listed on the JMF and shall not exceed the percentage of RAP approved in the JMF or for the specific application.

TABLE 1
VOLUMETRIC DESIGN CRITERIA

Design ESAL's (Millions)	Required Density (Percent of G _{mm})			Voids in the Mineral Aggregate (VMA)(Minimum Percent)				Voids Filled with Binder (VFB) (Minimum %)	Fines/Eff. Binder Ratio
				Nominal Maximum Aggregate Size (mm)					
	N _{initial}	N _{design}	N _{max}	19	12.5	9.5	4.75		
10 to <30	≤89.0	96.0	≤98.0	13.5	14.5	15.5	15.5	65-80	0.6-1.2

As part of the JMF submittal, there are Hamburg Wheel Tracker requirements, the Contractor shall provide the Authority the test results in accordance with AASHTO T324. The results shall be generated by a third-party independent testing laboratory as approved by the Authority. The test results for each individual specimen as well as the average shall meet the requirements of Table 1A

TABLE 1A
HAMBURG WHEEL TRACKER REQUIREMENTS

Specified PG Binder Grade	Test Temperature (°C)	Maximum Rut Depth (mm)	Minimum Number of Passes	Minimum Allowable SIP*
64-28	45	12.5	20,000	15,000
64E-28	45	8.0	20,000	15,000
70E-34	45	6.3	20,000	15,000

Section 401.031 Warm Mix Technology

Add the following to the end of the first paragraph:

Weather and seasonal limitations as outlined in section 401.06 may be reduced by a maximum 5°F with the use of WMA except for HMA being placed over bridge deck membrane.

Section 401.04 Temperature Requirements

No vehicular loads shall be permitted on newly completed pavement until adequate stability has been attained and the material has cooled sufficiently to prevent distortion or loss of fines. The newly paved area may be opened to traffic after the internal temperature of the pavement has cooled to 120° F. The Resident will test the internal temperature of the pavement and shall be the sole judge as to the opening to traffic. The period of time before opening to traffic may be extended at the discretion of the Resident. The lane closure may not be removed until the internal temperature has cooled to 120° F.

Section 401.06 Weather and Seasonal Limitations

The first paragraph shall be deleted and replaced with:

The Contractor may place Hot Mix Asphalt Pavement for use other than a traveled way wearing course, provided that the air temperature as determined by an approved thermometer (placed in the shade at the paving location) is 40°F or higher and the area to be paved is not frozen. The Contractor may place Hot Mix Asphalt Pavement as traveled way wearing course, provided the air temperature determined as above is 50°F or higher. For the purposes of this Section, the traveled way includes truck lanes, ramps, approach roads and auxiliary lanes. The atmospheric temperature for all courses on bridge decks shall be 50°F or higher.

Section 401.08 Hauling Equipment Trucks for Hauling HMA

Add the following paragraph:

The undercarriage of haul units actively hauling HMA to the site shall be relatively free of dust / mud agglomerations. Haul units found to be contaminating the paving surface shall be removed from the site and cleaned prior to returning.

Section 401.09 Pavers

Add the following to the end of the fourth paragraph:

The forward operating speed of the paver shall be limited based on the course being placed. A shim or leveling course shall have a maximum speed of 50 feet per minute (fpm). Any base, intermediate, or surface course shall have a maximum paver speed of 40 fpm. The limited speed is not to be calculated on an average basis over time but shall be the actual limitation at any moment during the paving operation.

Section 401.091 Material Transfer Vehicle (MTV)

The first paragraph shall be deleted and replaced with:

When required by Special Provision Section 403, the paver shall be supplied mixture by a material transfer vehicle (Roadtec SB2500 or approved equal) capable of receiving and storing bituminous mixture from haul trucks, remixing, and delivering the mix to the paver hopper in a

consistently uniform manner.

The fourth paragraph shall be deleted and replaced with:

The MTV shall be designed so that the mix receives additional mixing action.

Section 401.111 Layout

The contractor shall layout the site prior to any pavement course or final striping. Layout shall be achieved by physical measurements obtained every 50' along the length to be paved or striped. The contractor shall transfer the measurements to the pavement surface every 50' and apply a paint mark at each location. The marks shall then be connected by a smoothed string line and subsequent paint marks applied along the string at no greater than 10' intervals. The Resident will inspect the layout line before associated activities may begin.

Section 401.165 Longitudinal Joint Density

The first paragraph shall be deleted and replaced with:

When noted in Special Provision Section 403, the Authority will measure the pavement density of longitudinal joints between adjoining mainline travel lanes in both the unconfined and confined condition as determined by the days paving operation.

The eighth paragraph shall be deleted and replaced with:

The minimum density of the completed pavement shall be 92.0 percent of the theoretical maximum density obtained. Two consecutive failing tests shall result in production shut down. Prior to resuming paving operations, the contractor quality control unit shall satisfy the Authority that the paving operation will produce joint densities in compliance with the Specifications.

The eleventh paragraph and associated table shall be deleted and replaced with:

Payment reduction will be applied to each subplot that has a density lower than 92.0% as outlined below.

PERCENT COMPACTION	PERCENT PAY
92.0 or greater	100
91.9 to 90.0	95
89.9 to 88.5	90
88.4 or less	80

Section 401.17 Joints

The fourth paragraph shall be deleted and replaced with:

When required by Special Provision Section 403, Mainline Longitudinal joints shall be constructed as notched-wedge joint and constructed in a manner that will best ensure joint integrity.

Section 401.18 Quality Control

The following shall be added to section c. Quality Control Technician(s) QCT:

The QCT shall be on site during paving operations performing quality control activities. QCT's shall not act as equipment operators, trainers or laborers.

Section 401.191 Inspection/Testing

In paragraph nine delete and replace Item #8 with:

8. Secure High-Speed Internet Access

401.21 Method of Measurement

The second paragraph shall be deleted and replaced with:

A reduction in payment will occur when the voids, asphalt content, and density are other than the limits specified below for 100 percent payment. The payment reduction for voids and PGAB content and density will be based upon each subplot (500 tons) of production as specified in Subsections 401.162, 401.163, 401.164, and 401.165. The Contractor may request one retest for each failing subplot for core density only. The original core density and the recut core density shall be averaged together to determine payment for the subplot. No retest will be allowed for voids or asphalt content. The Contractor shall pay \$250.00 for each additional core tested. Pavement restoration will not be measured separately for payment but shall be incidental to the respective pay item.

SPECIAL PROVISIONSECTION 401HOT MIX ASPHALT PAVEMENTS

(HMA using Hydrated Lime)

The following sections of Section 400 have been revised with following additional requirements.

401.01 Description

The Contractor shall compose Hot Mix Asphalt (HMA) Pavement with aggregate, Performance Graded Asphalt Binder (PGAB), hydrated lime, and mineral filler if required. Hydrated Lime shall be utilized in all mixtures so denoted in Special Provision 403 - Hot Mix Asphalt Pavement.

401.02 Materials

Materials shall meet the requirements specified.

Hydrated Lime

AASHTO 216

401.03 Composition of Mixtures

The Contractor shall compose the Hot Mix Asphalt Pavement with aggregate, Performance Graded Asphalt Binder (PGAB), hydrated lime and mineral filler if required. HMA shall be designed and tested according to AASHTO R35 and the volumetric criteria in Table 1. The Contractor shall size, uniformly grade, and combine the aggregate fractions in proportions that provide a mixture meeting the grading requirements of the Job Mix Formula (JMF).

Hydrated lime shall be used in all HMA at a rate of one percent (1%) by weight of the total dry aggregate including RAP aggregate, if used. The Contractor shall obtain a shipping ticket for each shipment of hydrated lime. The Contractor shall provide the Resident with a copy of each shipping ticket from the supplier, including the date, time and weight of hydrated lime shipped and used in HMA production. The Contractor shall submit a material data sheet for the hydrated lime to the Resident for approval.

The Contractor shall provide the following information with the proposed JMF:

Safety Data Sheets (SDS) for hydrated lime

Supplier and source for Hydrated Lime

401.13 Preparation of Aggregates

The Contractor shall add water to the aggregates as required to maintain a minimum total aggregate moisture content of 3 percent. The Contractor shall mix the lime uniformly with the aggregate before introducing the aggregate into the dryer or dryer drum. Hydrated lime introduction systems must be controlled by a proportioning device to the amount required on the JMF plus or minus 0.1% of the target.

The Contractor shall add lime to the aggregate by one of the following methods:

- A. The Contractor shall add lime to the combined cold feed aggregate using an enclosed in-line cold feed mechanical pugmill mixer. The Contractor shall use a twin-shaft, continuous mixing pugmill with mixing paddles to thoroughly blend the lime with the aggregate. The Contractor shall adjust the retention time of the mixture in the pugmill so no unmixed lime is visible after the lime and aggregate exit the pugmill.
- B. The Contractor shall add lime to the combined cold feed aggregate by introducing the lime between aggregate layers as the aggregate flows from the cold feed bins. The Contractor shall thoroughly mix the lime and aggregate on the conveyor belt. The Contractor shall provide a lime introduction system so that no unmixed lime is visible before the lime and combined aggregate enter the drum.

The cold storage for hydrated lime shall be a separate bulk storage bin with a vane feeder or other approved feeder system which can be readily calibrated. The system shall provide a means for convenient sampling of the hydrated lime additive and verifying the quantity of lime dispensed. If the hydrated lime is to be introduced directly into the plant then the additive equipment shall be synchronized with the cold feed controls to operate concurrently with the cold feed operation. The system will be configured to automatically adjust the hydrated lime feed to variations in the cold aggregate feed. The hydrated lime system shall have out-of-tolerance sensing ability by weight, and have a means to indicate the out-of-tolerance condition.

401.14 Mixing

Hydrated lime shall be added into the HMA aggregate mixture prior to the aggregate blend mixing with the PGAB. Aggregate feed rate, or pugmill mixing times shall be adjusted to ensure complete blending of Hydrated Lime and aggregate before the PGAB is added.

401.18 Quality Control

The Contractor shall provide a written supplement to the project specific QCP outlining the proposed methods of adding and mixing the hydrated lime for approval by the Authority. This written summary shall also provide information describing how the Contractor will perform quality control on the addition of hydrated lime, specifically the method of introduction and how the lime use will be measured to assure that the specified percentage is consistently added, and appropriately mixed. The supplemental QCP covering hydrated lime introduction shall be provided to the Authority at least one week prior to the prepave meeting.

SPECIAL PROVISIONSECTION 403HOT MIX ASPHALT PAVEMENT403.01 Description

This work shall also consist of the construction, maintenance and removal of all temporary bituminous ramps at locations as shown on the Plans or as directed by the Resident.

403.02 General

The Contractor shall compose the Hot Mix Asphalt Pavement with aggregate, Performance Graded Asphalt Binder (PGAB), and mineral filler if required. The Performance Graded Asphalt Binder (PGAB) shall be polymer modified as detailed in this special provision and shall conform to the requirements of AASHTO M 332 (including Appendix 1). The PG64E-28 Binder shall contain a minimum of 2.25% Styrene-Butadiene-Styrene (SBS) polymer {BWT} in a homogeneous blend with a minimum average percent recovery of 75% as determined by AASHTO T350 @ 3.2 kPa (R3.2) on RTFO residue at 64°C to assure significant polymer load and performance. The stability of the modified binder shall be verified in accordance with ATSM D7173 using the Dynamic Shear Rheometer (DSR). The DSR $G^*/\sin(\delta)$ results from the top and bottom sections of the ATSM D7173 test shall not differ by more than 10%. The results of ASTM D7173 shall be included on the Certified Test Report.

When required PG70E-34 Binder shall be modified with Styrene-Butadiene-Styrene (SBS) polymer {BWT} in a homogeneous blend with a minimum average percent recovery of 75% as determined by AASHTO T350 @ 3.2 kPa (R3.2) on RTFO residue at 70°C to assure significant polymer load and performance. The stability of the modified binder shall be verified in accordance with ATSM D7173 using the Dynamic Shear Rheometer (DSR). The DSR $G^*/\sin(\delta)$ results from the top and bottom sections of the ATSM D7173 test shall not differ by more than 10%. The results of ASTM D7173 shall be included on the Certified Test Report.

403.03 Construction

All areas which have been milled or overlaid shall have a minimum length temporary ramp constructed as determined by the Resident at the milled or overlaid limits prior to opening the roadway to traffic. Temporary ramps shall be constructed using the same material as being placed on that day or as directed by the Resident. All temporary ramps are to be constructed on a sand joint. The Contractor shall be responsible for all repairs and maintenance required for the temporary ramps.

The Contractor shall be responsible for the layout of the longitudinal centerline between the travel lanes.

The sand and loose debris adjacent to the median guardrail shall be removed and disposed of by the Contractor off of Turnpike property.

The forty-five degree pavement safety edge needed between lanes 1 and 2 shall be incidental to the 202 pay items.

A minimum test strip of 100 tons placed at a nominal depth of 1 ½ inches, full lane width, shall be required. It shall be evaluated under testing requirements for mix volumetric and density. The exact location will be identified by the Authority. Prior to placement of the test strip, a leveling course (Item 403.211) shall be placed at the chosen location. A fog coat of Item 409.15, Bituminous Tack Coat, shall be applied to the level course prior to the placement of the HMA surface course, payment to be made under the 409.15 pay item. The test strip will be excluded from the remainder of the projects' QA analysis. The Contractor shall notify the Authority at least 48 hours in advance of placing the test strip. The test strip is intended to allow the Contractor to establish a method of compaction and adjust plant settings prior to mainline plant production.

403.04 Method of Measurement

The construction and removal of temporary ramps on sand joints, and maintaining the ramps will not be measured separately for payment, but shall be incidental to Items 403.

The removal of sand and loose debris will not be measured separately for payment, but shall be incidental to paving items.

Hot Mix Asphalt, 12.5 mm (Polymer Modified pavement with (up to) 15% RAP, placed as a wearing surface will be measured under Item 403.2081 Hot Mix Asphalt, 12.5 mm (Polymer Modified) - RAP.

403.05 Basis of Payment

Hot Mix Asphalt, 12.5 mm (Polymer Modified) pavement with (up to) 15% RAP, placed as a wearing surface will be paid under Item 403.2081 Hot Mix Asphalt, 12.5 mm (Polymer Modified) – RAP.

The following pay items are added:

<u>Pay Item</u>	<u>Pay Unit</u>
403.2081 Hot Mix Asphalt, 12.5 mm (Polymer Modified) – RAP	Ton

SPECIAL PROVISIONSECTION 403HOT MIX ASPHALT PAVEMENT

Course	HMA Grading	Item Number	Total Thickness	No. of Layers	Complimentary Notes
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**Turnpike I-95 Mainline &
I-295 Northbound and Southbound ORT and Cash Lanes
Full Depth Construction and Full Depth Pavement Removal**

Wearing	12.5mm	403.2081	1.5"	1	A,D,E,G,H,I,J,K
Intermediate	12.5mm	403.213	1.5"	0-1	C, I
Base	19.0mm	403.207	7"	0-3	C, I
Shim	4.75mm 19.0mm	403.212	Varies	Varies	C, I

I-295 Hot Mix Slope Paving

Wearing	9.5mm	403.209	2"	1	C
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**Exit 51 Southbound Off Ramp and Northbound Off and ON Ramps
Full Depth Construction and Full Depth Pavement Removal**

Wearing	12.5mm	403.2081	1.5"	1	A,D,E,G,H,I,J,K
Intermediate	12.5mm	403.213	1.5"	1	C, I
Base	19.0mm	403.207	3"	1	C, I

Access Road and Parking Lot

Wearing	12.5mm	403.208	2"	1	C, I
Base	12.5mm	403.213	2"	1	C, I

COMPLEMENTARY NOTES

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

- F. Joints shall be constructed as the “notched wedge” type in accordance with Subsection 401.17.
- G. Joint density will be measured in accordance with Subsection 401.165.
- H. PGAB shall conform to the provisions of 403.02 – Polymer Modified PGAB for HMA
- I. The contractor shall furnish a quality control technician equipped with an approved densometer to ensure density requirements are met.
- J. Hydrated Lime shall be incorporated into the mixture.
- K. The antistrip additive Zycotherm manufactured by Zydex Industries shall be incorporated into the PGAB at a rate of 0.1%.(or an approved equal)

SPECIAL PROVISION

SECTION 409

BITUMINOUS TACK COAT

409.01 Description

This Subsection is deleted and replaced with the following:

This work consists of furnishing and applying one uniform application of UltraTack (NTSS-1HM) by Blacklidge or an approved equal as indicated in this specification and as per manufacturers' recommendation. The application rate shall be 0.06 gal/yd²

409.05 Equipment

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

409.06 Preparation of Surface

The following paragraph is added:

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

409.08 Method of Measurement

The following paragraphs are added:

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

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

Cleaning of the surface area where tack coat is to be applied shall be incidental to Item 409.152, Bituminous Tack Coat - Applied.

409.09 Basis of Payment

The following pay items are added:

<u>Pay Item</u>		<u>Pay Unit</u>
409.152	Bituminous Tack Coat NTSS-1HM Trackless – Applied	Gallon

SPECIAL PROVISION

SECTION 419

SAWING AND SEALING JOINTS IN BITUMINOUS PAVEMENT

(Sawing Bituminous Pavement)

419.01 Description

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

419.02 General

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

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

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

419.03 Method of Measurement

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

419.04 Basis of Payment

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

Payment will be made under:

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

SPECIAL PROVISION

SECTION 470

BERM DROP OFF CORRECTION

(Berm Dropoff Correction - Grindings)
(Berm Correction)

470.01 Description

This work shall consist of furnishing and placing bituminous grindings to eliminate the berm dropoff along the inside and outside shoulder edges at all locations, including guardrail sections at locations shown on the plans or as directed by the Resident.

The work shall also consist of removing materials at the inside and outside shoulder edges at all locations, including guardrail sections at locations shown on the plans or as directed by the Resident.

470.02 Bituminous Materials

The recycled bituminous pavement shall be reprocessed (crushed) to meet the following gradations:

Sieve Designation	Percentage by Weight Passing Square Mesh Sieve
3/4"	100
1/2"	95-100
No. 4	50-80
No. 50	18-28
No. 200	3-10

470.03 Method of Construction

Work under this item shall be in accordance with the details as shown on the Plans or as directed by the Resident.

At a minimum, a walk behind plate compactor shall be used for compaction. Other methods may be used upon approval by the Resident.

470.04 Method of Measurement

Berm Dropoff Correction – Grindings will be measured by the ton of Pavement grindings delivered and installed.

Material included in the delivery slips and not used or rejected shall be deducted from the amount being measured for payment.

Berm Correction will be measured by the linear foot for material removed.

470.05 Basis of Payment

The accepted quantity of “Berm Dropoff Correction – Grindings” will be paid for at the contract unit price per ton, which price shall include all materials, crushing to gradation range, weighing, transportation, placement, labor, equipment, and all incidentals necessary to accomplish the work.

The accepted quantity of “Berm Correction” will be paid for at the contract unit price per linear foot, which price shall include removing all materials, grading, transportation, labor, equipment, and all incidentals necessary to accomplish the work.

Payment will be made under:

<u>Pay Item</u>		<u>Pay Unit</u>
470.08	Berm Dropoff Correction – Grindings	Ton
470.081	Berm Correction	LF

SPECIAL PROVISION

SECTION 502

STRUCTURAL CONCRETE

This Subsection of the Supplemental Specifications shall apply in its entirety and shall be amended with the following:

Add the following:

502.041 Testing Equipment

Slump cone.

502.175 Miscellaneous Construction of Conduits and Anchor Bolts

All conduit materials and installation procedures shall follow the requirements of Section 626.03 through 626.033 of the MaineDOT Standard Specifications. The Contractor's attention is directed to the need to carefully coordinate the placement of embedded conduits and anchor bolts throughout the structure.

Before placing concrete, the location and position of all embedded conduits, required elbows of entrance conduits, reinforcement, and anchor bolts shall be carefully positioned. The anchor bolt size and the bolt circle diameter shall be determined from data furnished by the supplier of the poles or as shown on the Plans. Anchor bolts for use with breakaway couplings, longitudinally grooved-type, shall be 1 inch diameter and shall project between 2-1/2 and 3 inches above the top of the foundation. All other anchor bolts shall be a minimum of one inch diameter and shall project sufficiently to accommodate the thickness of the base plus all nuts and washers. The bolt length shall also be sufficient to allow clearances of approximately 1/2 inch below the leveling nut and 1/4 inch above the top nut. At least two threads on each anchor bolt shall project beyond the outside of the nuts holding the plumbed pole.

When the anchor bolt template is removed, the threads of the anchor bolts shall be greased and protected with a metal sleeve, held in position with nuts and washers to be furnished with the bolts. This thread protection shall remain in place until the item to connect to the bolts is installed.

A copper-clad steel ground rod shall be installed when shown on the Plans.

502.18 Method of Measurement

The limits to be used in determining the quantities of the structural concrete items will be as follows:

1. Structural Concrete, Space Frame Pedestals & Footings. The limits will be vertically from the top of the space frame pedestal to the bottom of footing.

2. Structural Concrete, Utility Pits. The limits will be vertically from the bottom of the cash slab to the bottom of the utility pit footing.
3. Structural Concrete, ORT Slabs. The limits will be the entire ORT slab bounded transversely and longitudinally by the extreme ends.
4. Structural Concrete, Cash Slabs. The limits will be the entire cash slab bounded transversely and longitudinally by the extreme ends.
5. Structural Concrete, Plaza Island, Bumpers and Curtain Walls. The limits will be the entire concrete island including the island extension slab, outside to outside, both transversely and longitudinally and vertically, exclusive of curbing and space frame pedestals. Concrete bumpers and curtain walls placed atop the plaza islands, are included in this item. Infill concrete against the barrier curtain walls, the cast-in-place concrete stair enclosure walls at the Islands B & E and all other concrete not associated with other items.

502.19 Basis of Payment

No direct payment will be made for concrete admixtures with the exception of Synthetic Fiber Reinforcement, which shall be paid for under its respective Pay Item, 503.90.

Steel reinforcing and GFRP reinforcing will be measured and paid for separately as outlined in Section 503.

Payment will be made under:

<u>Pay Item</u>		<u>Pay Unit</u>
502.231	Structural Concrete, Space Frame Pedestals & Footings	Cubic Yard
502.232	Structural Concrete, Utility Pits	Cubic Yard
502.261	Structural Concrete, ORT Slabs	Cubic Yard
502.262	Structural Concrete, Cash Slabs	Cubic Yard
502.263	Structural Concrete, Plaza Islands, Bumpers, and Curtain Walls	Cubic Yard

SPECIAL PROVISION

SECTION 503

REINFORCING STEEL

(GFRP Reinforcing)

503.01 Description

The first paragraph is amended to read:

This work shall consist of fabrication, delivery and placing glass fiber reinforced polymer (GFRP) reinforcement in accordance with these Specifications and in conformance with the Plans, Supplemental Specifications and Special Provisions.

This work shall also consist of furnishing synthetic fiber reinforcement to be used as temperature and shrinkage reinforcement in the structural concrete cash slabs and ORT slabs.

503.02 Materials

The following paragraphs are added:

Materials shall meet the following requirements:

All GFRP reinforcement shall conform to the requirements shown in AASHTO Bridge Design Guide Specifications for GFRP - Reinforced Concrete Bridge Decks and Traffic Railings (November 2009), except as shown on the Plans, and as stated herein. All GFRP reinforcement bar shall be sand coated or both deformed and sand coated. Deforming methods shall be performed during the fabrication process. GFRP reinforcement shall not be deformed in the field.

GFRP bars shall be from one of the following approved manufacturers or approved equal:

1. Aslan 100 by Hughes Brothers Inc.
2. V-Rod by Pultrall Inc.
3. ComBAR by Schoeck Bauteile.
4. Mateen-Bar by Sigma Development Group, LLC.

All GFRP bars in the same structural component shall be supplied by the same manufacturer.

Synthetic fibers shall be STRUX 90/40 as manufactured by W. R. Grace & Co. or an approved equal.

Documentation

For all GFRP reinforcement bar used on Authority projects, the bar manufacturer shall furnish the Resident with one hardcopy and one electronic copy of written certifications that the GFRP reinforcement meets the requirements of this specification. In addition, the certification shall list the test values and test procedures used to determine the physical properties of the GFRP reinforcement. Certifications bearing the notarized signature of a responsible authorized representative of the bar manufacturer are required. Each bundle of GFRP reinforcement shall be identified with a co responding lot number with the lot numbers affixed to each bundle by means of a durable tag.

Repair Material

The material used to repair the cut ends of GFRP reinforcement shall comply with the requirements established by the bar manufacturer.

The following Subsection shall be added:

503.03 Dosage

The dosage rate for synthetic fibers shall be five lbs per cubic yard of concrete.

503.04 Protection of Material

The following paragraphs are added:

Delivery, storage and handling of GFRP reinforcing bars shall be in accordance with these Specifications. Prevent bending, coating with earth, oil, or other material, or otherwise damaging the reinforcement. When handling reinforcement, use equipment to avoid damaging or abrading the bar. Do not drop or drag reinforcement.

GFRP reinforcement shall be stored on skids or other supports a minimum of 12 inches above the ground surface and protected at all times from damage and surface contamination. The storage supports shall be constructed of wood, or other material that will not damage the surface of the reinforcement. Bundles of bars shall be stored on supports in a single layer. Each bundle shall be placed on the supports out of contact with adjacent bundles. Reinforcing bars expected to be stored outdoors for a period in excess of two months, shall be protected from ultraviolet radiation. Prevent exposure of reinforcing to temperatures above 120 degrees Fahrenheit during storage.

All handling of reinforcing bars by mechanical means shall be done by equipment having padded contact areas, or by the use of nylon webbing slings. The use of chains or wire rope slings shall not be allowed, even when used with padding. All bundles of bars shall be lifted with a strong back, spreader bar, multiple supports or a platform bridge to prevent bar-to- bar abrasion from sags in the bundles. Support points during lifting or transporting of bundled reinforcing bars shall be spaced at a maximum of 15 feet, or as required by the manufacturer, whichever is more restrictive.

Bundled bars shall be strapped together with non-metallic or padded straps in a manner to prevent bar-to-bar abrasion due to relative movement between bars.

Bars loaded for transport shall be loaded and strapped down in a manner that will prevent damage from motion and vibration, to the greatest extent possible. Bundles of bent bars shall be transported strapped to wooden platforms or shall be crated. All individual bundles and layers of bundles shall be separated, and supported by dunnage.

Individual bars shall be handled in a manner that prevents damage due to abrasion or impact, and at no time shall any bar be moved by dragging over any surface, including other reinforcing bars. Sufficient personnel shall be assigned to assure compliance with the above.

For GFRP bars the maximum total visible damage permitted on each linear foot shall not exceed two percent of the surface area in that linear foot of bar. The depth of the permissible damage shall not exceed 0.04 inches.

503.06 Placing and Fastening

The following paragraphs are added:

All reinforcement shall be accurately placed in the positions shown on the Plans and shall be firmly held there during the placing and setting of the concrete. Immediately before placing concrete the reinforcement shall be free from all foreign material which could decrease the bond between the reinforcing and concrete. Such foreign material shall include, but not be limited to: dirt, paint, oil, bitumen and dried concrete mortar.

Reinforcing bars within the formwork shall be secured to prevent movement during concrete placement. The bars must be adequately supported or tied to resist settlement, floating upward, or movement in any direction during concrete placement.

Field bending of GFRP shall not be allowed.

Field cutting of GFRP will be permitted only with the approval of the Resident. The field cutting shall be with a high speed cutter, fine blade saw, diamond blade or masonry saw. The GFRP bars shall not be shear cut.

Proper distances from the forms shall be maintained by means of stays, blocks, ties, hangers or other approved means. Blocks used for this purpose shall be precast Portland cement mortar blocks of approved shape and dimensions. Chairs may be used for this purpose and, when used, must be GFRP or plastic. The use of pebbles, pieces of broken stone or brick, metal pipe or wooden blocks shall not be permitted. The placing of reinforcement as concrete placement progresses, without definite and secure means of holding the bar in its correct position, shall not be permitted. Reinforcing bars used as support bars and spreader bars shall be the same type used for the main reinforcing.

Bars shall be fastened together at all intersections except where spacing is less than one foot in either direction, in which case, fastening at alternate intersections of each bar with other bars will be permitted providing this will hold all the bars securely in position. This fastening may be plastic or nylon ties only.

Minimum embedment lengths of reinforcing bars shall comply with the manufacturers published recommendations for the anchoring material selected. These embedment lengths shall be verified by the Resident before installation of the reinforcing bars. The reinforcing bar lengths indicated on the Plans may be reduced, at the Contractor's option, to the determined minimum embedment lengths.

Reinforcement shall be inspected and approved by the Resident before any concrete is placed.

503.07 Splicing

The following sentence is added:

Lap splice length for GFRP bars shall be as per manufacture's recommendation.

503.10 Method of Measurement

The first sentence of the first paragraph is amended as follows:

GFRP reinforcing bars shall be measured by the computed number of linear feet of reinforcement authorized.

Synthetic fiber reinforcement will be measured by the pound.

503.11 Basis of Payment

The following is added:

<u>Pay Item</u>	<u>Pay Unit</u>
503.181 Glass Fiber Reinforced Polymer (GFRP) Reinforcing Bars (#5), Fabricated and Delivered	Linear Foot
503.182 Glass Fiber Reinforced Polymer (GFRP) Reinforcing Bars (#12), Fabricated and Delivered	Linear Foot
503.191 Glass Fiber Reinforced Polymer (GFRP) Reinforcing Bars (#5), Placing	Linear Foot
503.192 Glass Fiber Reinforced Polymer (GFRP) Reinforcing Bars (#12), Placing	Linear Foot

The accepted quantity of GFRP reinforcing will be paid for at the Contract unit price per pound for each item involved, completed, and accepted.

SPECIAL PROVISION

SECTION 504

STRUCTURAL STEEL

504.03 Drawings

This Subsection is amended by the addition of the following:

When structural steel erection is to take place over travel ways, the Contractor shall submit a structural steel erection plan stamped by a Professional Engineer licensed in the State of Maine. The erection plan shall include the number and location of crane(s), the weight of the pick, crane capacities, bracing locations and all other pertinent information needed to demonstrate the structural steel can be safely erected and assembled.

504.51 Installation

This Subsection is amended by the addition of the following:

Where an outer face of the bolted parts has a slope of more than one to 20 with respect to a plane normal to the bolt axis, a smooth beveled washer will be used to compensate for the lack of parallelism.

504.641 Method of Measurement

There will be no additional payment for the required erection plan. The cost shall be incidental to the Structural Steel Erection pay item.

SPECIAL PROVISION

SECTION 504

STRUCTURAL STEEL

(Toll Plaza Canopies)

504.01 Description

This work shall consist of the furnishing and installing materials and components to construct new toll plaza canopies, as well as all other related electrical and communication facilities and drainage facilities needed for the new toll plaza that will be attached to the canopies as described in the Plan drawings and herein as required for the installation of new canopies at Interchange 103. Shop paint coating of steel and any field touch-up shall be incidental to this work.

504.02 Materials

This section is amended by the addition of the following:

Steel Supports 720.03

Anchor Bolts 720.07

All steel components shall be hot dip galvanized after fabrication.

Aluminum roof facias shall have a milled finish.

504.03 Drawings

This subsection is amended by the addition of the following:

Approval for deviations from the contract drawings and/or specifications shall be requested in writing and shall be approved by the Fabrication Engineer before being incorporated in the manufacturer's drawings. Requests for substitution of all specified material shall be submitted in writing, with full documentation (specifications, mill certification, etc.) enabling the Turnpike to evaluate the proposal.

Subsections 504.14 through 504.15 are deleted in their entirety and are not replaced.

504.16 Fabrication

The first sentence of the first paragraph of this section is deleted and replaced with the following:

Fabrication shall be in accordance with the AWS D1.1 *Structural Welding Code* (the D1.1 Code), as modified herein, and these Specifications.

504.17 Nondestructive Examination

All references to the "D1.5 Code" in this section are deleted and replaced with the "D1.1".

Magnetic particle testing of welds for members with a thickness of less than 5/16" will be acceptable.

504.26 Camber and Curvature

All references to the "D1.5 Code" in this section are deleted and replaced with the "D1.1".

Subsections 504.28 through 504.29 are deleted in their entirety and are not replaced.

The following subsection is added:

504.28 Welding

All welding shall be completed in accordance with the D1.1 Code.

The following subsection is added:

504.29 Inspection of Welds

Weld inspection shall be completed in accordance with the D1.1 Code and these requirements.

Unless otherwise specified, all welds shall be inspected in accordance with Subsection 504.64.

The Contractor shall have the fabricator make his own inspection to maintain quality control. Such inspection shall comply with the D1.1 Code and shall be completed by AWS certified welding inspectors in accordance with the appropriate subsections thereof. All welds shall meet the "quality of welds" requirements specified in the sections on "Design of New Bridges" and "Tubular Structures" of the structural welding code.

All welds not meeting these quality requirements shall be repaired and/or replaced by the Contractor to meet these requirements and check tests, without additional cost to the Authority. The procedures, techniques, standards of acceptance, and methods of repair shall be in accordance with the requirements of AWS D1.1

- A. All testing of welds, as herein required, shall be certified by a qualified laboratory engaged by the Contractor and approved by the Resident. The Contractor shall forward the certifications to the Resident and shall pay for all costs of weld inspection and certification as herein specified.
- B. The Authority reserves the right to inspect by nondestructive testing techniques all welds and adjacent base metal as he deems warranted. All such additional testing shall be paid for by the Turnpike and at no cost to the Contractor.

Subsection 504.31 is deleted in its entirety and is not replaced.

504.32 Tolerances

This subsection is deleted and replaced with the following:

Before erection, the assembled structural steel shall not exhibit a sweep in excess of 0.2 percent of the nominal height or length, as measured with the element in a horizontal position.

Elements that do not conform to the sweep requirements shall be corrected with a method approved by the Engineer.

The following subsection is added:

504.401 General Construction requirements

The erection of steel structures shall be in accordance with the following:

- A. The erection of toll plaza canopies shall be in accordance with the erection procedure as described on the Plans, as approved by the Resident, and as specified herein. Attention is directed to the maintenance and protection of traffic during work adjacent to or over active roadways. The Contractor is advised that any work on the erection of the toll plaza canopies, or other work that might endanger traffic on active lanes, shall not be commenced until the proper lane closures have been made, or traffic slowdowns have been instituted, in accordance with the requirements of the Contract Documents.
- B. Under no circumstances shall the toll plaza canopies be erected before the expiration of the curing period of all supporting concrete.

504.53 Construction Requirements

The work in this item generally includes, but is not limited to construction of the following:

- A. Canopy: The contractor shall install new canopies over NB and SB entry lanes as shown in the plan drawings and described within these specifications. The canopy installation shall include shop painted structural steel, EPDM roofing system, canopy and toll booth pit drains from the canopy to the roadway drainage system as shown on the plans, heat trace and all electrical and toll systems mounted to or routed through the canopy, installation of canopy sign supports, coordination with the installation of canopy signs and

luminaires and all other attachments, and all material, labor, equipment, and incidentals required to complete the work.

504.65 Method of Measurement

Toll Plaza Canopies, shall be measured as one lump sum, fabricated, delivered, erected and accepted.

Electrical and communication items associated with the toll system will be paid for under their respective pay items.

504.66 Basis of Payment

Payment shall include all labor, material, equipment, and incidentals required to complete the canopy installations in accordance with the plans and these specifications.

Shop paint coating of steel and any field touch-up shall be incidental to this item.

All canopy drains and toll booth utility pit drains as shown on the plans, including material, labor and equipment, shall be incidental to this item.

Payment will be made under:

<u>Pay Item</u>		<u>Pay Unit</u>
504.50	Toll Plaza Canopies	Lump Sum

SPECIAL PROVISION

SECTION 504

STRUCTURAL STEEL

(Space Frame Canopies, Fabricated and Delivered)
(Space Frame Canopies, Erection)
(Steel Post Support Systems)

504.01 Description

The following paragraphs are added:

This work shall also consist of designing, fabricating, and erecting space frame canopies in accordance with the Plans, these Specifications, and as directed by the Engineer. The Contractor shall have the option to fabricate space frame canopies from galvanized steel or aluminum.

This work shall also consist of fabricating and erecting steel support post systems to support the space frame canopies in accordance with the Plans, these Specifications, and as directed by the Engineer. The steel support post systems shall be fabricated from galvanized steel.

The space frames shall be designed, fabricated and manufactured by one of the following companies, or an approved equal:

- Delta Structures, Inc., 811 Eagle Drive, Bensenville, IL 60106
- Novum Structures, LLC, W126 N8585 Westbrook Crossing, Menomonee Falls, WI 53051
- Gossamer Space Frames, 5622 Research Drive, Ste. B, Huntington Beach, CA 92649

Design of the space frame canopies and steel post support systems shall be in accordance with the Plans, these Specifications, and the AASHTO LRFD Specifications for Structural Supports for Highway Signs, Luminaries, and Traffic Signals, 1st Edition.

Fabrication of space frame canopies and steel post support systems shall be completed in accordance with Standard Specification Subsections 504.14 through 504.39 with modifications included in this Specification.

Erection of space frame canopies and steel post support systems shall be completed in accordance with Standard Specification Subsections 504.40 through 504.56.

504.02 Materials

The following paragraphs are added:

The space frame canopies and steel post support systems shall be fabricated from the following:

- Structural steel plates and shapes shall be ASTM A572, Grade 50 and shall meet the requirements of AWS D1.1, Section 4, Part D for CVN testing.
- Aluminum extrusions shall conform to 6061-T6.

Pipes for use in the space frame canopy shall conform to one of the following:

- ASTM A500, Grade B ($F_y = 46$ ksi) (minimum)
- 6061-T6 Aluminum

Anchor rods shall conform to ASTM F1554, Grade 105.

Nuts, washers, and anchor rods shall be hot dip galvanized. Bolts and anchor rods shall be furnished with double nuts and washers. Threaded length shall be in accordance with the details shown.

Galvanized components, including fasteners, used in the space frame canopies and support post systems that are in contact with aluminum elements shall be stainless steel; or provisions shall be made to isolate galvanized components from direct contact with aluminum parts using stainless steel sheet metal separators or Teflon pads.

Materials not specifically covered in the Plans and Specifications shall be in accordance with the AASHTO LRFD Specifications for Structural Supports for Highway Signs, Luminaries, and Traffic Signals, 1st Edition, and shall be subject to approval by the Engineer.

504.03 Drawings

The first sentence of the first paragraph is deleted and replaced with the following:

The Contractor shall submit design computations, fabrication drawings, erection plans and other necessary working drawings in accordance with Subsection 105.7, Working Drawings.

All Submittals under this Item shall be signed and stamped by a Professional Engineer registered in Maine.

504.06 Inspection

The second paragraph is deleted and replaced with the following:

Quality Control and all testing of welds shall be certified by a qualified laboratory engaged by the Contractor and approved by the Engineer. The Contractor shall forward the certifications to the Engineer and shall pay for all costs of weld inspection and certification as herein specified.

The Engineer reserves the right to inspect, by nondestructive testing techniques, all welds and adjacent base metal as deemed warranted. All such additional testing shall be paid for by the Authority.

504.142 Design

This Subsection is added:

Design, detail, and load requirements shall conform to the AASHTO LRFD Specifications for Structural Supports for Highway Signs, Luminaries, and Traffic Signals, 1st Edition, and shall be subject to approval by the Engineer.

504.143 Fabrication

This Subsection is added:

Fabrication shall be in accordance with *ANSI/AASHTO/AWS D1.1 Structural Welding Code* (the D1.1 Code) as modified herein, and these Specifications.

Ends of sections shall be cut true and smooth, free from burrs and ragged breaks. Open ends of tubular sections shall be capped. Drain holes shall be provided where required and as noted on the Plans.

End connections for the space frame canopy chords to the nodal points shall be bolted. No welding shall be used for the field assembly of the space frame canopy. Crimped end connections for tubular members shall not be used in the space frame canopy structure.

Material shall be handled in a manner that prevents nicks, gouges or other damage from chains, wire ropes or other handling devices during all phases of construction.

All surfaces of the completed steel support post system shall be finished with a galvanized coating. The support post system components shall be fabricated in complete units as shown on the Plans, so as to provide for ease of handling in pickling and galvanizing tanks so that galvanizing may be done on the fabricated section. Any repair of zinc coatings damaged by handling and erection shall be kept to a minimum. Damaged galvanized coatings shall be repaired in accordance with ASTM A780.

Aluminum material 1/2-inch-thick or less may be cut by shearing, sawing, or milling. Material over 1/2 inch thick shall be sawed or milled. Cut edges shall be true and smooth and free from excessive burrs or ragged breaks. Reentrant cuts shall be filleted by drilling prior to cutting. Flame cutting will not be permitted. No welding of aluminum shall be permitted.

504.28 Welded Fabrication

The following paragraphs are added:

All welding shall be done in the shop by the inert gas shielded arc method. The procedures, techniques, standards of acceptance, inspection, and methods of repair for all welded joints shall be in accordance with AWS D1.1. Any defects detected shall be corrected by removing and replacing the entire weld.

All welds shall meet the "quality of welds" requirements specified in the sections on "Design of New Bridges" and "Tubular Structures" of the structural welding code. All welds not

meeting these quality requirements shall be repaired and/or replaced by the Contractor to meet these requirements and check tests, without additional cost to the Authority.

Welds shall be tested using the magnetic particle inspection procedure in accordance as follows:

100 percent of the welds securing the support post columns to their base plates.

No less than 25 percent of all other welds within the completed structure.

Transverse butt welds shall be tested throughout their entire length using radiographic inspection procedures. Longitudinal seam welds shall be tested throughout their entire length using ultrasonic inspection procedures.

504.41 Methods and Equipment

This Subsection is deleted and replaced with the following:

The erection of space frame canopies shall be in accordance with the space frame canopy Manufacturer's recommendations, as approved by the Engineer, and with these Specifications. A manufacturer's representative of the space frame canopy shall be onsite to supervise the assembly and erection of the space frame canopy.

After the support posts for the canopy have been placed over the anchor bolts onto the leveling nuts, the nuts shall be adjusted until the support posts are truly vertical. The upper nuts shall then be tightened and the space between the concrete base and the underside of the base plate shall be completely filled with non-shrink grout. Following placement of the grout, exposed surfaces of the grout and concrete shall be kept moist for at least 72-hours by means of wet burlap or fabric mats.

Under no circumstances shall the space frame canopy be erected before the expiration of the curing period for the grouted portion of all pedestals.

Attention is directed to Special Provision Section 652 regarding maintenance and protection of traffic during work adjacent to, or over active roadways. Work adjacent to, or over active roadways will not be permitted unless appropriate traffic control measures are in place and have been approved by the Resident.

504.65 Method of Measurement

The following is added:

Fabrication and delivery of accepted space frame canopies will be measured as one lump sum.

Erection of space frame canopies will be measured as one lump sum.

The steel post support systems will be measured as one lump sum, satisfactorily fabricated, delivered and erected.

Any temporary false work or support systems required for the erection process will not be measured for payment separately, but shall be considered incidental to the related Contract items.

504.66 Basis of Payment

This Subsection is deleted and replaced with the following:

Space frame canopies and steel post support systems will be paid for at the Contract Lump Sum price for the respective pay items. Payment will be full compensation for all materials, fabrication, inspection, testing, installation, false work, equipment, labor, and incidentals necessary to fabricate, deliver, and erecting space frame canopies and support systems.

Payment will be made under:

<u>Pay Item</u>		<u>Pay Unit</u>
504.80	Space Frame Canopies, Fabrication and Delivered	Lump Sum
504.81	Space Frame Canopies, Erection	Lump Sum
504.90	Steel Post Support Systems	Lump Sum

SPECIAL PROVISION

SECTION 504

STRUCTURAL STEEL

(Mounting Bracket Assemblies)

504.01 Description

The following paragraphs are added:

This work shall consist of fabricating and erecting Mounting Bracket Assemblies for the support of overhead signs as shown on the Plans and ORT equipment to be furnished and mounted by others in accordance with the Plans and as directed by the Engineer.

Fabrication and Erection of the Mounting Bracket Assemblies shall be completed in accordance with Subsections 504.01 through 504.13 and with Subsections 504.57 through 504.64.

504.02 Materials

The following paragraphs are added:

The Mounting Bracket Assemblies shall be constructed of hot dip galvanized Unistrut Brand materials, manufactured by Unistrut Corporation, or an approved equal.

Nuts, washers, and all miscellaneous hardware, unless otherwise noted, shall be stainless steel conforming to ASTM A276. All bolts shall be furnished with nuts and lock washers.

Any components of the Mounting Bracket Assemblies that are in contact with aluminum elements shall be stainless steel; or provisions shall be made to isolate galvanized components from direct contact with aluminum parts using stainless steel sheet metal separators or Teflon pads.

Materials not specifically covered in the Plans and Specifications shall be in accordance with the AASHTO Standard Specifications for Structural Supports for Highway Signs, Luminaries, and Traffic Signals, 5th edition, with 2010 and 2011 Interims, and shall be subject to approval by the Engineer.

504.03 Drawings

The first sentence of the first paragraph is deleted and replaced with the following:

The Contractor shall submit design computations, fabrication drawings, erection plans, and other necessary working drawings in accordance with Subsection 105.07, Working Drawings.

All Submittals under this Item shall be signed and stamped by a Professional Engineer registered in Maine.

504.141 Fabrication

The following Subsection is added:

Ends of sections shall be cut true and smooth, free from burrs and ragged breaks. Material shall be handled in a manner that prevents nicks, gouges or other damage from chains, wire ropes or other handling devices during all phases of fabrication.

All connections between the mounting bracket assemblies and the supporting space frame shall be bolted. No welding will be permitted for field assembly or erection of the mounting bracket assemblies.

All surfaces of the completed mounting bracket assemblies shall be hot dip galvanized. Any repair of zinc coatings damaged by handling and erection shall be kept to a minimum. Damaged galvanized coatings shall be repaired in accordance with ASTM A780.

504.41 Methods and Equipment

This Subsection is deleted and replaced with the following:

The erection of the mounting bracket assemblies shall be in accordance with the Plans, as approved by the Engineer, and with these Specifications.

Attention is directed to Special Provision Section 652 regarding maintenance and protection of traffic during work adjacent to, or over active roadways. Work adjacent to, or over active roadways will not be permitted unless appropriate traffic control measures are in place and have been approved by the Resident.

504.65 Method of Measurement

This Subsection is deleted and replaced with the following:

The specified quantity of Mounting Bracket Assemblies will be measured as one lump sum, satisfactorily fabricated, installed, and accepted by the Resident.

504.66 Basis of Payment

This Subsection is deleted and replaced with the following:

Mounting Bracket Assemblies will be paid for at the Contract Lump Sum price for the respective pay items. Payment will be full compensation for all materials, fabrication, installation, equipment, labor, and incidentals necessary for furnishing and erecting the Mounting Bracket Assemblies.

Payment will be made under:

<u>Pay Item</u>		<u>Pay Unit</u>
504.91	Mounting Bracket Assemblies	Lump Sum

SPECIAL PROVISIONSECTION 504STRUCTURAL STEEL

(Metal Stairs)

504.01 Description

This work shall consist of furnishing and installing industrial-type metal stairs and railings in accordance with these Specifications and in conformity with the locations and dimensions shown on the Plans. The stairs shall consist of steel stringers and framing; steel pans for concrete in-fill stair treads, platforms, and landings; steel risers; and steel tube handrails attached to the concrete walls adjacent to the metal stairs. Concrete surfaces of treads, platforms and landings shall have a broom finish. Metal stairs are located at cash toll booth islands B & E.

504.02 Materials

The following information is added:

- Steel Pipe: ASTM A53, Standard Weight, zinc coated.
- Sheet Steel: ASTM A1008.
- Structural Steel: ASTM A36.
- Steel Floor Plate: ASTM 786.
- Steel Decking: Form from zinc coated steel conforming to ASTM A446, with properties conforming to AISI Specification for the Design of Cold-Formed Steel Structural Members.
- Steel Plate: ASTM A1011.

Concrete for stair tread in-fill shall conform to Section 502 and shall be Class AAA.

504.03 Drawings

The following paragraphs are added:

The Contractor's stair manufacturer shall submit shop drawings of the metal stair elements which shall illustrate individual element dimensions, layout, and installation procedures as necessary for the Contractor to construction the stairs in accordance with the phased construction denoted in the contract Plans. The shop drawings will be reviewed by the engineer of record and approval will be established in accordance with Section 105.7 of these Specifications. Approval of the shop drawings shall be completed prior to fabricating any stair segments.

All Submittals under this Item shall be signed and stamped by a Professional Engineer registered in Maine.

504.031 Design

The following Subsection is added:

- Design stairs to support a live load of 100 pounds per square foot.
- Concentrated Load: 300 lbf applied on an area of 4 sq. in.
- Uniform and concentrated loads need not be assumed to act concurrently.
- Structural design, fabrication, and assembly in accordance with requirements of NAAMM Metal Stairs Manual, except as otherwise specified or shown.
- Design pipe railings in accordance with NAAMM Pipe Railing Manual for 200 pounds in any direction at any point.

504.571 Fabrication of Stairs and Railings

The following Subsection is added:

Fasteners:

- Conceal bolts and screws wherever possible.
- Use countersunk heads on exposed bolts and screws with ends of bolts and screws dressed flush after nuts are set.

Welding:

- Structural steel, AWS D1.1 and sheet steel, AWS D1.3.
- Where possible, locate welds on unexposed side.
- Grind exposed welds smooth and true to contour of welded member.
- Remove welding splatter. Remove sharp edges and burrs.

Fit stringers to head channel and close ends with steel plates welded in place where shown.

Painting: Prepare surface and apply paint coating system as specified for metals in Section 506, Coatings. Paint coating system shall comprise a zinc primer with a polyurethane top coat. The top coat shall be a glossy finish and a color chosen by the Authority from the manufacturer's standard color pallet.

Railings: Fabricate railings, including handrails, from steel pipe with flush connections.

- Connections may be standard fittings designed for welding, or coped or mitered pipe with full welds.
- Return ends of handrail to wall and close free end.
- Provide standard terminal castings where fastened to newel.
- Space intermediate posts not over six feet on center between end post or newel post.
- Provide standard terminal fittings at ends of post and rails.

Stairs:

- Provide treads, platforms, railings, stringers, and other supporting members.
- Treads and platforms:
- Support tread and platforms with angles welded to plate.
- Do not leave exposed fasteners on top of treads or platform surfaces.
- Provide flat sheet steel risers for stairs.
- Provide toe plates around the perimeter of platforms.

Stair Installation:

- Provide hangers and struts required to support the loads imposed.
- Perform job site welding and bolting as specified for shop fabrication.
- Set stairs and other members in position and secure to structure as shown.
- Install stairs plumb, level and true to line.
- Provide steel closure plate to fill any gap between the stringer and surrounding wall.
- Weld and finish with prime and paint finish of adjoining steel.

Railing Installation:

- Install standard terminal fittings at ends of posts and rails.
- Secure brackets, posts, and rails to steel by welds, and to masonry or concrete with expansion sleeves and bolts, except secure posts at concrete by setting in sleeves filled with commercial non-shrink grout.
- Set rails horizontal or parallel to rake of stairs to within 1/8-inch in 12 feet.
- Set posts plumb and aligned to within 3 mm in 1/8-inch in 12 feet.

Field Painting (touch-up):

- When installation is complete, clean field welds, connections, and surrounding areas to bright metal, and coat with same primer paint used for shop priming.
- Touch-up abraded areas with same primer paint used for shop priming.
- Complete painting with touch-up polyurethane coat.

504.65 Method of Measurement

The following paragraph is added:

The Metal Stairs will be measured for payment as one lump sum unit, complete, and accepted.

504.66 Basis of Payment

The following paragraphs are added:

The accepted quantity of Metal Stairs will be paid for at the contract lump sum price, which shall include all labor and materials required for the fabrication, delivery, and installation of the stair segments. Shop drawing submittals shall be incidental to the Metal Stairs pay item.

Payment will be made under:

<u>Pay Item</u>		<u>Pay Unit</u>
504.96	Metal Stairs	Lump Sum

SPECIAL PROVISION

SECTION 506

SHOP COATING APPLICATION

506.01 Description

This Specification covers the shop cleaning and painting of the new Toll Plaza Structure Canopy Support Columns (HSS 8x8 - 12 total) and the new Canopy Structural Members (HSS 12x8 - 6 total) including all connection components (plates, blocks, etc.).

The work shall consist of furnishing all supervisory personnel, competent person(s), labor, tools, equipment, Quality Control activities, materials, and incidentals necessary for satisfactory completion of the work. This work will be considered incidental to Pay Item 504.50 Toll Plaza Canopies. Any field touch-up shall also be included.

506.02 Materials

Materials shall comply with the requirements of the respective Subsections of this Specification.

506.03 Submittals

The Contractor shall submit for review by the Authority a materials list and other such details as described within the Plans and the respective Subsections of this Specification.

506.05 Quality Control

For the purpose of this Specification, the following definitions shall apply:

Quality Assurance Inspector (Q.A.I.): The Authority's authorized representative for shop inspection.

Quality Control Inspector (Q.C.I.): The Contractor's authorized representative for shop surface preparation and application.

Quality Control (Q.C.) is the responsibility of the Contractor. The Q.C.I. shall inspect all aspects of the work and shall supervise required testing. The Q.C.I. shall record measurements and test results in a Job Control Record (JCR). The Q.C.I. shall reject materials and workmanship that do not meet Contract requirements. The results of all testing shall be documented and a copy made available to the Q.A.I. on a daily basis or as requested by the Resident or Q.A.I.

The JCR shall include the following, as applicable:

- Surface Preparation Cleanliness and Anchor Profile – before application of the first or primer coat.
- Environmental Conditions – Ambient temperature, surface temperature, relative humidity, and dew point.

- Dry Film Thickness (DFT) – After the coating has cured and before the application of any subsequent coating.
- Type of testing equipment, model, serial number, and calibration data, if applicable.
- Type of application equipment.
- Coating batch and/or lot number, date of manufacture, and shelf life.
- Manufacturer’s certification of conformance.
- Name(s) of applicator(s).
- Cure data, cure times, temperature, and relative humidity.
- Final inspection by the Q.C.I. and acceptance by the Resident or Q.A.I.

Quality Assurance (Q.A.) is the prerogative of the Authority. The Q.A.I. will ensure that the Q.C. is being performed properly, verify documentation, periodically inspect workmanship and witness testing. Q.A. testing deemed necessary by the Resident in addition to the minimum test requirements shall be scheduled to minimize interference with the production schedule.

Quality Assurance Inspector’s Authority

The Q.A.I. will have the authority to reject material or workmanship that does not meet the Contract requirements. The acceptance of material or workmanship by the Q.A.I. will not preclude subsequent rejection, if materials or workmanship is found unacceptable, by other authorized representatives of the Authority.

Rejections

Rejected material or workmanship, as described above, shall be corrected or replaced by the Contractor at no additional cost to the Authority.

506.08 Contractor Qualification

Shop applied coating systems shall be applied in facilities holding a current AISC Sophisticated Paint Endorsement (SPE) or has been qualified in accordance with SSPC QP3-Standard Procedure for Evaluating Qualifications of Shop Painting Applicators.

All Contractor and Subcontractor SSPC certifications specified above shall be current and in-place prior to bid opening. The Contractor shall ensure that all required SSPC certifications are kept current throughout the duration of the Contract until final acceptance of the work. A copy of valid current certifications shall be transmitted with the Bid Package.

COATING SYSTEM

506.11 Materials

This Subsection is deleted and replaced with the following:

The following coating system shall be used. Alternately, an equivalent system may be proposed and used by the Contractor, subject to approval by the Authority:

Manufacturer:	The Sherwin Williams Company
Primer:	Corothane I Galvapak 1K zinc-rich primer
Intermediate:	Corothane I Ironox B moisture-cure urethane
Finish:	Corothane I HS moisture-cure urethane

All three coats of the paint system shall be contrasting colors as follows:

Primer:	Default by the manufacturer
Intermediate:	As approved by the Resident
Finish:	“Toll Booth Dark Blue”: Color formula to be provided by the Resident

The Contractor shall provide a dried sample of the specified finish color to the Authority for approval prior to the batching of the finish coat. Sample size, shape, and material shall be agreed upon with the Resident prior to submission.

The Contractor shall provide the paint batch description, lot number, date of manufacture, shelf life, and the manufacturer’s published storage requirements to the Resident. The Contractor shall provide the manufacturer’s product data sheet for each coating. The product data sheets shall include the manufacturer’s recommended requirements for the equipment, surface cleanliness, mixing, thinning, application, environmental conditions, touch-up/repair procedures, and cure times for the entire range of allowable environmental conditions. All product data sheets and MSDS shall be submitted to the Resident for approval prior to initiating any coating work.

The product data sheets shall also provide the minimum and maximum recoat times for the primer and intermediate coat over the expected range of temperatures, relative humidity, and range of acceptable dry film thicknesses. The manufacturer’s product data sheets at the time of submission shall be those used during the duration of the Project. Newly published product data sheets may be substituted as approved by the Resident.

506.12 Limits of Work

This Subsection is deleted and replaced with the following:

The new canopy support columns (HSS 8x8 - 12 total) which includes all surfaces with the approved 3-coat system. The new canopy structural members (HSS 12x8 - 6 total) which includes all surface areas with one coat of the approved zinc-rich primer. The new connection components between the support columns and structural members (plates, blocks, etc.) with one coat of the approved zinc-rich primer.

The faying surfaces of bolted connections shall be painted with one coat of the zinc-rich primer meeting the AASHTO/RCSC requirements for Class B slip-critical connections. This coat shall not exceed the maximum thickness nor fail to meet the minimum cure time specified on the manufacturer’s product data sheet. Both surfaces of bolted connections shall be masked off within

two inches of bolt holes after application and curing of the primer for subsequent coating application. Areas required to be field painted after welding and bolting is complete shall meet the application requirements of Subsection 506.36 Coating Repairs and Touch-up.

506.13 Surface Preparation

This Subsection is deleted and replaced with the following:

Prior to abrasive blast cleaning, all corners and edges of members and plates, whether rolled cut or sheared, exposed in the assembled product shall be rounded to approximately an 1/8-inch radius. A series of tangents to the approximate radius will be considered as a rounded. The Contractor shall prepare a plate approximately 2-inch x 12 inch with the appropriate rounded corner and edge. The Q.C.I. and Q.A.I. shall agree upon the acceptability of the corner preparation and the plate shall become the Job Standard. The plate shall remain the property of the Contractor.

Surfaces to be coated shall be abrasive blast cleaned to meet the requirements of SSPC- SP 10/NACE No. 2 or the coating manufacturer's published recommendations, whichever is the more stringent. SSPC-VIS 1 shall be used to determine acceptable cleanliness. The Q.C.I. and Q.A.I. shall evaluate the first piece using VIS 1 as a comparator. No further blast cleaning shall be done until the Q.C.I. and Q.A.I. agree upon the acceptable Job Standard for cleanliness. If more than one method of abrasive blast cleaning is used (e.g., centrifugal blast and compressed air), the acceptable Job Standard shall be established for each method. At the Contractor's option, a sample piece may be abrasive blast cleaned and sealed with a clear coating to preserve the surface preparation and the sample piece may be used as a comparator to establish the agreed upon Job Standard.

After abrasive blast cleaning, the surface shall be visually inspected for fins, tears, delaminations and other discontinuities. Fins, tears, and other discontinuities shall be removed with a grinder or other suitable power tool and the area shall be blended at a slope of approximately 1:20. The affected area(s) shall be abrasive blast cleaned to develop an acceptable anchor profile.

The anchor profile shall meet the requirements of the coating manufacturer's published recommendations. The blast media shall contain enough grit to provide an angular anchor profile. The anchor profile shall be measured in accordance with ASTM D 4417 Method C. If the anchor profile fails to meet the minimum requirements, the Contractor shall re-blast the substrate until the minimum required anchor profile is achieved. If the anchor profile exceeds the maximum allowed in the manufacturer's published recommendations, the substrate shall be coated only with the approval of the Resident.

The Q.C.I. shall measure the anchor profile of the substrate on each plane of the first piece and each additional piece with a significant change in size or geometry. The Q.A.I. will witness the testing. After it has been established to the satisfaction of the Resident, that the abrasive blast equipment is capable of providing uniform, acceptable surface preparation, a diminished degree of testing may be agreed upon by the Q.C.I. and Q.A.I. The Quality Assurance Inspector may require that the anchor profile be measured and recorded on any surface that is, in the judgment of the Quality Assurance Inspector, unacceptable. Failure to measure anchor profile as required will result in rejection of the surface preparation on the piece in question.

If there is a significant change in surface cleanliness or anchor profile due to blast media degradation or other reasons, the Contractor shall cease the blast operation until corrective action is taken.

If compressed air is used for abrasive blast cleaning, a blotter test shall be performed in accordance with ASTM D 4285 at the beginning of each shift and at any other time the Q.A.I. directs it. The Q.C.I. and Q.A.I. shall be present to witness the blotter test.

The allowable time between abrasive blast cleaning and primer application shall not exceed the manufacturer's published recommendations or eight-hours, whichever is less. If the substrate develops flash rust (rust bloom) before the primer is applied or before the primer application is completed, the piece shall be re-blasted to bare substrate and re-coated.

506.14 Mixing and Application

This Subsection is deleted and replaced with the following:

All protective coating shall be applied using either conventional or airless spray equipment meeting the manufacturer's published recommendations. Striping and touchup of areas less than 36 in² may be applied by other methods with the approval of the Resident. Protective coating shall not be applied when the ambient temperature in the immediate vicinity of the piece(s) in question is above 90°F or below 40°F. Thinning and mixing of coatings shall be in conformance with the manufacturer's published instructions. Thinner shall be measured using a graduated cup or other container that clearly indicates the amount of thinner being added. Mixing shall be done using the method, equipment and for the amount of time recommended by the coating manufacturer.

Primer, intermediate, and top coat shall be applied in accordance with the manufacturer's published recommendations. Environmental conditions in the immediate vicinity of the surfaces to be coated shall be within the range of the manufacturer's published requirements both during the coating operation and during the curing period. Primer shall not be force-cured.

Environmental conditions shall be measured by the Q.C.I. in the immediate vicinity of the surfaces to be coated. The Q.A.I. may perform environmental testing in addition to the testing performed by the Q.C.I. If there are significant differences between the test results, the differences shall be resolved or explained to the satisfaction of the Resident prior to coating application. The results of the environmental testing shall be recorded in the JCR.

Corners, fasteners, welds, and inaccessible locations shall be striped in accordance with SSPC-PA 1. The Contractor shall meet the minimum Dry Film Thickness (DFT) requirements on all surfaces. The Contractor may stripe with the intermediate coat if approved by the Resident.

Recoat time shall be in accordance with the manufacturer's published requirements for the environmental conditions at the time of application and cure. If the coating is contaminated with dust, debris, over spray or other deleterious material, the surface shall be cleaned in accordance with SSPC-SP 1 immediately prior to recoating. Other methods of cleaning may be used if approved by the Resident.

The Q.A.I. shall be given ample notice in order to inspect the product prior to coating, recoating or removal of paint from the area. "Ample notice" shall be defined at the Pre-Job meeting depending on shop or site conditions.

Substrates that are primed or surfaces that are recoated without notification of the Q.A.I. will be rejected and no further coating shall be done on the piece. Coating applied without notification of the Q.A.I. will be investigated by destructive and non-destructive testing as approved by the Resident and by a review of the JCR. The Resident may reject, conditionally accept, or accept the coating based on documentation and test results. Rejected coating shall be removed and re-applied. Conditionally accepted coatings shall be made acceptable as approved by the Resident. The cost of additional testing and repairs shall be borne by the Contractor.

506.15 Dry Film Thickness

This Subsection is deleted and replaced with the following:

DFT shall be measured in accordance with SSPC-PA 2. The results shall be documented in the JCR. The JCR documentation shall include the actual gage readings, spot average and the location(s).

506.16 Coating Repairs and Touch-up

This Subsection is deleted and replaced with the following:

Touch-up shall be done in accordance with the manufacturer's product data sheet and this Specification. Areas to be touched-up shall be prepared to assure proper adhesion of each coat. Each existing coat shall be feathered back to assure that each touch-up coat is continuous with each corresponding existing coat. The top-coat shall be smooth and uniform in appearance.

Damaged or unacceptable coatings shall be repaired using the same coating system. Environmental conditions cure times, and DFTs shall be in accordance with manufacturer's product data sheet for the coating being applied. Repairs to topcoat shall result in a uniform gloss and color match. The Resident shall have final authority concerning acceptable appearance.

506.17 Handling and Storage

This Subsection is deleted and replaced with the following:

The coating shall be adequately cured before handling, but under no circumstances shall the product be handled before the coating has achieved the manufacturer's published minimum cure time. Coated steel members shall be handled in a manner to avoid damage to the coating. Members shall be lifted and moved using non-metallic slings, padded chains and beam clamps, softeners, or other non-injurious methods. Material shall be stored, both at the coating facility and in the field, in a manner that prevents damage to the coating.

Material shall not be loaded for shipment until the shop coating has adequately cured and been inspected. The components will be stamped "APPROVED" only after the loading has been completed and approved, and no material shall be shipped without the prior approval of the Resident.

Damage to the coating that is discovered after the product is loaded for shipment to the jobsite shall be documented by the Q.C.I. Repairs shall not be made unless the damaged area is repaired in accordance with Subsection 506.26 Coating Repairs and Touch-up. Repairs that cannot be acceptably done on the truck shall be done in the shop or in the field at the Contractor's option.

SPECIAL PROVISION

SECTION 508

WATERPROOFING MEMBRANE

(Membrane Waterproofing)

This Subsection is deleted and replaced with the following:

508.01 Description

This work shall consist of furnishing and applying an approved waterproofing membrane to the exterior surfaces of the below grade tunnel, and stairwell structures with a barrier type membrane in accordance with this specification, other applicable Contract documents and the manufacturer’s published recommendations, complete, in place and accepted.

Waterproofing membrane shall be spray applied high performance waterproofing membrane (high performance membrane). The membrane system shall be listed under MaineDOT’s Qualified Products List for High Performance – Spray Applied Waterproofing Membranes.

508.09 Basis of Payment

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
508.14 High Performance Waterproofing Membrane	Lump Sum

SPECIAL PROVISIONSECTION 511COFFERDAMS

(Temporary Earth Support Systems)

Section 511, Cofferdams, is deleted in its entirety and replaced with the following:

511.01 Description

This work shall consist of the complete design, construction, maintenance and removal of temporary earth support systems and other related work, including dewatering and inspection, required to allow for the excavation of foundation units, to permit and protect the construction of bridge or other structural units, and to protect adjacent roadways, adjacent public or private rights-of-way, embankments, or other structural units, in accordance with the Contract.

Temporary earth support structures may require pumping or dewatering to complete the Project work. The locations of temporary earth support structures may, or may not, be shown on the Plans whether required for the completion of the Contract or not. Temporary earth support structures do not require seal concrete.

511.02 Materials

The Contractor shall submit Working Drawings for the proposed temporary earth support systems for review and acceptance. The submission shall include plans, details and calculations designed and sealed by a Professional Engineer licensed in the State of Maine. This Professional Engineer may be directly employed by, or otherwise retained by, the Contractor. Working drawings shall consist of plan views and cross sections to illustrate clearances, limits, and retainment heights as applicable at roadway cuts, cofferdams, abutment footings, and phased construction areas. Construction shall not be started on temporary earth support systems until such submittals are accepted. Any review of or comment on, or any lack of review of or comment on, these Working Drawings by the Department shall not result in any liability upon the Department and it shall not relieve the Contractor of the responsibility for the satisfactory functioning of the cofferdam.

Temporary earth retaining structures shall be designed to support all appropriate combinations of earth, hydrostatic, and surcharge loads (from traffic, construction equipment, material stockpiles, and other sources) imposed on the system during all phases of construction. Temporary earth support systems adjacent to traveled ways, shall additionally be designed to resist any vibration or impact forces due to traffic and shall incorporate sufficient protection against impact by errant vehicles. Sufficient redundancy shall be designed into the support system so that failure of one member will not cause the collapse of the entire system. The Contractor's design shall consider the means and methods and construction sequencing proposed by the Contractor.

The Working Drawings shall also show the Contractor's proposed method of excavation, water diversion and dewatering methods (sumps, wells, seal concrete, or well points) to minimize

the flow of groundwater into the excavation. Such methods should preserve the undisturbed condition of the subgrade and permit foundation construction in-the-dry.

Design computation shall be in accordance with the AASHTO LRFD Bridge Design Specifications, Latest Edition.

Following construction of each temporary earth support system the Professional Engineer responsible for the design of the system shall inspect the installation and provide a certification to the Resident stating that construction was completed in conformance with the accepted working drawings. The certification shall be signed and sealed by the Professional Engineer responsible for the design of the system.

511.03 Temporary Earth Support System Construction

Temporary earth support systems shall, in general, be carried well below the elevation of the bottom of footings or approach slabs, and shall be well braced and watertight. In cases where pile foundations contain batter piles, the temporary earth support system shall be installed to accommodate, without obstruction, the proper placement and alignment of the batter piles, either by staggering the depth of the support system or by increasing the annulus between the foundation and the support system. The interior dimensions of temporary earth support systems shall provide sufficient clearance for the construction and inspection of forms and to permit pumping outside of forms. Exterior dimensions of the temporary earth support system shall be limited to the size shown on the Plans or those illustrated in the Project permits, whichever is more stringent.

Temporary earth support systems shall be constructed such that water will not come in contact with concrete as required in Section 502, Structural Concrete.

Temporary earth support systems, including all sheeting and bracing involved, shall be completely removed after the completion of the work unless otherwise noted on the Contract Drawings. Care shall be taken not to disturb or otherwise injure the finished masonry or foundation elements.

No timber or other bracing shall be used in temporary earth support systems in such a way as to remain in the substructure masonry.

511.04 Pumping

Pumping from the interior of any foundation enclosure shall be done in such a manner as to prevent any current of water that would carry away or segregate the concrete.

Pumping to dewater a sealed temporary earth support system shall not commence until the seal concrete has set sufficiently to withstand the hydrostatic pressure. In no case will pumping be permitted until a minimum of five (5) days has elapsed since the completion of the installation of the seal concrete, when the temperature of the water body outside the temporary earth support system is greater than 4°C [40°F], or a minimum of seven (7) days has elapsed since the completion of the installation of the seal concrete, when the temperature of the water body outside the temporary earth support systems is less than 4°C [40°F].

Sediment laden water will not be allowed to leave the Project area. The Contractor shall be required to install appropriate erosion and sedimentation control devices as approved by the Resident. Erosion and sedimentation control devices may include plain riprap, haybales, silt fence and sedimentation basins.

All water and materials pumped from excavation shall be pumped into a sedimentation basin which is of sufficient volume to detain the pumped water and materials. The water and materials removed from the excavation shall be pumped at a rate that permits infiltration of the water into the earth, preventing any overland flow or direct discharge into a stream or other waterbody.

511.05 Method of Measurement

Temporary Earth Support Systems shall be measured for payment as one lump sum per Contract, regardless of the number of Temporary Earth Support structures required at the Project site or sites, which price shall include full compensation for design, furnishing materials, excavation beyond the pay limits, installation, removal, tools, equipment and labor necessary to construct, maintain and remove the work in accordance with the Plans or as called for in the Contract.

If Temporary Earth Support Systems is not required due to the acceptance of a Value Engineering Proposal in accordance with Subsection 109.6, the cost of the deleted Temporary Earth Support Systems shall be included as part of the Value Engineering Proposal.

511.06 Basis of Payment

The accepted quantity of Temporary Earth Support Systems will be paid for at the Contract lump sum price, per Contract. Such payment shall be full compensation for furnishing and installing all materials required to construct the Temporary Earth Support Systems including, but not limited to steel sheeting and shoring, timber bracing and cribbing, seal concrete, crushed stone. Payment will also be full compensation for excavation, dewatering, erosion control and other incidentals required to construct, maintain and remove the Temporary Earth Support Systems.

When required, the elevation of the bottom of footing of any substructure unit may be lowered, without change in the price to be paid for Temporary Earth Support Systems. However, if the average elevation of more than 25 percent of the area of the excavation is more than three feet below the elevation shown on the Plans, and if requested by the Contractor, then the entire cost of the Temporary Earth Support Systems will be paid in accordance with Subsection 109.7, Equitable Adjustments to Compensation, instead of the Contract lump sum price.

All costs of constructing, maintaining and removing sedimentation basins; water testing; and pumping or transporting water and other materials to the sedimentation basin will not be measured separately for payment, but shall be incidental to the Temporary Earth Support Systems pay item.

All costs of related temporary soil erosion and water pollution controls, including inspection and maintenance, will not be measured separately for payment, but shall be incidental to the Temporary Earth Support Systems item.

Payment will be made under:

Pay Item

Pay Unit

511.091 Temporary Earth Support Systems

Lump Sum

SPECIAL PROVISION

SECTION 515

PROTECTIVE COATING FOR CONCRETE SURFACES

(Pigmented Concrete Protective Coating – Tunnel and Stairway Walls and Ceiling)
(Pigmented Concrete Protective Coating – Tunnel Floor)

This is deleted in its entirety and replaced with the following:

515.01 Description

The work shall include the surface preparation and application of a pigmented concrete protective coating system to protect new concrete and masonry structures. The coating system shall be applied to the interior walls, ceiling, and the floor of the precast concrete tunnel, and interior walls, floor and steps of the stairways at Islands B & E in accordance with the Plans, Specifications, and the manufacturer's published recommendations.

515.02 Materials

A. For Walls and Ceiling:

The pigmented concrete protective coating system shall consist of Drylok Masonry Waterproofing and Drylok Extreme, as manufactured by UGL, or an approved equal, consisting of the following:

One primer coat of latex-based Drylok masonry waterproofer. Color: White.

One finish coat of latex-based Drylok masonry waterproofer. Color: White.

One primer coat of Drylok Extreme to be used on walls with handrails. Color: White.

One finish coat of Drylok Extreme to be used on walls with handrails. Color: White.

B. For Floors:

The pigmented concrete protective coating system shall consist of Drylok Concrete Floor Paint, as manufactured by UGL, or an approved equal, consisting of the following:

One primer coat of latex-based Drylok concrete floor paint. The floor paint shall be brush applied per manufacturer's instructions to provide a non-skid surface. Color: Gray ("Gull").

One finish coat of latex-based Drylok concrete floor paint. The finish coat shall be brushed or roller applied per manufacturer's instructions to provide a non-skid surface. Color: Gray ("Gull").

The products shall comply with regulations limiting the Volatile Organic Compound (VOC) content of architectural and industrial maintenance coatings.

The Contractor shall submit the UGL product data sheets, material safety data sheets and recommended instructions for application of the coating products.

Materials shall be delivered to the site in original packages or containers bearing the manufacturer's labels and identification.

515.021 Substitute Materials

The Contractor shall submit a written request for approval of proposed substitute material naming the proposed manufacturer and product. This request shall be accompanied by:

Test data from an independent testing laboratory stating that the proposed substitute meets or exceeds the specified requirements as listed and has been tested in accordance with the specified test standards.

Documentation that the proposed material has a proven record of performance when used in the intended application as confirmed by actual field tests and successful installations in place on at least five similar projects.

Certification that if two or more types of products are intended to be used as part of a system they will be supplied by the same manufacturer to ensure compatibility of materials, and to maintain single source manufacturer responsibility.

The Resident reserves the right to require additional testing to evaluate any proposed substitute product at no additional cost to the Authority. The Resident's decision as to the acceptability or non-acceptability of the proposed product shall be final.

515.03 Surface Preparation

All caulking, patching, and joint sealant shall be installed prior to application of the concrete protective coating system. The surface shall be prepared in strict accordance with the instructions of the approved manufacturer. Surface shall be fully cured, dry, and free from contamination such as asphalt coatings, oil, grease, loose particles, decaying matter, moss, algae growth, and curing compounds.

The Contractor may use, when required, appropriate cleaning materials recommended by the coating manufacturer for cleaning the concrete or masonry.

515.04 Application

The materials shall be mixed and applied in strict accordance with the instructions of the approved manufacturer. Brush or roll the coatings at the recommended application rate.

The Contractor shall, in the presence of the Resident, apply the materials on a sample area which is representative of a jobsite application. When color and application methods are approved, the sample area shall serve as a standard of acceptance for all further work.

The coatings shall not be applied in direct sunlight when the air or surface temperature is greater than 90°F, or when air or surface temperature is below 35°F. The coatings shall not be applied when air or surface temperature is below 40°F or as approved by the Resident.

The primer coat shall be allowed to dry for a minimum of eight-hours before applying the finish coat. Under poor drying conditions this time shall be extended. The finish coat shall not be applied until the primer coat is dry. The finish coat should be applied by brush or roller.

The finish coat material shall be applied per the manufacturer's recommended application rate and in strict accordance with the manufacturer's written instructions. The finish coat shall provide consistent color without light spots or shadows. The Resident reserves the right to have the Contractor recoat the finish coat if the dried finish coat(s) lack consistent color or show light spots or shadows.

Protect walls, ceiling, and utilities during application of the final coat from splatter.

515.05 Method of Measurement

Pigmented Concrete Protective Coating will be measured for payment by the square yard of final coated surface, satisfactorily applied and accepted. The quantity of primer coat and finish coat will not be measured separately.

515.06 Basis of Payment

Pigmented Concrete Protective Coating will be paid at the Contract unit price per square yard which price shall be full compensation for all labor, materials, equipment, and incidentals required for furnishing and applying the pigmented concrete protective coating as shown on the Plans, in accordance with these Specifications or as approved by the Resident.

Surface preparation, and protection of surfaces not designated for treatment will not be paid for separately, but shall be incidental to the Pigmented Concrete Protective Coating item.

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
515.2011 Pigmented Concrete Protective Coating – Tunnel and Stairway Walls & Ceiling	Square Yard
515.2012 Pigmented Concrete Protective Coating – Tunnel Floor	Square Yard

SPECIAL PROVISIONSECTION 515PROTECTIVE COATING FOR CONCRETE SURFACES

(Clear Concrete Protective Coating)

Section 515, Protective Coating for Concrete Surfaces, is deleted in its entirety and replaced with the following:

515.01 Description

The work shall include the surface preparation and application of a clear protective coating on concrete surfaces to protect new cast-in-place concrete, precast concrete and masonry structures. The coating system shall be applied to all exposed toll islands, bumpers, curbs, median barriers, walls, pedestals and other exposed concrete surfaces in accordance with the Plans, Specifications and the manufacturer's published recommendations.

515.02 Materials

The penetrating sealer shall be StandOff® SLX100 Water & Oil Repellent, as manufactured by ProSoCo, Inc., or an approved equal. The sealer shall have the following properties:

Active Substance:	modified alkyl alkoxy silane
Active Content:	> 90%
Form:	clear liquid
VOC:	< 3.5 pounds per gallon

The product shall comply with regulations limiting the Volatile Organic Compound (VOC) content of architectural and industrial maintenance coatings.

The Contractor shall submit the ProSoCo's product data sheets, material safety data sheets and recommended instructions for application of the StandOff® SLX100.

Materials shall be delivered to the site in original packages or containers bearing the manufacturer's labels and identification.

515.021 Substitute Materials

The Contractor shall submit a written request for approval of proposed substitute material naming the proposed manufacturer and product. This request shall be accompanied by:

1. Test data from an independent testing laboratory stating that the proposed substitute meets or exceeds the specified requirements as listed and has been tested in accordance with the specified test standards.

2. Documentation that the proposed material has a proven record of performance when used in the intended application as confirmed by actual field tests and successful installations in place on at least five similar projects.
3. Certification that if two or more types of products are intended to be used as part of a system, they will be supplied by the same manufacturer to ensure compatibility of materials, and to maintain single source manufacturer responsibility.

The Resident reserves the right to require additional testing to evaluate any proposed substitute product at no additional cost to the Authority. The Resident's decision as to the acceptability or non-acceptability of the proposed product shall be final.

515.03 Surface Preparation

All caulking, patching, and joint sealant shall be installed prior to application of the sealer. On new surfaces to be treated, all voids shall be dressed by dry rubbing to remove form marks and blemishes to present a neat appearance. Concrete and masonry surfaces shall be cleaned free of dust, surface dirt, oil, efflorescence and contaminants to ensure penetration of the sealer. The surface may be slightly damp at the time of treatment.

The Contractor may use, when required, appropriate cleaning materials recommended by the sealer manufacturer in conjunction with high pressure water for cleaning the concrete or masonry.

515.04 Application

The Contractor shall apply the clear concrete protective coating in strict accordance with the manufacturer's published recommendations.

The application shall not be conducted when surface and air temperatures are below 40°F or above 90°F. The work shall not be conducted when there is a chance of the surface temperature falling below 40°F in the 24-hours following application; nor should it be applied on hot, windy days.

The treatment shall not be applied during rain to wet surfaces or when there is a chance of rain within 24-hours after application. After treatment, surfaces should be protected from rain for not less than 48-hours. It shall not be applied when winds are sufficient to carry airborne chemicals to unprotected surfaces.

Prior to applying the sealer, the Contractor shall protect all surrounding non-masonry/non-concrete surfaces, landscape and lawn areas, and surfaces not designated for treatment, from contact with the penetrating sealer, and prevent overspray of the penetrating sealer caused by wind drift.

The Contractor shall ensure that all safety equipment, facilities and precautions recommended by the product manufacturer are furnished and/or strictly adhered to.

The sealer material shall be applied in the manner and with the equipment recommended by the product manufacturer. Coverage will vary depending on condition, texture and porosity of the surfaces. Pre-testing is required.

Sealer shall be applied as packaged without dilution or alteration. The sealer shall be applied with low pressure (20 psi) airless spray equipment or with a heavily saturated brush or roller unless otherwise permitted by the Resident. Sufficient material shall be applied to thoroughly saturate the surface making sure to brush out excess material that does not penetrate.

When the sealer is applied to horizontal surfaces, it shall be applied in a single saturating application with sufficient material and applied so the surface remains wet for one to two minutes before penetration into the concrete. Surface residues, pools and puddles shall be broomed-out thoroughly until they completely penetrate into the surface.

When the sealer is applied to vertical and sloped surfaces, it shall be applied in a "wet-on-wet" application for best results on most porous materials. In the case of extremely dense concrete, it may be necessary to restrict the amount of material applied to one saturating application in order to prevent surface darkening. Apply from the bottom up with sufficient material to thoroughly coat the surface and create a slight rundown below the spray pattern. Allow the first application to penetrate the concrete surface, and within a few minutes after the first coat appears dry, reapply in the same saturating manner.

When the sealer is applied to vertical and sloped surfaces, it shall be applied in two applications, 10 minutes apart, with a low pressure (20 psi) airless sprayer.

515.05 Method of Measurement

Clear Protective Coating for Concrete Surfaces will be measured for payment by the square yard, satisfactorily applied and accepted.

515.06 Basis of Payment

Clear Protective Coating for Concrete Surfaces will be paid at the Contract unit price per square yard which price shall be full compensation for all labor, materials, equipment and incidentals required for furnishing and applying the clear concrete protective coating as shown on the Plans, in accordance with these Specifications or as approved by the Resident.

Surface preparation, vegetation removal, and protection of surfaces not designated for treatment will not be measured separately for payment, but shall be incidental to the Clear Concrete Protective Coating item.

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
515.202 Clear Protective Coating for Concrete Surfaces	Square Yard

SPECIAL PROVISIONSECTION 515PROTECTIVE COATING FOR CONCRETE SURFACES

(Epoxy Overlay)

515.01 Description

The first paragraph is amended to read:

This special provision describes furnishing and applying two layers of a two-component polymer overlay system in accordance with what is shown on the Plans or as approved by the Resident. The total thickness of the overlay system shall be 1/4 inch.

515.02 Materials

Furnish materials specifically designed for use over concrete. Pre-qualified polymer liquid binders are as follows:

Product Trade Name	Manufacturer or Supplier	Telephone
Mark-163 Flexogrid	PolyCarb, Inc.	(866) 765-9227
E-Bond 526 Lo-Mod*	E-Bond Epoxies, Inc.	(954) 566-6555
Propoxy DOT Type III	Unitex	(816) 231-7700
Sure Level Epoxy (J-57)	Dayton Superior	(888) 977-9600
ICO Flexi-Coat	International Coatings, Inc.	(800) 624-8919
Flexolith	Euclid Chemical Co.	(800) 321-7628

*MTA preferred product.

Polymer Resin

The polymer resin base and hardener shall be composed of two-component, 100 percent solids, 100 percent reactive, thermosetting compound with the following properties:

Property	Requirements	Test Method
Gel Time ^A	15 - 45 minutes @ 75° F	ASTM C881
Viscosity ^A	7 - 70 poises	ASTM D2393, Brookfield RVT, Spindle No. 3, 20 rpm
Shore D Hardness ^B	60-75	ASTM D2240
Absorption ^B	1% maximum at 24 hour	ASTM D570
Tensile Elongation ^B	30% - 70% @ 7 days	ASTM D638
Tensile Strength ^B	>2000 psi @ 7 days	ASTM D638
Flexural Strength ^B	>4500 psi @ 7 days	ASTM D790
Chloride Permeability ^B	<100 coulombs @ 28 days	AASHTO T277

^A Uncured, mixed epoxy binder ^B Cured, mixed epoxy binder

Aggregates

Furnish natural or synthetic aggregates that have a proven record of performance in applications of this type. Furnish aggregates that are non-polishing, clean, free of surface moisture, fractured or angular in shape; free from silt, clay, asphalt, or other organic materials; and meet the following properties and gradation requirements:

Aggregate Properties:

Property	Requirement	Test Method
Moisture Content	≤0.2%	ASTM C566
Hardness	≥6.5	Mohs Scale
Fractured Faces	100% with at least 1 fractured face & 80% with at least 2 fractured faces of material retained on No. 16	ASTM 5821

Gradation:

Sieve Size	% Passing by Weight
No. 4	100
No. 8	30 – 75
No. 16	0 – 5
No. 30	0– 1

515.21 Required Properties of Overlay System

The required properties of the overlay system are listed in the table below:

Property	Requirement ^A	Test Method
Minimum Compressive Strength at 8 Hrs. (psi)	1,000 psi @ 8 hours 5,000 psi @ 24 hours	ASTM C 579 Method B, Modified ^B
Thermal Compatibility	No Delaminations	ASTM C 884
Minimum Pull-off Strength	250 psi @ 24 hours	ACI 503R, Appendix A

^A Based on samples cured or aged and tested at 75°F

^B Plastic inserts that will provide 2-inch by 2-inch cubes shall be placed in the oversized brass molds.

515.22 Approval of Polymer Overlay System

Submit product data sheets and specifications from the manufacturer, and a certified test report to the Resident for approval.

For materials not pre-qualified, in addition to the above submittals, submit product history/reference projects and a certified test report from an independent testing laboratory showing compliance with the requirements of the specification.

Product data sheets and specifications from the manufacture consists of literature from the manufacturer showing general instructions, application recommendations/methods, product properties, general instructions, or any other applicable information.

515.23 Construction

Conduct a pre-installation conference with the manufacturer's representative prior to construction to establish procedures for maintaining optimum working conditions and coordination of work. Furnish the Resident a copy of the recommended procedures and apply the overlay system according to the manufacturer's instructions. The manufacturer's representative familiar with the overlay system installation procedures shall be present at all times during surface preparation and overlay placement to provide quality assurance that the work is being performed properly.

Store resin materials in their original containers in a dry area. Store and handle materials according to the manufacturer's recommendations. Store all aggregates in a dry environment and protect aggregates from contaminants on the jobsite.

Surface Preparation

Determine an acceptable shot blasting machine operation (size of shot, flow of shot, forward speed, and/or number of passes) that provides a surface a profile meeting CSP 5 according to the International Concrete Repair Institute Technical Guideline No. 03732. If the Resident requires additional verification of the surface preparation, test the tensile bond strength according to ACI 503R, Appendix A of the *ACI Manual of Concrete Practice*. The surface preparation will be considered acceptable if the tensile bond strength is greater than or equal to 250 psi or the failure area at a depth of 1/4 inches or more is greater than 50 percent of the test area. Continue adjustment of the shot blasting machine and necessary testing until the surface is acceptable to the Resident, or a passing test result is obtained.

Prepare the entire surface using the final accepted adjustments to the shot blasting machine as determined above. Thoroughly blast clean with hand-held equipment any areas inaccessible by the shot blasting equipment. Surface preparation must be performed no more than 24-hours prior to the application of the overlay system.

Just prior to overlay placement, clean all dust, debris, and concrete fines from the concrete surface with compressed air. These concrete surfaces include vertical faces of curbs and barrier walls up to a height of one inch above the overlay. When using compressed air, the air stream must be free of oil. Any grease, oil, or other foreign matter that rests on or has absorbed into the concrete shall be removed completely.

The Resident may consider alternate surface preparation methods per the overlay system manufacturer's recommendations. The Resident will approve the final surface profile and cleanliness prior to the Contractor placing the epoxy overlay.

Application of the Overlay

Perform the handling and mixing of the epoxy resin and hardening agent in a safe manner to achieve the desired results according to the manufacturer's instructions. Do not apply the overlay system if any of the following exists:

- a. Ambient air temperature is below 50°F;
- b. Concrete surface temperature is below 50°F;
- c. Moisture content in the concrete exceeds 4.5 percent when measured by an electronic moisture meter or shows visible moisture after two-hours when measured in accordance with ASTM D4263;
- d. Rain is forecasted during the minimum curing period;
- e. Materials component temperatures below 50°F;
- f. Concrete age is less than 28 days unless approved by the Resident.

After the concrete surface has been shot blasted or during the overlay curing period, only necessary surface preparation and overlay application equipment will be allowed on the concrete surface. Begin overlay placement as soon as possible after surface preparation operations.

The polymer overlay shall consist of a two-course application of epoxy and aggregate. Each of the two courses shall consist of a layer of epoxy covered with a layer of aggregate in sufficient quantity to completely cover the epoxy. Apply the epoxy and aggregate according to the manufacturer's requirements. Apply the overlay using equipment designed for this purpose. The application machine shall feature positive displacement volumetric metering and be capable of storing and mixing the polymer resins at the proper mix ratio. Disperse the aggregate using a standard chip spreader or equivalent machine that can provide a uniform, consistent coverage of aggregate. First course applications that do not receive enough aggregate before the epoxy gels shall be removed and replaced. A second course applied with insufficient aggregate may be left in place, but will require additional applications before opening to traffic.

After completion of each course, cure the overlay according to the manufacturer's instructions. Follow the minimum cure times as prescribed by the manufacturer. Remove the excess aggregate from the surface treatment by sweeping, blowing, or vacuuming without tearing or damaging the surface; the material may be re-used if approved by the Resident and manufacturer. Apply all courses of the overlay system before opening the area to traffic. Do not allow traffic on the treated area until directed by the Resident.

After the first layer of coating has cured to the point where the aggregate cannot be pulled out, apply the second layer. Prior to applying the second layer, broom and blow off the first layer with compressed air to remove all loose excess aggregate.

Prior to opening to traffic, clean all debris and polymer from the roadway. If required by the Resident remove loosened aggregates from the concrete and approach pavement a minimum of three days following opening to traffic.

Application Rates

Apply the epoxy overlay in two separate courses in accordance with the manufacturer’s instructions, but not less than the following rate of application.

Course	Minimum Epoxy Rate ^A (GAL/100 SF)	Aggregate ^B (LBS/SY)
1	2.5	10+
2	5.0	14+

^A The minimum total applications rate is 7.5 GAL/100 SF.

^B Application of aggregate shall be of sufficient quantity to completely cover the epoxy.

Minimum Curing Periods

As a minimum, cure the coating as follows:

Course	Average temperature of concrete surface, epoxy and aggregate components in °F					
	60-64	65-69	70-74	75-79	80-84	85+
1	4 hrs.	3 hrs.	2.5 hrs	2 hrs	1.5 hrs.	1 hr.
2 *	6.5 hrs.	5 hrs.	4 hrs.	3 hrs.	3 hrs.	3hrs.

*Cure course 2 for eight hours if the air temperature drops below 60° F during the curing period.

515.05 Method of Measurement

The Authority will measure Epoxy Overlay in area by square yards completed and accepted, in accordance with the Plans.

515.06 Basis of Payment

Payment is full compensation for preparing the surface; for tensile bond testing; for providing the overlay; for cleanup; for sweeping/vacuuming and disposing of excess materials; and for labor, equipment, tools, and incidentals necessary to complete the work.

Payment will be made under:

Pay Item

Pay Unit

515.23 Epoxy Overlay

Square Yard

SPECIAL PROVISION

SECTION 526

CONCRETE BARRIER

(Temporary Concrete Barrier Type I)

526.01 Description

The following paragraphs are added:

The work also includes supplying connecting pins and furnishing and mounting retro-reflective delineators, per Subsection 526.02 and 526.03.

526.02 Materials

The following paragraphs are added:

f. Delineators shall be bi-directional with a minimum effective reflective area of eight square inches as approved by the Resident. The reflectors shall be methyl methacrylate and the housing of acrylonitrile butadiene styrene. Color shall be in accordance with the MUTCD.

g. Temporary traffic barrier shall be one of the barriers included under FHWA's Roadside Hardware Policy and Guidance for crashworthy longitudinal barriers, at the Contractor's discretion, unless otherwise specified. The type of temporary traffic barrier shall be provided to the Engineer prior to use. All temporary traffic barrier and corresponding connections shall meet, unless otherwise specified in the Plans, Test Level 3 (TL-3) criteria as defined in NCHRP Report 350 or the AASHTO Manual for Assessing Safety Hardware (MASH). The appropriate resource shall be determined as described in the MASH publication. The Contractor shall supply the FHWA approval letter, manufacturer approved shop drawings and connection and anchorage details (if applicable) and catalogue cuts for each barrier type to the resident engineer for approval. The manufacturer's shop drawings shall specify the maximum deflection distance the product is approved for. The Contractor's shop drawing submittal shall specify the available distance between the back or non-roadway side of the barrier to the closet fixed object or edge of open excavation being protected for each location of differing available deflection distance.

526.021 Acceptance

The Resident shall have the authority to accept or reject all Temporary Concrete Barrier Type I – Supplied by Authority used on the Project that does not meet the requirements of this specification

526.03 Construction Requirements

The following paragraphs are added:

Concrete barrier placed at roadway low points shall be shimmed on 1” by 2” by 2’ long wood planks to allow drainage to pass under the barrier. In addition, the Resident may direct the Contractor to shim the concrete barrier at other locations to provide for proper roadway drainage. Contractor shall also be responsible for keeping the back side of barrier clear of snow and ice to allow for drainage of roadway. All labor, material, and equipment necessary to shim the barrier and maintain clear area behind barrier will not be measured separately for payment, but shall be incidental to the Concrete Barrier.

The removal of concrete barrier from adjacent to the travel lane may be conducted without a lane closure if it is accomplished in accordance with the following requirements:

- Barrier is removed from the trailing end and the workmen and equipment involved in the operation are always behind the barrier. No workmen or equipment shall enter the travel lane.
- Barrier shall be dragged away from the travel lane to at least a 30-degree angle by the use of a cable.
- Barrier shall be lifted no more than six inches while within 10 feet of the travel lane.

Retro-Reflective Delineators shall be mounted as follows:

- One on top of each barrier.
- One on the traffic side of every barrier used in a taper.
- One on the traffic side of every other barrier at regularly spaced intervals and locations.
- Delineators shall be installed on both sides of the barrier if barrier is used to separate opposing traffic.
- Delineators shall be physically adhered so as to withstand the force of throw from a snow plow.
- If more than 25% of delineators in any 50 foot section of barrier fall off for any reason, the Contractor will be responsible for reinstalling all the delineators in that run at that their own cost.
- Contractor is required to submit the installation method for review and approval to the Resident.

526.04 Method of Measurement

The following paragraphs are added:

Payment for furnishing, installing and maintaining retro-reflective delineators will not be measured for payment separately but shall be incidental to the Temporary Concrete Barrier Pay Item.

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
526.301 Temporary Concrete Barrier, Type I	Lump Sum

SPECIAL PROVISION

SECTION 526

CONCRETE BARRIER

(Temporary Barrier Markers)

526.1 Description

The following paragraphs are added:

This work shall consist of furnishing, installing and maintaining temporary barrier markers on all temporary barrier supplied by the Contractor and the Authority.

526.2 Materials

The following paragraphs are added:

Temporary barrier markers shall be "Big Dog" barrier markers manufactured by Custom Products Corporation, or approved equal. Markers shall be bi-directional with a minimum effective reflective area of 96 square inches (48 square inches each side) as approved by the Resident. The reflectors shall meet MUTCD reflectivity requirements and shall be orange in color.

526.3 Construction Requirements

The following paragraphs are added:

Temporary barrier markers shall be mounted as follows:

1. One on top of each barrier, including all barriers supplied by the Authority and all barriers furnished by the Contractor.
2. Delineators shall be physically adhered so as to withstand the force of throw from a snow plow.
3. If more than 25% of delineators in any 50 foot section of barrier fall off for any reason, the Contractor will be responsible for reinstalling all the delineators in that run at that their own cost.
4. Contractor is required to submit the installation method for review and approval to the Resident.

526.4 Method of Measurement

The following paragraphs are added:

Temporary barrier markers shall not be measured for payment separately but shall be incidental to the temporary barrier item.

526.5 Basis of Payment

The following paragraphs are added:

Temporary barrier markers shall not be paid for separately but shall be incidental to the temporary barrier item.

SPECIAL PROVISIONSECTION 526CONCRETE BARRIER

(Median Barrier Type I, IA,IB, IC, ID, IE, II)
(Median Barrier Transition Type I, II)

526.01 Description

This Section is deleted and replaced with the following:

This work shall consist of the furnishing, constructing, erecting, and setting permanent concrete barrier and associated elements in accordance with these Specifications and the lines and grades shown on the Plans or established by the Resident. The length of each precast barrier segment shall be in accordance with the parameters shown on the Plans. The Contractor shall minimize the number of joints in the final barrier assembly to the extent possible.

526.351 Median Barrier Type I – Precast

Double faced single slope barrier 2'- 0 1/8" wide at the base, 48" high and 45" reveal as shown on the Plans.

526.3511 Median Barrier Type IA - Precast

Double faced single slope barrier 2'- 1 7/8" wide at the base, 54" high and 45" reveal as shown on the Plans.

526.3513 Median Barrier Type IB – Precast

Double faced single slope barrier 2'- 3 7/8" wide at the base, 60" high and 45" reveal as shown on the Plans.

526.3514 Median Barrier Type IC – Precast

Double faced single slope barrier 2'- 5 5/8" wide at the base, 66" high and 45" reveal as shown on the Plans.

526.3515 Median Barrier Type ID – Precast

Double faced single slope barrier 2'- 7 5/8" wide at the base, 72" high and 45" reveal as shown on the Plans.

526.3516 Median Barrier Type IE – Precast

Double faced single slope barrier 2'- 9 5/8" wide at the base, 78" high and 45" reveal as shown on the Plans.

526.352 Median Barrier Type II

Double faced single slope barrier 4'- 0" wide at the base, 48" high and 45" reveal as shown on the Plans.

526.3611 Median Barrier Transition Type IA - Precast

Section of barrier to transition from double faced single slope barrier to vertical section for guardrail attachment as shown on the plans. The barrier is 2' – 1 7/8" wide at the base, 54" high and 45" reveal.

526.3612 Median Barrier Transition Type IB - Precast

Section of barrier to transition from double faced single slope barrier to vertical section for guardrail attachment as shown on the plans. The barrier is 2' – 3 7/8" wide at the base, 60" high and 45" reveal.

526.362 Median Barrier Transition Type II - Precast

Section of barrier to transition from Median Barrier Type I to Median Barrier Type II as shown on the Plans.

526.371 Median Barrier with Mounted Light Pole, Type I

Cast in place section of barrier including light pole foundation, anchor bolts, junction box as shown on the plans.

526.12 Materials

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

All concrete Median Barrier and Median Barrier Transitions, except Median Barrier with Mounted Light Pole, Type I shall be supplied as precast units produced by an approved commercial precasting plant. Precast concrete shall be Class P, in accordance with Special Provisions, Section 502.05 - Composition and Proportioning, with a minimum compressive strength of 4,500 psi. Cast-in-Place concrete shall be Class AAA-Deck (without synthetic reinforcement) in accordance with Special Provisions, Section 502.05 - Composition and Proportioning, with a minimum compressive strength of 4,500 psi.

Materials for barrier connection assemblies shall be fabricated in accordance with MaineDOT Standard Specification 504. All barrier connection assemblies shall be hot dip galvanized after fabrication in accordance with ASTM A123 and A153.

The second paragraph is amended by the addition of the following:

All reinforcing steel for concrete barrier shall be epoxy coated. Reinforcing steel shall be fabricated and placed in accordance with the Standard Specifications, Section 503.

526.13 Construction Requirements

The first and second paragraphs are deleted and replaced with the following:

All permanent concrete barrier and transition barrier shall be constructed in accordance with the provisions of Special Provision 502 – Composition and Proportioning, through Section – Curing Concrete, inclusive, with the following additions:

The following is added to Section 502.10 A. – Construction of Forms, after Construction of Forms: “Permanent concrete barrier shall not be formed using slip forming methods. Temporary concrete barrier may be formed by precasting and/or prestressing methods.”

The following paragraphs are added after the fourth paragraph:

Sections of barrier shall be uniform in color and in good condition, free from cracked or spalled surfaces.

Defects shall be divided into two categories, minor defects and major defects. Minor defects in the barrier may be repaired in the field. Major defects shall be cause for rejection of the section or, at the Authority’s sole discretion, the section shall be repaired in a manner directed by the Resident.

Minor defects are defined as holes, honeycombing or spalls which are 6 inch or less, in diameter, and which do not expose the outermost surface of the steel reinforcement. Surface voids 3/8 inch, or less, in diameter and 3/8 inch, or less, in depth are not considered defects and do not require repair.

Major defects are defined as any defect which does not meet the definition of a minor defect or minor defects which, in aggregate, comprise more than 2% of the surface area of the barrier section.

The repair of hardened concrete shall be as follows:

Minor Defect Repair: Repair shall be made with a fast set non-shrink patching material included on MaineDOT’s list of prequalified materials. Methods of repair shall be acceptable to the Resident. The color of the repaired portion shall match as nearly as practicable, the color of the surrounding concrete. Repaired portions shall match shape and tolerance requirements.

Major Defect Repair: Major defect repair shall be pre-approved by the Engineer.

The following paragraphs are added at the end of this section:

The layout and placement of the concrete barriers shall be to the alignment and elevations shown on the Plans or as directed. Before any barrier or transitions may be placed, the subbase shall be compacted to 95 percent density and fine graded to a tolerance of +/- 1/2 inch of the true grade at any location under the barrier.

All Cast-in-Place barrier adjacent to precast barriers shall include hardware for the barrier connection as detailed in the Plans.

526.14 Method of Measurement

The following paragraphs are added:

Median Barrier Type I, IA, IB, IC, ID, IE, and II will be measured for payment by the linear foot from end to end of each run of barrier measured along the centerline of the barrier complete in place. No deduction in pay length will be made for joints between abutting barrier sections.

Median Barrier Transition Type I and II and Median Barrier with Mounted Light Pole Type I will be measured by each barrier as shown on the plans.

Basis of Payment

The following paragraphs are added:

The accepted quantities of Median Barrier Type I, IA, IB, IC, ID, IE, and II will be paid for at the Contract unit price per linear foot, as specified, complete in place. Such payment shall be full compensation for furnishing all material, assembling and all incidentals necessary to complete the work.

The accepted quantities of Median Barrier Transition Type I and II and Median Barrier with Mounted Light Pole, Type I shall be paid for at the Contract unit price per each, as specified, complete in place.

Payment will be made under:

<u>Pay Item</u>		<u>Pay Unit</u>
526.351	Median Barrier Type I	Linear Foot
526.3511	Median Barrier Type IA - Precast	Linear Foot
526.3513	Median Barrier Type IB - Precast	Linear Foot
526.3514	Median Barrier Type IC - Precast	Linear Foot
526.3515	Median Barrier Type ID - Precast	Linear Foot
526.3516	Median Barrier Type IE - Precast	Linear Foot
526.352	Median Barrier Type II	Linear Foot

526.3611	Median Barrier Transition Type IA - Precast	Each
526.3612	Median Barrier Transition Type IB - Precast	Each
526.362	Median Barrier Transition Type II - Precast	Each
526.371	Median Barrier With Mounted Light Pole Type I	Each

SPECIAL PROVISION

SECTION 527

ENERGY ABSORBING UNIT

(Center Barrier Crash Attenuator)

527.01 Description

This task shall include furnishing, installing and securing the energy absorbing units as described in the Plan drawings and detailed by the vendor. This task shall also include supplying a spare unit and delivery and stacking of the unit to the location noted. Drawings and general provisions of this Contract, including General Provisions and Special Conditions, apply to work of this Section.

527.02 Materials

Energy absorbing units shall be Smart Cushion[®] manufactured by Work Area Protection Corp., or an approved equal. Units must be fully re-directive, non-gating and suitable for installation on a concrete or asphalt surface. The energy absorbing units shall be approved by AASHTO Manual for Assessing Safety Hardware (MASH) Test Level 3 and must be approved by the Resident.

527.03 Execution

Installation and securing of the energy absorbing units shall be done according to the manufacturer’s recommendations so that the unit meets MASH Test Level 3 criteria. Installation must be approved by the Resident.

One complete unit will be furnished and delivered to the West Gardiner Maintenance Facility at Mile Marker 101.8 Northbound.

527.04 Basis of Payment

The energy absorbing units will be paid for at the Contract unit price per each which shall include all associated hardware and equipment required for a complete operational system which meets MASH Test Level 3.

One complete unit will be furnished and delivered to the West Gardiner Maintenance Facility at Mile Marker 101.8 Northbound.

Payment will be made under:

<u>Pay Item</u>		<u>Pay Unit</u>
527.306	Center Barrier Crash Attenuator	Each

SPECIAL PROVISION

SECTION 527

ENERGY ABSORBING UNIT

(Work Zone Crash Cushion)

527.01 Description

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

The Contractor shall furnish and install work zone crash cushions where shown on the Plans, as specified herein, in Special Provision 652, or as approved by the Resident. Work zone crash cushions are required at each exposed end of temporary concrete barrier or guardrail.

The exposed end of the concrete barrier within 30 feet of the mainline travel lane shall be protected at all times. Barrier shall not be reset until after the work zone crash cushion(s) has been set to protect the exposed end of the barrier.

527.02 Materials

The following paragraph is added:

Only work zone crash cushions meeting the NCHRP Report 350 TL-3 crash test requirements may be used on the turnpike and local roadways with posted speeds of 45 MPH or greater. Work zone crash cushions meeting the NCHRP Report 350 TL-2 crash test requirements may be used with posted speeds of 40 MPH or less. The Contractor shall provide the Resident with documentation of the proposed work zone crash cushion's NCHRP Report 350 Crash Test Results prior to installation at the jobsite.

527.03 Construction Requirements

The following is added to the end of the first paragraph:

The design speeds for work zone crash cushions shall be 40 mph and 70 mph for turnpike roadways unless otherwise noted on the Plans.

527.04 Method of Measurement

Work Zone Crash Cushions used to protect exposed ends of guardrail for steel girder erection will not be measured separately for payment, but shall be included under the Maintenance of Traffic for Steel Girder Erection item.

527.05 Basis of Payment

Payment will be made under:

<u>Pay Item</u>		<u>Pay Unit</u>
527.342	Work Zone Crash Cushions – TL-2	Unit
527.343	Work Zone Crash Cushions – TL-3	Unit

SPECIAL PROVISIONSECTION 535PRECAST, PRESTRESSED CONCRETE SUPERSTRUCTURE

(Precast Concrete Tunnel)

Description

This work shall consist of furnishing and installing precast concrete tunnel sections into one continuous unit in accordance with these Specifications and in conformity with the lines, grades, and dimensions shown on the Plans. The tunnel shall consist of individual concrete sections connected together via connection rods located within the sides of the segments and extending across the lap joints of each segment. The precast concrete tunnel in its final configuration shall be watertight. Underground precast concrete shall include precast stairwells at Islands B&E.

Materials

The following information is added:

Joint Sealants:

Self-leveling joint sealant shall be Sikaflex 1C-SL or an approved equal. Material shall be a premium-grade, high-performance, self-leveling one-part polyurethane sealant. Material shall meet Federal Specification TT-S-00230C, Type I, Class A; ASTM C920, Type S, Grade P, Class 25; and shall exhibit the following minimum data properties at 21 days:

Shore A Hardness:	40 +/-5 (ASTM D2240)
Tensile Strength:	150psi (ASTM D412)
Elongation @ Break:	450% (ASTM D412)
Modulus of Elasticity:	110psi (ASTM D412, @ 100%)

Non-sag joint sealant shall be Sikaflex 1A or an approved equal. Material shall be a premium-grade, high-performance, moisture cured polyurethane-based elastomeric sealant. Material shall meet Federal Specification TT-S-00230C, Type II, Class A, and ASTM C920, Type S, Grade NS, Class 35.

Shore A Hardness:	40 +/-5 (ASTM D2240)
Tensile Strength:	175psi (ASTM D412)
Elongation @ Break:	550% (ASTM D412)

Modulus of Elasticity: 85psi (ASTM D412, @ 100%)

Non-Shrink Grout Materials:

Non-shrink grout material shall be chosen from the MaineDOT qualified product list for grout materials. The design compressive strength shall be no less than 5,000 psi.

Gasket Materials:

Gasket material shall be a prelubricated RFS (Reduced Friction Seal) for sealing the tunnel joints as manufactured by Hamilton Kent, Tylox Superseal TSS Series, or an approved equal. The gasket shall be comprised of a synthetic rubber compound which meets the requirements of ASTM C1619 Class C and ASTM C443. Material shall be shaped with *rounded-corners* and shall exhibit the following minimum data properties:

Shore A Hardness:	50 +/-10 (ASTM D2240)
Tensile Strength:	1200 psi (ASTM D412)
Elongation @ Break:	350% (ASTM D412)
Watertightness:	5 psi (ASTM C1677)
Installation:	Per manufacturer's instructions

Connection Rods:

Connection rods and corresponding nuts and bearing plates shall be made of a high strength steel material such as a DSI Dywidag system or an approved equal. Connections rods shall be in conformance with the following minimum data properties:

Bar Diameter:	1 inch (25 mm) (min.)
Ultimate Tensile Strength:	$f_u = 150$ ksi (ASTM A722)
Ultimate Tensile Load:	$F_u = 237$ kips
Bearing Plates:	$F_y = 36$ ksi (ASTM A36)

Design Criteria

The following paragraph is added:

The precast concrete tunnel shall be a precast concrete steel-reinforced structure designed to satisfy the AASHTO HL-93 modified live load requirements when combined with the thickness of fill above the tunnel as shown on the Contract Plans.

The design cross-section shall contain haunches within the corners to increase the rigidity of the slabs and walls; however, the limits of the haunches must be minimized as shown on the drawings to avoid conflicts with the electrical equipment.

References

The following paragraph is added:

This special provision incorporates by reference ASTM Specification C1433, “*Standard Specification for Manufacturer of Precast Reinforced Concrete Box Culvert Sections for Culverts, Storm Drains and Sewers.*” ASTM C1433 shall provide the minimum design standards for the precast concrete tunnel segments, unless otherwise noted herein or on the Contract Plans.

535.03 Working Drawings

The following paragraphs are added:

The Contractor’s precast manufacturer shall submit shop drawings of the precast concrete tunnel elements which shall illustrate individual element dimensions, reinforcing layout, and erection procedures as necessary for the Contractor to construction the tunnel in accordance with the phased construction denoted in the contract Plans. Concrete mix designs and design calculations shall be included with the submittal. The design calculations and shop drawings shall be signed and stamped by a Professional Engineer registered in Maine. The shop drawings and design calculations will be reviewed by the engineer of record and approval will be established in accordance with Section 105.7 of these Specifications.

Approval of the shop drawings shall be completed prior to fabricating any precast tunnel segments. Drawings shall illustrate tunnel dimensions, connection rod locations and pocket sizes, gaskets, and lap splice details. Concrete mix designs shall include aggregate specific gravity, absorption, percent fracture, fineness modulus, gradation, and reports of previous test results.

The Contractor’s concrete precaster/manufacturer shall submit shop drawings of the tunnel segments including the gasket and connection rod materials. Shop drawings for these elements shall include gasket properties, gasket installation procedures, connection rod steel material properties, connection rod pocket dimensions (within the walls and ceiling of the tunnel sections), and bearing plate dimensions. The shop drawings will be reviewed by the engineer of record and approval will be established in accordance with Section 105.7 of these Specifications.

The Contractor’s concrete precaster/manufacturer shall also be responsible for the design of the lifting devices.

535.11 Reinforcing Steel

The following paragraph is added:

The mild steel reinforcing shall be Grade 60 ksi in accordance with ASTM A615 and shall be epoxy coated in accordance with ASTM A775.

535.115 Connection Rods

The following paragraph is added:

Connection rods shall be placed within the small voided pockets on the interior walls, corners, floor and ceiling of the tunnel segments as shown in the Contract Plans. Connection rods shall be hand-tightened with a wrench once the tunnel segment is installed into its final position.

Voids and Inserts

The following paragraph is added:

The Contractor shall take notice that there are voids/penetrations identified in several tunnel segments for the installation of utilities such as conduits and water pipes. This information shall be shown on the shop drawings. Steel reinforcement layout shall be predetermined to avoid conflicts with penetrations. Penetrations shall be formed with sleeves prior to casting of the segments. Field drilling will not be permitted without written consent from the Engineer of Record.

Concrete

The following paragraph is added:

The concrete mix design shall meet the requirements shown in the table and result in a minimum 28-day compressive strength of 5,000 psi.

Tolerances

The following paragraphs are added:

Permissible variation to each tunnel segment is as follows:

- Internal Dimensions – The internal dimensions shall not vary from the design by more than 1% with a maximum variation of 1/4 inch. Do not allow the internal diagonal dimensions to vary by more than 1/2 inch. Do not allow the haunch dimensions to vary more than 1/4 inch from design dimensions.
- Slab and Wall Thickness – The slab and wall thickness shall not vary from the design dimensions by more than 3/16 inch.
- Length of Opposite Surface – The laying length of the two opposite surfaces of the tunnel section shall not vary by more than 1/8 inch/foot of the internal span, with a maximum of 1/2 inch.
- Position of Reinforcement – The position of reinforcement shall not vary from the approved shop drawings by more than 1/2 inch in any direction. Place reinforcement so the indicated cover clearance does not deviate more than +/- 1/4 inch). Provide 1-1/2-inch minimum cover at the mating surface, as measured to the end of the joint.
- Position of connection rod pockets shall not vary by more than 1/8-inch in any direction.
- Joint gap between segments shall be no more than 1/2 inch (to minimize joint sealant materials).

Permissible variation to the cumulative assembly of the individual segments into a completed tunnel structure is as follows:

Deviation from theoretical cumulative overall tunnel length, line, grade, and direction shall not exceed 1 inch in any direction. The Contractor shall measure the as-built position of the leading

end of each segment after setting each segment as the work progresses and shall report the measurements to the Resident Engineer.

If cumulative measurements exceed this tolerance, or if the observed trend of incremental measurements indicates the potential for exceeding tolerances, the Contractor shall cease installation and submit a corrective action for review and approval prior to resuming work.

The Contractor is alerted to the critical need for segments no.11 & 32 (staircases) to fit within tolerance at the interface with the at-grade toll island and adjacent traffic lanes.

535.235 Installation of Precast Tunnel Segments

The following paragraphs are added:

Precast tunnel segments shall be erected as shown on the Plans. Subbase materials shall be installed to the grades shown on the plans prior to setting the tunnel segments.

A thin sheet of aluminum shall be placed on top of the subbase material to act as a bond breaker to allow for final adjustment and fit-up of the segment, and to prevent subbase materials from fouling the lap splice joint and the adhesive material along the bottom lap splice joint.

The Contractor shall take care to prevent subbase materials from fouling the lap splice joint and the adhesive material along the bottom lap splice. Prevention of subbase migration into the joint shall be accomplished by extending the limits of the aluminum sheeting used for bearing, or otherwise controlling the placement and preventing the migration of the underdrain backfill subbase material.

The Contractor, at its option, may provide alternative materials, means or methods for accomplishing the intended bearing and for preventing fouling of the joint, subject to review and approval by the Engineer.

Manufacturer-installed gaskets shall be checked prior to setting each segment to ensure the gasket is securely affixed at the concrete joint. Defective gaskets shall be immediately replaced, and gaskets not securely fastened to the concrete shall be repaired with factory-supplied adhesive for field installation.

The precast tunnel segment shall be set to the elevation and location shown on the Plans. Once in position, the next tunnel segment shall be aligned and adjoined to the previous segment.

Prior to releasing subsequent segments from the crane support, the segment shall be tightened to the adjoining segment by installing the connection rods at the interior pocket locations to create a watertight seal at the joint. Bearing plates and nuts shall be readily available on-hand to commence the tightening of 403the rods. To overcome the bottom friction between the tunnel segment and the subbase materials, the crane may be used to lift the tunnel segment and to slightly lift the previously installed tunnel segment to enable a tight fit at the joint. Once the joint is tight and the rods are hand-tightened, the position of the tunnel segments shall be checked for alignment and condition. Tolerances shall be checked and maintained, including the gap between the segments. Upon successful inspection by the resident, the crane may release the segments and tunnel construction may continue.

After setting all of the tunnel segments within the specific construction phase, and after tightening of the connection rods, the joint sealant material shall be applied to the exterior side of the segment gap per the joint sealant manufacturer's instructions. Backer rod material may be used around the perimeter of the joint (top face and two side faces only) so that the depth of the joint sealant material is no greater than 1 inch. Special care shall be taken to ensure full application along the gaps of the segment. The bottom gap will not receive any joint sealant material. Non-sag joint sealant material shall be used on the vertical surfaces, while self-leveling joint sealant material shall be used on the top exterior surface of the joint.

Exterior waterproofing membranes shall be applied to the exterior tunnel faces (including underground sections of the stairwells) once all tunnel sections are fully installed for the designated construction phase. Full installation shall include snug-tight fitting of the tunnel segments and hand-tightening of the connection rods. Exterior perimeter drainage and backfill shall be installed upon completion of the waterproofing installation. Exterior waterproofing and backfilling shall be completed in accordance with their respective specifications.

Temporary earth support systems placed at the opening of the tunnel segments in support of phased construction shall be installed in accordance with Section 511 of these Specifications. Care shall be taken to prevent any damage, settlement, or shifting of the tunnel segments during installation of the temporary earth support system.

Once exterior waterproofing is performed for each particular construction phase, the interior waterproofing materials shall be installed. Backer rod material may be used around the interior perimeter of the joint (four sides) so that the depth of the joint sealant material is no greater than 1 inch. The self-leveling joint sealant shall be installed in the floor gap, while the non-sag joint sealant shall be installed in the gaps along the walls and ceiling. The bottom pockets (connection rod locations) shall be filled with non-shrink grout. The top pockets shall remain unfilled.

Once interior waterproofing per phase is completed and the bottom pockets are filled, the walls and ceiling of the tunnel shall be coated with a pigmented coating as described in Special Provision 515. Wall and ceiling coating shall be applied prior to installation of utilities.

The floor of the tunnel shall be coated with a non-skid coating material as described in Special Provision 515. The floor coating shall only be applied once all tunnel segments and architectural enclosures are installed and the tunnel is weather tight.

Method of Measurement

The following paragraph is added:

The Precast Concrete Tunnel will be measured for payment as one lump sum unit, complete, and accepted.

Basis of Payment

The following paragraphs are added:

The accepted quantity of Precast Concrete Tunnel will be paid for at the contract lump sum price, which shall include all labor and materials required for the fabrication, delivery, and installation of the precast concrete tunnel segments; delivery and installation of connection rods; non-shrink grout; and installation of joint sealant materials around the interior and exterior perimeter of each tunnel joint. Low-friction sheets, neoprene pads, and all other accessories used to install the tunnel segments and shop drawing submittals shall be incidental to the Precast Concrete Tunnel pay item. Any cast-in-place closure section substitution elected by the Contractor to achieve assembly tolerances shall be incidental to the Precast Concrete Tunnel pay item, along with the assembly monitoring and measurement.

The precast staircase segments at Islands B&E are included in the basis of payment.

Excavations, subbase preparation, drainage, exterior waterproofing membranes, metal staircases, interior coatings, architectural components, and temporary earth support systems are not included herein, but rather will be paid for separately under their respective pay items.

Payment will be made under:

<u>Pay Item</u>		<u>Pay Unit</u>
535.70	Precast Concrete Tunnel	Lump Sum

SPECIAL PROVISIONSECTION 602PIPE LINING

(Flowable Concrete Fill)

602.01 Description

This work shall consist of providing and placing flowable concrete fill at the locations designated on the Plans.

602.02 Materials

Materials shall conform to the requirements specified in the following Subsections of Division 700 — Materials:

- | | |
|-----------------------------|-----------------------|
| ▪ Portland Cement | 701.01 |
| ▪ Water | 701.02 |
| ▪ Air Entraining Admixtures | 701.03 |
| ▪ Water Reducing Admixtures | 701.04 |
| ▪ Fly Ash | 701.10 |
| ▪ Fine Aggregate | 703.01 |
| ▪ Accelerating Admixtures | AASHTO M-194 Type “C” |

602.03 Composition and Proportioning

Flowable concrete fill shall be composed of a homogeneous mixture of Portland Cement and/or pozzolans, fine aggregate, water, and chemical admixtures proportioned according to these Specifications.

The flowable concrete fill shall be proportioned to produce a 28 day compressive strength of 110-500 psi.

The water cement ratio for flowable concrete fill shall not be high enough to cause segregation of the mix.

Air content of five to 15 percent is the target. Higher air contents may be acceptable but will increase set time. All flowable concrete fill shall be air entrained by the addition of an air entraining admixture or other chemical admixtures.

At least 30 days prior to the first placement, a flowable concrete fill mix design shall be submitted by the Contractor to the Resident for approval. No flowable concrete fill shall be placed on the Project until the mix design is approved by the Resident. At a minimum, the mix design submitted by the Contractor shall include the following:

- A. Target water cement ratio
- B. Target strength

C. Target air content

602.04 Quality Control

Process control measurements of air content, mix temperature, and slump shall be performed on the portion or portions of flowable concrete fill batches delivered to the site. At least one (1) set of measurements for air content, temperature, and slump of flowable concrete fill mix shall be performed per placement or per day, whichever is less frequent. Test cylinders will not be required.

Air content shall be measured following the requirements of AASHTO T152 utilizing Type B equipment.

Slump shall be measured by Modified Slump Test as described below.

Apparatus:

Scoop, measuring tape, flat edge, 3 in. x 6 in. cylinder mold open at both ends, and a flat non-absorbent surface.

Procedure:

1. Set cylinder upright on flat non-absorbent surface.
2. Scoop representative sample of flowable concrete fill.
3. Fill the cylinder, with the sample in one lift without tamping. Strike-off the top with the flat edge to form a level surface.
4. Clear any residue from around the bottom of the cylinder.
5. During a count of three seconds, lift the cylinder straight up allowing the sample to spread on the flat surface.
6. Measure the spread diameter to the nearest 1/2 inch. A spread of nine to 14 inches is considered flowable.

602.05 Batching

Measuring and batching of materials shall be performed at an approved batching plant, either commercial or otherwise.

602.06 Mixing and Delivery

The Contractor shall provide a Certificate of Compliance as described in Standard Specification Section 502, Structural Concrete, Subsection 502.0501, Quality Control METHOD C, for each truckload of flowable concrete fill.

602.07 Cold Weather Placement

The following amended requirements of Standard Specification Section 502, Structural Concrete, Subsection 502.08, Cold Weather Concrete, will apply.

The Cold Weather Temperature Table does not apply to flowable concrete fill. The minimum concrete temperature as placed shall be 40°F. No housing framework or heating will be required when placed under approved cold weather conditions.

602.08 Forms and Containment Berms

When necessary to contain flowable concrete fill within a defined area, berms shall be constructed of compacted granular material.

602.09 Placing Flowable Concrete Fill

Flowable concrete fill shall not be placed until forms and/or containment berms have been checked and approved. Flowable concrete fill shall not be placed under water. The method and sequence of placing flowable concrete fill shall be approved by the Resident before any flowable concrete fill is placed.

All flowable concrete fill shall be placed before it has taken its initial set. Flowable concrete fill shall be placed in such a manner as to avoid separation and segregation of the mix. Consolidation, tamping, and vibration is not required or allowed.

Flowable concrete fill shall be discharged directly from the truck into the space to be filled. The drop height of the flowable concrete fill shall be as low as practicable. Flowable concrete fill shall not flow down the vertical face of a trench causing erosion of the trench face. Finishing and curing of flowable concrete fill is not required.

Flowable concrete fill placed will not be opened to traffic or covered with structural concrete or pavement for a minimum of 24-hours.

602.10 Method of Measurement

Flowable Concrete Fill satisfactorily placed and accepted will be measured by the cubic yard, in accordance with the pay limits established, if such limits have been established. If the Contractor elects to omit forms or berms, then any excavation or Flowable Concrete Fill placed beyond the pay limits as indicated on the Plans will not be paid for, but shall be at the Contractor's own expense.

602.11 Basis of Payment

The accepted work done under Flowable Concrete Fill will be paid for at the Contract unit price per cubic yard. Payment will be full compensation for furnishing and placing Flowable Concrete Fill, including all forms, berms, granular material, pumping, dewatering and necessary incidentals.

Payment will be made under:

<u>Pay Item</u>		<u>Pay Unit</u>
602.30	Flowable Concrete Fill	Cubic Yard

SPECIAL PROVISIONSECTION 603PIPE CULVERTS AND STORM DRAINS

(Reinforced Concrete Pipe)
 (Corrugated Polyethylene Pipe)
 (Concrete Collar for Reinforced Concrete Pipe)

603.01 Description

The following paragraphs are added:

This work shall also consist of furnishing and installing Class III or Class V reinforced concrete pipe at the locations as shown on the Plans or as approved by the Resident.

This work shall also consist of furnishing and installing various sizes of corrugated HDPE pipe, including a dual wall adaptor fitting by Hancor or an approved equal as shown on the plans. No other pipe types within the Option III alternatives will be accepted.

603.02 Materials

All Corrugated High Density Polyethylene (HDPE) pipe for storm water and drainage systems shall meet the requirements of Subsection 706.06.

603.11 Method of Measurement

The following paragraph is added:

Dual Wall Adapter Fitting shall be included for payment as three additional linear feet of the largest pipe involved.

603.12 Basis of Payment

Corrugated HDPE pipe will be paid for under the appropriate sized Culvert Pipe Option III pay items.

Payment will be made under:

<u>Pay Item</u>		<u>Pay Unit</u>
603.155	12 inch Reinforced Concrete Pipe - Class III	Linear Foot
603.165	15 inch Reinforced Concrete Pipe - Class III	Linear Foot
603.175	18 inch Reinforced Concrete Pipe - Class III	Linear Foot
603.195	24 inch Reinforced Concrete Pipe - Class III	Linear Foot
603.205	30 inch Reinforced Concrete Pipe - Class III	Linear Foot
603.280	Concrete Collar for Reinforced Concrete Pipe	Each

SPECIAL PROVISION

SECTION 605

UNDERDRAINS

(12 Inch Underdrain Type C – SDR)

605.01 Description

The following paragraphs are added:

This work shall also consist of furnishing and installing 12 inch diameter PVC SDR35 pipe with perforations and fittings for the precast concrete tunnel underdrain at the locations as shown on the Plans or as approved by the Resident.

605.02 Materials

All 12 inch diameter PVC Schedule SDR35 pipe for the precast concrete tunnel underdrain shall be made of compounds conforming to ASTM D1784 manufactured in accordance with the material requirements of ASTM D3034 or ASTM F679. All 12 inch diameter PVC Schedule SDR35 pipe shall meet dimensional, chemical, and physical requirements as outlined in ASTM D3034 or ASTM F679. Joints shall meet the requirements of ASTM D3212.

The pipe shall be provided with 1/2” diameter holes spaced at 6” along the length of the pipe located in 2 rows at the bottom 1/3 points of the pipe diameter and installed with perforations down.

605.06 Method of Measurement

Underdrain will be measured by the length in linear feet along the centerline of underdrains and underdrain outlets of the types and sizes completed and accepted.

When elbows, tees, wyes, or other special fittings are required in underdrain, each fitting shall be included for payment as 3 additional linear feet of the largest pipe size involved.

603.12 Basis of Payment

The 12 Inch Underdrain Type C – SDR will be paid for at the contract unit price.

Payment will be made under:

<u>Pay Item</u>		<u>Pay Unit</u>
605.111	12 inch Underdrain Type C – SDR	Linear Foot

SPECIAL PROVISION

SECTION 606

GUARDRAIL

- (31" W-Beam Guardrail – Mid-way Splice (7' Steel Posts, 8" Offset Blocks, Single Faced)
- (31" W-Beam Guardrail – Mid-way Splice (8' Steel Posts, 8" Offset Blocks, Single Faced)
- (31" W-Beam Guardrail – Mid-way Splice (7' Steel Posts, 8" Offset Blocks, Double Faced)

606.01 Description

The section is amended by the addition of the following:

This work shall consist of furnishing and installing guardrail components the required locations in accordance with the Specifications and in reasonably close conformity with the lines and grades shown on the Plans. The types of guardrail are designated as follows:

- 31" W-Beam Guardrail – Mid-way Splice (7' Steel Posts, 8" Offset Blocks)
- 31" W-Beam Guardrail – Mid-way Splice (8' Steel Posts, 8" Offset Blocks)

606.02 Materials

The section is amended by the addition of the following:

Steel posts shall be 7 feet or 8 feet long as specified in the plans.

The guardrail elements shall be per the Components' List found on Sheet No. 2 of 2 of draft Drawing SGR47 – 31" W-Beam Guardrail with Standard 8" Offset Block in the Task Force 13 Report noted above and/or as noted in the Contract Documents unless noted otherwise.

606.04 Rails

The section is amended by the addition of the following:

Height of top of rail shall be 31" measured from final grade. Height transition from 31" W-Beam, mid-spliced guardrail to existing guardrail shall occur over a 25' length.

606.08 Method of Measurement

The section is amended by the addition of the following:

31" W-Beam Guardrail – Mid-way Splice (7' Steel Posts, 8" Offset Blocks) and 31" W-Beam Guardrail – Mid-way Splice (8' Steel Posts, 8" Offset Blocks) will be paid for at the contract unit price per linear foot of rail satisfactorily installed and accepted.

606.09 Basis of Payment

The section is amended by the addition of the following:

The accepted quantity of 31” W-Beam Guardrail – Mid-way Splice (7’ Steel Posts, 8” Offset Blocks) and 31” W-Beam Guardrail – Mid-way Splice (8’ Steel Posts, 8” Offset Blocks) will be paid for at the contract unit price per linear foot of rail and shall be full compensation for furnishing all labor, equipment and materials necessary to complete the work.

Payment will be made under:

<u>Pay Item</u>		<u>Pay Unit</u>
606.13	31” W-Beam Guardrail – Mid-way Splice (7’ Steel Posts, 8” Offset Blocks, Single Faced)	Linear Foot
606.131	31” W-Beam Guardrail – Mid-way Splice (8’ Steel Posts, 8” Offset Blocks, Single Faced)	Linear Foot
606.132	31” W-Beam Guardrail – Mid-way Splice (7’ Steel Posts, 8” Offset Blocks, Double Faced)	Linear Foot

SPECIAL PROVISION

SECTION 606

GUARDRAIL

(31" W-Beam Guardrail – Mid-way Splice Tangent Terminal)

606.01 Description

The following sentences are added:

This work shall consist of furnishing and installing a MSKT (MASH-compliant Sequential Kinking Terminal) for use with the 31" W-Beam Guardrail – Mid-way Splice (7' Steel Posts, 8" Offset Blocks, Single Faced) as manufactured by Road Systems, Inc., 3616 Old Howard County Airport Road, Big Spring, Texas 79720, (432) 263-2435, and retroreflective adhesive sheeting in accordance with these Specifications and the manufacturer's installation instructions, and in reasonably close conformity with the lines and grades as shown on the Plans or as approved by the Resident.

606.02 Materials

The following sentence is added:

31" W-Beam Guardrail – Mid-way Splice Tangent Terminal components shall be comprised of those shown in the manufacturers installation instructions. 8" blocks shall be used.

Reflective sheeting shall meet the requirements of Subsection 719.01, Reflective Sheeting – minimum ASTM Type XI; 3M™ Diamond Grade™ DG³ Reflective Sheeting Series 4000 or approved equal, color white.

The contractor shall request for the impact face object marker, black chevron on yellow background, to be included in the shipped materials when installation is on the left side of roadway.

The following Subsections are added:

606.03 Posts

Wood offset blocks shall be toe-nailed in two locations to the wood post to prevent the blocks from moving.

606.035 Construction Requirements

The Contractor shall submit a set of installation drawings to the Resident for approval. The system shall be installed in accordance with the manufacturer's recommendation and the installation drawings.

A reflective adhesive sheeting shall be applied to the nose of the MSKT System after installation.

606.041 Reflective Sheeting

The color for the reflective sheeting shall be silver (white) when installed on the right shoulder and shall be black chevron on yellow background only when installed on the left shoulder.

606.08 Method of Measurement

The second paragraph is amended by the addition of: “31” W-Beam Guardrail – Mid-way Splice Tangent Terminal, ” after the words “Terminal section, ”.

31” W-Beam Guardrail – Mid-way Splice Tangent Terminal will be measured by each unit satisfactorily complete in place and accepted.

606.09 Basis of Payment

The first paragraph is amended by the addition of: “31” W-Beam Guardrail – Mid-way Splice Tangent Terminal, ” after the words “Terminal section, ”.

The second paragraph is amended by the addition of: “, 31” W-Beam Guardrail – Mid-way Splice Tangent Terminal, ” after the words “NCHRP 350 end treatments ”.

The retroreflective sheeting will not be measured separately for payment, but shall be incidental to the 31” W-Beam Guardrail – Mid-way Splice Tangent Terminal item.

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
606.1306 31” W-Beam Guardrail – Mid-way Splice Tangent Terminal	Each

SPECIAL PROVISION

SECTION 606

GUARDRAIL

(31" W-Beam Guardrail – Mid-way Splice Terminal End – Anchored End)

606.01 Description

The section is amended by the addition of the following:

This work shall consist of furnishing and installing Terminal End – Anchored End – 31" W-Beam Guardrail end treatment in accordance with these Specifications and Plan Sheet details, the AASHTO-AGC-ARBTA Joint Committee Task Force 13 Report: A Guide to Standardized Highway Barrier Hardware, Drawing SEW31 in AASHTO Manual for Assessing Safety Hardware (MASH) approval letter B-256; and in reasonably close conformity with the lines and grades as shown on the Plans or as approved by the Resident.

606.02 Materials

The following sentences are added:

The guardrail elements shall be per the Components' List found on Sheet No. 2 & 3 of 3 of Drawing SEW31 – Trailing-end Anchorage System in the Task Force 13 Report noted above and/or as noted in the Contract Documents. The component RWM14a shall be modified to a length of 9'-4½" measured from the center of the Mid-way Splice to the center of the last guardrail post.

606.042 Terminal End - Anchored End

The following sentences are added:

Installation of the Terminal End – Anchored End - 31" W-Beam Guardrail end treatment shall be in accordance with these plans and specifications, the AASHTO-AGC-ARBTA Joint Committee Task Force 13 Report and the Details on Sheet No. 1 of 3 of Drawing SEW31 – Trailing-End Anchorage System.

606.08 Method of Measurement

The second paragraph is amended by the addition of: “, Terminal End - Anchored End – 31" W-Beam Guardrail, ” after the words “Terminal section, ”.

606.09 Basis of Payment

The first paragraph is amended by the addition of: “, Terminal End - Anchored End – 31" W-Beam Guardrail, ” after the words “Terminal section, ”.

The second paragraph is amended by the addition of: “, Terminal End - Anchored End – 31" W-Beam Guardrail, and ” after the words “NCHRP 350 end treatments ”.

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
606.1351 31” W-Beam Guardrail – Mid-way Splice Terminal End – Anchored End	Each

SPECIAL PROVISION

SECTION 606

GUARDRAIL

(Bridge Transition- Type III, Modified)

606.01 Description

The following sentence is added:

This work shall consist of furnishing and installing Type III, Modified Bridge Transitions at concrete barrier ends as shown in the Contract Documents.

The following Subsection is added:

606.071 Guardrail Attachments at Bridges

Bridge Transition - Type III, Modified shall be used at concrete barrier end locations as shown on the plans.

606.08 Method of Measurement

The following sentence is added:

Bridge Transition- Type III, Modified will be measured by each unit of the type specified, installed and accepted.

606.09 Basis of Payment

The following paragraphs are added:

Bridge Transition - Type III, Modified, will be paid for at the Contract unit price each complete in place and shall be full compensation for furnishing all labor, equipment and materials necessary to complete the work consisting of, but not necessarily limited to, the following: furnishing and installing guardrail, modifications to barrier concrete to accept terminal anchor, one terminal connector, precast concrete transition curb, including terminal connector anchorage and all other detailed accessories; furnishing and installing all required posts, rails, offset brackets, back-up plates, nuts, bolts, washers, and all other items necessary to make for a complete installation as shown on the Plans or as approved by the Resident.

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
606.1724 Bridge Transition - Type III, Modified	Each

SPECIAL PROVISION

SECTION 606

GUARDRAIL

(Terminal End - Remove and Reset)

606.01 Description

The following sentences are added:

This work shall also consist of removing existing terminal end elements, component parts and hardware, and resetting to the proper location.

In locations where new guardrail is being installed on the departure side, terminal ends are required as end treatments. These terminal ends shall be provided from the ones designated under this item to be stacked. Installation of these terminal ends shall also be included under this item.

606.08 Method of Measurement

The following sentences are added:

Terminal End - Remove and Reset will be measured by each unit satisfactorily reset.

Terminal End - Remove and Stack will be measured by each unit satisfactorily stacked.

Terminal ends removed, but not suitable to be reset or stacked shall become property of the Contractor. Payment shall be incidental to the other guardrail pay items.

606.09 Basis of Payment

The following paragraphs are added:

The accepted quantity of Terminal End – Remove and Reset will be paid for at the Contract unit price bid which shall be full compensation for removing and resetting the terminal end and all equipment, labor and incidentals necessary to complete the work.

The accepted quantity of Terminal End – Remove and Stack will be paid for at the Contract unit price bid which shall be full compensation for removing and stacking the terminal end and all equipment, labor and incidentals necessary to complete the work. This price shall be full compensation for removing all rails, posts, offset brackets, nuts, bolts, washers, hardware, all labor, transportation and all other incidentals necessary to complete the work. No additional compensation will be made for furnishing terminal ends from the stacked location and installing them on the departure side of the new guardrail, but shall be incidental to the Remove and Stack Terminal End item.

Payment will be made under:

Pay Item

Pay Unit

606.2651 Terminal End - Remove and Reset

Each

SPECIAL PROVISIONSECTION 606GUARDRAIL

(Reflectorized Beam Guardrail Delineator)

606.01 Description

The following paragraphs are added:

Reflectorized beam guardrail delineators shall be installed on existing guardrail to remain in place, guardrail noted to be removed, modified and reset (single and/or double rail) or new guardrail, at the locations noted on Maintenance of Traffic plans or as approved by the Resident. The delineators shall be installed prior to traffic being shifted closer to the identified guardrail run. The color for the reflective sheeting shall be silver (white) when installed on the outside shoulder and yellow when installed on the inside shoulder.

Reflectorized beam guardrail delineators shall be mounted as follows:

1. Delineators on guardrail adjacent to a shifted detour should be spaced every other guardrail post and located at the bolt in the valley of the guardrail beam.
2. On existing steel bridge rail, the delineators shall be mechanically attached towards the top, every 10 feet, and bottom, every 20 feet. Delineators shall also be mechanically attached in a similar pattern to concrete endposts that are 10 feet or longer.
3. If more than 25% of delineators in any 50 feet of guardrail, bridge rail, or endposts fall off for any reason, the Contractor will be responsible for reinstalling all delineators in that run at their own cost.
4. In no instance shall delineators be installed on guardrail which deviates substantially from the alignment (horizontal or vertical) of the roadway or which is located more than eight feet from the edge of pavement.
5. On Tangents, mount delineators every 62.5-feet or every 10th post.
6. On Curves, mount delineators every 31.25-feet or every 5th post.

Exceptions and/or modifications will only be made with the approval of the Resident.

Contractor is required to submit installation method for review and approval to the Resident.

606.02 Materials

The fourth paragraph is deleted and replaced with the following:

The reflectorized beam guardrail delineators shall be fabricated from galvanized steel.

Reflective sheeting shall meet the requirements of Subsection 719.01, Reflective Sheeting – minimum ASTM Type XI; 3M™ Diamond Grade™ DG³ Reflective Sheeting Series 4000 or approved equal.

606.08 Method of Measurement

The following paragraph is added:

Reflectorized Beam Guardrail Delineators will be measured by each unit of the kind specified and installed. Maintenance and replacement of delineators will not be measured separately for payment unless otherwise approved by the Resident.

606.09 Basis of Payment

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

Reflectorized Beam Guardrail Delineators will be paid for at the Contract unit price each when installed on existing guardrail, complete in place, which price shall be full payment for furnishing and installing all components and for all incidentals necessary to complete the installation. Reflectorized Beam Guardrail Delineators will not be paid for on new guardrail.

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
606.352 Reflectorized Beam Guardrail Delineator	Each

SPECIAL PROVISIONSECTION 606GUARDRAIL

(Delineator Post – Remove and Reset)

606.01 Description

The following paragraphs are added:

This work shall also consist of furnishing and installing new delineator posts and/or removing and resetting existing delineator posts within the Contract limits. The existing reflectorized delineator panels shall be removed and replaced with new reflectorized delineator panels as required by the Resident.

Existing and new delineator posts shall be located as follows, with the indicated panel:

Outside Shoulder:

- One at guardrail trailing ends (green delineator).
- Two at guardrail approach ends (one red delineator on first post and one red delineator on angle points.)

Median:

- One at guardrail trailing ends (green delineator, facing traffic).
- Two at guardrail approach ends (one red delineator on first post of CAT units, green on guard rail side, red on median opening side; and one red (both sides) delineator at angle point.)
- One at all other median guardrail angle points (red on both sides)

Other Locations:

- One at culvert outlets (green delineator).
- Twenty per mile evenly spaced at the edge of outside shoulder (white delineator).
- One at electrical junction boxes not associated with another item (red delineator).
- One at communication only junction boxes not associates with another item(orange delineator).

Delineator posts that do not exist in the locations described above, shall be supplied and installed by the Contractor. The installation of the delineator post shall include the demountable reflectorized delineator panel.

White edge delineators shall not be installed on any portion of the widened shoulder for Guardrail 350 Flared Terminal installations, and shall not be installed behind the Guardrail 350 Flared Terminal rail segments.

606.02 Materials

The following paragraphs are added:

Non-guardrail Delineator Posts shall conform to Subsection 606.02 paragraph 3.

The seventh through ninth sentences of the fourth paragraph are deleted and replaced with the following:

Reflectorized flexible guardrail markers shall be a minimum of 2-inches in diameter, a maximum of 36" in length, ovalized at the top of the post to allow application of 3 inch by 9 inch high intensity reflective sheeting, and shall be capable of recovering from repeated impacts. The flexible guardrail delineator markers shall be grey and capped at the top with a flexible rubber cap; Safe-Hit Flexible Guardrail Delineator or approved equal. Reflective material shall meet the requirements of ASTM Type IX Diamond Grade VIP (Visual Impact Performance).

The demountable reflectorized delineator panels shall meet the material requirements of Subsection 719.06. The delineator panel shall be rectangles measuring 9" x 3".

606.03 Posts

The following paragraphs are added:

The top of delineator posts shall be installed 4' - 6" (54")) above edge of pavement elevation. Delineators shall be installed four feet from edge of pavement except those delineating end treatments, culverts and electrical items.

Mile marker posts shall be mounted on breakaway supports. The bottom of the sign shall be 5' - 0" (60") above the pavement at the solid white line and shall be offset five feet from the edge of pavement.

A mock-up of the guardrail delineator posts shall be submitted to the Resident for approval prior to installation.

Any materials damaged by the Contractor's operations shall be replaced at no additional cost to the Authority.

Top of the delineator panel shall be flush with the top of post.

606.08 Method of Measurement

The following paragraphs are added:

Delineator Posts shall be measured by each unit satisfactorily installed. Delineator Post-Removed and Reset will be measured by each unit satisfactorily removed and reset. Delineator Posts Removed and Stacked will be measured by each unit satisfactorily removed and stacked.

Mile Marker post shall be measured for payment as Delineator Post. The breakaway supports shall be incidental to the Underdrain Delineator Post pay item.

606.09 Basis of Payment

The following sentences are added:

The accepted quantity of Delineator Posts will be paid for under the Underdrain Delineator Post item, at the Contract unit price per each which price shall be full compensation for the post and specified delineator or mile marker panel, complete in place.

The accepted quantity of Delineator Post - Removed and Reset will be paid for at the Contract unit price each, which price shall be full compensation for removing and resetting the delineator panel or mile marker panel and post and all incidentals necessary to complete the work.

The accepted quantity of Delineator Posts Removed and Stacked will be paid for at the Contract unit price each, which price shall be full compensation for removing and stacking delineator panel or mile marker panel and posts and all incidentals necessary to complete the work.

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
606.3561 Delineator Post - Remove and Reset	Each

SPECIAL PROVISION

SECTION 606

GUARDRAIL

(Guardrail – Remove, Modify and Reset, Single Rail)

606.01 Description

The following paragraphs are added:

This work shall consist of removing, modifying and resetting existing single and double guardrail elements, component parts and hardware suitable for reuse as approved by the Resident. At the completion of the Contract, any unused guardrail elements, posts, component parts and hardware shall become property of the Contractor.

Stockpiled materials, suitable for reuse, shall be utilized on Remove, Modify and Reset items prior to new materials being paid for.

606.02 Materials

The following paragraph is added at the end of the subsection:

New non-wood offset blocks conforming to NCHRP 350 Test Level 3 shall be installed on all guardrail being reset. The existing steel offset brackets and backup plates shall become the property of the contractor.

606.08 Method of Measurement

The following paragraphs are added:

Raking and compacting the earth around each reset post with a minimum 8 pound hand tamper or an approved device, and infilling and compacting holes created due to resetting posts with a similar surrounding material will not be paid separately, but shall be incidental to the Guardrail - Remove, Modify and Reset pay items.

Guardrail removed and not reset or stacked shall be incidental to Contract Items and include all removal, disposal, equipment and labor necessary to satisfactorily complete the work.

Steel posts to replace damaged posts shall come from the stockpile of guardrail components to be disposed of, from this Contract and will not be measured separately for payment. If, in the opinion of the Resident, there are no suitable steel posts in the stockpile then steel posts will be measured for payment.

W-beam rail elements to replace damaged rail elements shall come from the stockpile of guardrail from the Remove and Stack or the guardrail to be disposed of from this Contract and will not be measured separately for payment. If, in the opinion of the Resident, there are no suitable W-beam rail elements in the stockpile then the W-beam rail elements will be measured for payment.

606.09 Basis of Payment

The following paragraphs are added:

Payment will be made under:

<u>Pay Item</u>		<u>Pay Unit</u>
606.3605	Guardrail – Remove, Modify, and Reset Single Rail	Linear Foot

SPECIAL PROVISION

SECTION 607

FENCES

(Automatic Entry Gate System)

607.01 Description

The following paragraphs are added:

This work shall consist of furnishing and constructing a bi-directional traffic, Automatic Upswing Rigid Cantilever Arm Barrier Gate (Gate System) in accordance with the following specifications.

The installation shall include the assembly and erection of all parts and materials complete at the locations shown on the Plans and as recommended by the Manufacturer or as approved by the Resident.

607.02 Materials

The following paragraph is added:

The automatic entry gate shall be the StrongArm14F UPS Premium Industrial Barrier System manufactured by Nice/HySecurity, 6705 S 209th St, Suite 101, Kent, WA 98032, (800) 321-9947. It shall have the following features:

Arm Length Max.	14 Feet
Open/Close Time	6 - 10 seconds
Arm Design	Aluminum, Side Mount, Breakaway
Temperature Rating	-40 degrees F to 158 degrees F
Duty Cycle	200 cycles/hr
Warranty	5 years
Relays	Three Standard with 8 Additional using Hy8 Relay
Communications	RS-232m RS-485, Ethernet/Fiber using Hynet Gateway, any necessary software shall be provided to the MTA.
Back Up Power	Integrated UPS shall be provided

Foundations necessary for the automatic entry gates and any ancillary equipment shall meet the requirements of Section 626 of the Standard Specifications and the Manufacturer's recommendations.

607.03 General

The following paragraphs are added:

A plan for the Gate System and conduit system shall be designed and submitted to the Resident Engineer for approval. The system shall be designed for bi-directional traffic and provide vehicles sensors to determine when vehicles have passed through the gate and it is safe for the gate to close.

Operational control of the automatic entry gate shall be as follows:

The gate operation shall be via the existing Mighty Mule gate remote transmitters that the MTA currently utilizes and in addition shall be controlled by the MTA Lenel electronic card system. The MTA will be responsible for providing the Lenel card system. Contractor shall be responsible for the integration of the Lenel system with the Gate System. Contractor shall provide and install conduit, mounting posts, & foundations for card readers located 20 feet on either side of gate or as shown on the plans or directed by the Resident. Readers shall be mounted 4 feet (for cars/light duty trucks) and 6 feet (for large vehicles) above the road surface and protected with a bollard. Gate system shall also include a Knox Single Key Switch on Mounting Plate (Knox Model #3502) located on the Access Road side of the gate attached to the same post as the Lenel card reader.

A UPS battery backup system that is capable of operating the automatic entry gate through a power outage shall be included in the installation.

Gate Beam shall be replaceable and come with three (3) additional replacement beams. Gate beams and gate support (control cabinet) shall be retroreflectorized with Rail Gate Arm Type V alternating red and white prismatic reflective tape both sides, for full width of beam and height of cabinet.

Obstruction Detection Devices: Provide Gate System with automatic safety sensor(s). Activation of sensor(s) causes operator to immediately function as follows:

- Action: Reverse gate in both opening and closing cycles and hold until clear of obstruction.
- Action: Stop gate in opening cycle and gate in closing cycle and hold until clear of obstruction.
- Internal Sensor: Built-in torque or current monitor senses gate is obstructed.
- Photoelectric/Infrared Sensor System: Designed to detect an obstruction in gate's path when infrared beam in the zone pattern is interrupted

Contractor will be responsible for the meter, meter pedestal, separate 334 NEMA cabinet to house the necessary circuit breakers for the gate system and the Lenel Card System.

Gate System shall include 10 Bollards. Bollards shall be installed on either side of the gate mechanism and at the end approximately two feet from the end of the gate when it is in the closed position. A clear distance of no less than 16 feet and no more than 16'6" should be provided for vehicles to drive through the gate opening. Additionally, bollards will be placed with each card reader and placed such that the bollard does not obstruct the intended use of the card reader or hinder normal vehicular movement and plowing operations.

The Contractor shall install wires for communications and wires for electrical power in separate conduits.

All materials and workmanship shall conform to the requirements of the National Electric Code.

The Contractor shall provide a qualified technician to thoroughly review and confirm that the gate system is satisfactory and operational as designed. Prior to the gate system becoming operational, both Contractor and Resident shall review and comment upon the Gate System.

607.06 Method of Measurement

Automatic Entry Gate System will be measured as one lump sum which shall include fully operational systems at the Access Road.

607.07 Basis of Payment

Automatic Entry Gate System will be paid for the complete in place system, which payment shall be full compensation for furnishing and installing all materials, necessary hardware, cabinets, foundations, meter, wire, bollards, excavation and concrete, and all incidentals required for a complete functioning installation at the Access Road. Materials and work required to connect to the Administrative Building will be considered incidental to this work.

Conduit shall be paid under respective items in Section 626 of the Standard Specifications.

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
607.2326 Automatic Entry Gate System	Lump Sum

SPECIAL PROVISION

SECTION 607

FENCES

(Chain Link Fence - 3' High)
(Post Assemblies for Chain Link Fence - 3' High)

Description

This Subsection is amended by the addition of the following:

This work shall consist of fabricating and erecting 3'-0" high barrier mounted chain link fence and barrier mounted post assemblies for support of chain link fence and/or road signs as shown on the Plans.

Materials

This Subsection is amended by the addition of the following:

All materials for the chain link fence and Post Assemblies shall be hot dip galvanized after fabrication in accordance with ASTM A123 or A153 as applicable.

All anchor bolts shall be drilled and anchored into concrete barrier using an approved chemical anchoring material selected from the MaineDOT list of qualified anchoring materials. The use of cementitious grouts will not be allowed.

Method of Measurement

This Subsection is amended by the addition of the following:

Post Assemblies for Sign or Chain Link Fence shall be measured by each unit satisfactorily fabricated and installed.

Basis of Payment

This Subsection is amended by the addition of the following:

Payment for Post Assembly for Sign or Chain Link Fence shall include furnishing and installing anchor rods and related hardware required to fasten the post assemblies to the precast barrier.

Payment will be made under:

<u>Pay Item</u>		<u>Pay Unit</u>
607.40	Chain Link Fence – 3’ High	Linear Foot
607.41	Post Assembly For Sign Or Chain Link Fence	Each

SPECIAL PROVISION

SECTION 607

FENCE

(Dumpster Enclosure)

607.01 Description

The following paragraphs is added:

This work shall also consist of installing a Dumpster Enclosure of dimensions conforming to the plans and at the location depicted on the plans.

The installation shall include the assembly and erection of all parts and materials complete at the locations as shown on the Plans or as approved by the Resident.

The installation shall include installing a concrete pad for the dumpster enclosure as detailed in the project plans and these specifications.

607.02 Materials

The following sentences are added:

Privacy Slats shall be UV light stabilized fiber-glass reinforced plastic slats, not less than 0.06 inches thick, size to fit mesh specified for direction indicated. Color shall be as indicated on the drawings.

Polymer Coated Fabric shall be per ASTM F668, Class 1 over zinc coated steel wire. Color shall be as indicated on the drawings.

Concrete shall be Class "A" concrete (4000 PSI) and shall meet the requirements of Section 502.

Reinforcing steel shall meet the requirements of Section 503.

607.03 Chain Link Fence

The following sentences are added:

Privacy Slats shall be installed in the vertical direction per the manufacturer's recommendations.

607.04 Method of Measurement

Dumpster Enclosure will be measured by each unit of the kind specified and installed.

607.05 Basis of Payment

Dumpster Enclosure will be paid for at the Contract price each, complete in place, which payment shall be compensation for furnishing and installing all fence enclosure panels/slats and with necessary hardware, concrete pad, excavation and concrete.

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
607.4211 Dumpster Enclosure	Lump Sum

SPECIAL PROVISION

SECTION 610

STONE FILL, RIPRAP, STONE BLANKET AND STONE DITCH PROTECTION

(Temporary Stone Check Dams)

610.01 Description

Paragraph (g) is added as follows:

(g) Stone Check Dams – Machine placed stone, including the placement, removal and storage of the stone used for temporary stone check dams.

610.032.e. Stone Check Dams

The following paragraph is added:

Stone check dams shall be constructed in accordance with the details as shown on the Plans, detailed in the MaineDOT's latest Best Management Practices, or as approved by the Resident. The stone shall be placed in one operation without special handling or handwork except to create a low point along the top gradient above the ditch flow lines.

The following Subsection is added:

610.033 Removing Stone

The stone for temporary stone check dams shall be removed after vegetation has been established in the ditches as approved by the Resident.

Any damage to the slopes and ditches caused by the removal of the stone check dams shall be repaired by the Contractor at his own expense.

The area directly under the temporary stone check dams shall be loamed, seeded and mulched immediately after the removal of the stone check dams. The loam, seed and mulch will be measured for payment under the appropriate pay items.

Stone used for temporary stone check dams shall be removed and stored and shall become the property of the Contractor at the completion of the Project.

The following Subsection is added:

610.034 Maintenance

Stone check dams shall be maintained by the Contractor. Sediment deposits behind check dams shall be removed when the depth of sediment reaches 50 percent of the check dam height.

610.05 Method of Measurement

The following paragraphs are added:

Stone for Temporary Stone Check Dams will be measured by the cubic yard complete in place. The removal and storage of the stone will not be measured separately for payment, but shall be incidental to the Temporary Stone Check Dam item. This shall include the transporting and unloading of the stone. If this stone is reused on the Project, it will be measured separately for payment under the appropriate pay item.

The removal and disposal of sediment from behind the Temporary Stone Check Dams will not be measured separately for payment, but shall be incidental to the Temporary Stone Check Dam pay item.

610.06 Basis of Payment

The following sentences are added:

The accepted quantities of stone for Temporary Stone Check Dams will be paid for at the Contract unit price per cubic yard.

Payment will be made under:

<u>Pay Item</u>		<u>Pay Unit</u>
610.181	Temporary Stone Check Dam	Cubic Yard

SPECIAL PROVISION

SECTION 613

EROSION CONTROL BLANKET

613.01 Description

This work shall also include seeding, mulching and watering the median swale and/or longitudinal flow line to the limits and width as shown on the Plans or as directed by the Resident.

613.02 Materials

The following sentences are added:

Seeding shall meet the requirements of Section 618, Seeding, Method Number 2.

Mulch shall meet the requirements of Section 619.

The following Subsection is added:

613.041 Maintenance and Acceptance

See Section 618.10 for maintenance and acceptance of seeding.

613.042 Mulch

All mulch shall be placed after the area has been seeded and prior to the installation of the Erosion Control Blanket.

613.09 Basis of Payment

The following "and mulch" is added after the words "initial seeding" in the second sentence.

Payment will be made under:

<u>Pay Item</u>		<u>Pay Unit</u>
613.319	Erosion Control Blanket	Square Yard

SPECIAL PROVISION

SECTION 619

MULCH

(Mulch – Plan Quantity)
(Temporary Mulch)

619.01 Description

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

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

Add the following sentence at the end of the first paragraph:

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

619.03 General

The first paragraph is deleted and replaced with the following:

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

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

619.06 Method of Measurement

The following sentence is added:

Temporary Mulch will be paid for by the lump sum.

619.10 Basis of Payment

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

Payment will be made under:

Pay Item

619.1201 Mulch – Plan Quantity
619.1202 Temporary Mulch

Pay Unit

Unit
Lump Sum

SPECIAL PROVISION

SECTION 621

LANDSCAPING

(Tree and Shrub Planting)

621.01 Description

This Subsection is deleted in its entirety and replaced with the following:

This work will consist of furnishing and planting trees and shrubs, and shall include all planting operations and materials, including mulch, as well as care and replacement of plants during the establishment period, all in accordance with this Specification, the plans, planting details and schedules, and the directions of the Resident.

A two-year Warranty Bond will be required of the Contractor or the landscape subcontractor for all 621 items. The Bond must name the “Maine Turnpike Authority” as an obligee. The Contractor shall provide a copy of said bond to the Authority before the performance of any affected on-site Work. Should the subcontractor be required to provide the Warranty Bond, the Contractor hereby authorizes the Authority to directly contact landscape subcontractor and/or its Surety in the event of a failure of the bonded item to replace the specified items. There will be no specific establishment period in the Contract, but shall be considered incidental to the Contract.

621.02 Materials – General

The following sentence is added:

Submittals: The Contractor shall provide samples and data sheets for fertilizers for approval by the Resident.

621.0018 Layout

The following paragraph is added:

The Resident shall be on-site during placement of all plants to identify location of plantings prior to any excavating any tree/shrub pits and plantings.

621.0020 Planting Seasons

The following paragraph is added:

Installation of the specified plants in Stream Buffer Planting Areas shall be performed only during periods when beneficial results can be obtained, based on seasonal and climatic factors and local weather conditions. For the specified plantings, spring and summer planting times are preferred over fall planting to allow time during the growing season for root systems to become well established prior to winter. This specification is intended to help plants

withstand the expected potential for stress and damage caused by road salt applications in this location.

621.0023 Setting Plants

The following paragraphs are added:

The Resident will reject any plants not installed correctly and the Contractor shall re-install plant stock as determined by the Resident at no additional cost to the Authority.

List of Plantings at Admin. Building.

ITEM NO.	DESCRIPTIONS	UNIT	QUANTITY
621.043	Thuja Occidentalis Northern White-Cedar (5' - 6')	EA	2
621.396	Juniperus Chinensis "Sergenti" Sargent Juniper (18" - 24")	EA	7
621.396	Tauntoni Yew (18" - 24")	EA	1
621.512	Dwarf Rhododendron(2' - 2.50')	EA	3
621.553	Cornus Sericea "Kelseyi" Kelsey Dogwood (3 Gal.)	EA	4

621.0025 Fertilizing

The following sentence is added:

Slow release fertilizer tablets or packets shall be placed within the planting hole, at least one inch below the surface, but not directly touching the root mass.

621.0026 Mulching

The following sentences are added:

In order to reduce competition from herbaceous species and threats from herbivory, all trees and shrubs planted on the site will be mulched with woodwaste mulch.

Woodwaste mulch shall consist of a clean fine-textured composted mix of decomposing bark chips, sawdust, wood shavings, and small wood fragments. Woodwaste Mulch shall meet the following requirements:

- (a) pH - Range 5.5 - 7.0.
- (b) Screen size – three inch minus.
- (c) Containing no less than 80 percent organic content.
- (d) Moisture content shall be loose and friable, not dusty.
- (e) No clods, roots, or materials over three inches in any dimension will be allowed.
- (f) No stones over 1/4 inch.
- (g) Must be manufactured under DEP license or permit by rule, and/or officially determined by DEP to be "non-regulated" and/or specifically approved by DEP for use in wetlands or waterways.

Woodwaste mulch shall be placed to a uniform depth of at least four (4) inches around individual plants, as part of landscape planting operations, immediately upon planting woody trees and shrubs. The placement of mulch shall cover at least the extent of disturbed soil for each plant and have a diameter of at least two feet centered on the woody plant.

The following Subsection is added:

621.0032 Watering

Woody plants shall be watered during installation and at least once per week for at least three weeks after planting or until plants go dormant. Watering can be skipped any week that the site receives more than 1/2 inch of natural rainfall during the week, or if ground conditions are saturated. The Contractor may use a sprinkler system and a pump that can be left on-site for up to two years following the original planting. The Contractor may create a borrow hole in an upland area on-site to create a ready source of water. Any such borrow holes need to be restored to preconstruction conditions prior to Project completion.

621.0033 Protection from Rodents

The following paragraph is added:

All trees and shrubs planted on the site will be encased in rodent guards. The rodent guards must cover the plants to a height of at least eight (8) inches above the ground surface. The guards shall not be removed and will remain on the planted stock after completing the Establishment Period.

621.0036 Maintenance Period

The entire section is deleted and replaced with the following:

621.0036 Establishment Period

The acceptability of the plant material furnished and planted under this contract shall be at the end of the Establishment Period, during which the Contractor, as necessary, shall employ all possible means to preserve the plants in a healthy and vigorously growing condition and to insure their successful establishment. During this period, the Contractor shall water, cultivate and prune the plants, and do any other work necessary to maintain the plants in a healthy growing condition. This shall include seasonal spraying with approved insecticides or fungicides as may be required. The Contractor shall also be responsible for protecting the plants from rodents. All dead or rejected plants shall be promptly removed from the project and replaced by live healthy plants meeting the same specifications. If such plants are declared unacceptable during the planting season, they shall be replaced during this planting season, otherwise, they shall be replaced during the next subsequent planting season.

Such replacement plants are subject to the same requirements as the original plants and must be replaced in turn if they fail to meet the required standards. Plants designated for spring planting only, will be replaced only during the spring planting season unless otherwise directed by the Resident.

The Establishment Period shall commence after Physical Work Complete but not before the Landscape Warranty Bond has been received by the Resident if required by Special Provision and shall extend for two years after that date unless otherwise directed. Necessary replacements shall be made so that at the end of the Establishment Period all plants shall be in a healthy, vigorous growing condition and free from sizable die-back.

Replacements will be required for plants lost, damaged, or rejected, whatever the cause. The Contractor will be considered responsible for the plants until the end of the Establishment Period.

It shall be the sole responsibility of the Contractor to replace any unsatisfactory plants on the project regardless of whether they are specifically designated by the Resident. In the case of individual doubtful plants, the Contractor may call upon the Resident to make a determination as to their acceptability, but it shall not be incumbent on the Resident to furnish the Contractor with exact lists of replacements.

The Establishment Period shall commence after Physical Work Complete but not before the Landscape Warranty Bond has been received by the Resident and shall extend for two years after that date unless otherwise directed.

The Contractor shall be responsible for 100 percent replacement of dead woody stock for a period of two years from the date of acceptance of the plantings.

621.0361 Schedule

All trees and shrubs must be installed before September 15, 2021. Bare root stock must be dormant and not show any new leaves at the time of planting.

621.0038 Basis of Payment

The Contractor shall provide a Landscape Warranty Bond acceptable to the Authority, to the Authority as a condition of Final Acceptance and follow MTA Supplemental Specifications Section 110.2.3.

Payment will be made under:

<u>Pay Item</u>		<u>Pay Unit</u>
621.043	Evergreen Tree (6'-8') Group A	Each
621.396	Dwarf Evergreen (18"- 24") Group B	Each
621.512	Hybrid Rhododendron (2' - 2.5')	Each
621.553	Deciduous Shrubs (3' - 4') Group B	Each

SPECIAL PROVISIONSECTION 625WATER SERVICE SUPPLY LINE625.01 Description

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

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

625.02 General

The work in this Section shall also include the following:

- Furnishing and installation of pipe, tubing, valves, service boxes, fittings, water meter pit, insulation and any required accessories for a complete water service supply.
- Connections to existing water systems.
- Resetting service boxes and covers to finish grade.
- Disinfection and testing.
- This work shall be done with as little interruption of water service as possible. Ample notification shall be given to the users of the water before any disruption of water service.

The municipal water department and the Maine Turnpike Authority shall be notified prior to starting construction of any portion of the water service supply line.

625.03 MaterialsWater Service Supply Lines

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

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

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

Curb Stops

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

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

Fittings

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

Service Boxes, Covers and Rods

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

Bedding

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

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

Bedding material for water service supply lines shall be compacted to a minimum of 92% of the laboratory derived Maximum Density Values at optimum moisture content as determined by ASTM D1557, Method C.

Insulation

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

625.04 Installation

Service Pipe

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

Separation from Structures

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

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

Testing

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

Disinfection

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

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

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

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

Following the chlorination period, all treated water shall be flushed from the pipe section and replaced with water from the distribution system. Prior to disposal of treated water, the Contractor shall check with local authorities to determine if the discharge will cause damage to the

receiving body or sewer and, if required, the Contractor shall neutralize the chlorinated water in accordance with Appendix B, AWWA C650. Bacteriological sampling and analysis of the replacement water shall then be made by the Contractor in full accordance with AWWA Specification C651. A minimum of three samples shall be taken by the Contractor at locations directed by the Engineer along the length of water pipe being chlorinated and sent to a state-approved private laboratory for analyses. The Contractor shall rechlorine if the samples show presence of coliform, and the pipe section shall not be placed in service until all of the repeat samples show no presence of coliform.

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

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

625.05 Method of Measurement

Non-metallic pipe will be measured by the linear foot.

625.06 Basis of Payment

The accepted quantities of non-metallic pipe will be paid for at the contract unit price, complete and accepted in place, which payment shall be compensation for furnishing and installing all necessary fittings for connecting to existing systems, and for capping the ends of the pipe sleeve.

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

The accepted quantity of water meter pits will be paid for at the contract unit price. Meter setters, valves, fittings, pipe supports, seals, frame and covers, joint sealant and ballast shall be considered included in the work of the contract items.

Payment will be made under the following:

<u>Pay Item</u>	<u>Pay Unit</u>
625.106 Water Service Supply Line (< 3 in.)	Linear Foot

SPECIAL PROVISION

SECTION 626

FOUNDATIONS, CONDUIT, AND JUNCTION BOXES
FOR HIGHWAY SIGNING, LIGHTING AND SIGNALS

626.031 General

The fourth paragraph shall be deleted and replaced with:

Where conduits enter exposed junction boxes, they shall be sloped to drain towards the conduit entrance holes, unless otherwise directed. All conduit ends in exposed junction boxes or in concrete foundations shall be fitted with bell ends. Weep holes of ¼ inch diameter shall be placed in all pull boxes, junction boxes, and fuse boxes.

626.033 Polyvinylchloride Conduit Installation

The following paragraph shall be added:

Exposed conduit shall be rigidly and securely fastened with acceptable fasteners or supports, as indicated on the plans or approved. Fasteners or supports shall not be placed more than 6 feet apart on centers, except as otherwise authorized. Conduits shall generally be supported by an approved spacer at the point of support, so that there is an air space between the conduit and the supporting surface. Ends of conduit runs terminating in any box without a threaded hub shall be provided with a metallic locknut and insulated bushings on the inside of the box.

626.034 Concrete Foundations

The following paragraph shall be added after the 10th paragraph:

Any concrete foundation that is damaged during placement or doesn't meet design requirements will be replaced. No repairs to the foundations will be allowed.

SPECIAL PROVISION

SECTION 626

FOUNDATIONS, CONDUIT, AND JUNCTION BOXES
FOR HIGHWAY SIGNING, LIGHTING AND SIGNALS

(Quazite Junction Box (36x24))
(Quazite Junction Box (18x11))

626.02 General

The following paragraph is added:

Junction boxes for the electrical and communication conduit associated with the toll equipment and intelligent transportations systems shall be polymer concrete as manufactured by QUAZITE® a division of Hubbell Power Systems. The boxes shall be 36” x 24” and 21” deep. The words ELECTRICAL or COMMUNICATION shall be stamped on the cover as noted in the Plans or directed by the Resident. The boxes shall have an 15,000 lb. load rating. All existing QUAZITE® Junction Boxes in useable condition shall be removed and relocated as directed by the Resident Engineer.

Junction boxes for the electrical associated with highway lighting shall be polymer concrete as manufactured by QUAZITE® a division of Hubbell Power Systems. The boxes shall be 18” x 11” and 18” deep. New boxes shall have the word LIGHTING stamped on the cover as noted in the Plans or directed by the Resident. The boxes shall have an 15,000 lb. load rating.

626.04 Method of Measurement

The following sentence is added: Quazite junction box shall be measured by each unit in place and accepted existing or new.

626.05 Basis of Payment

The words, “polymer concrete” shall be added after the words, “precast concrete” in the second sentence of the second paragraph.

Payment will be made under:

<u>Pay Item</u>		<u>Pay Unit</u>
626.121	Quazite Junction Box (36X24)	Each
626.122	Quazite Junction Box (18X11)	Each

SPECIAL PROVISION

SECTION 626

FOUNDATIONS, CONDUIT, AND JUNCTION BOXES
FOR HIGHWAY SIGNING, LIGHTING AND SIGNALS

(4' X 6' Splice Box with Access Door)

626.02 General

The following paragraph is added:

4' X 6' Splice Box with Access Door for electricity shall be a two-piece precast concrete unit of dimensions depicted within the drawings. Concrete shall have a minimum compressive strength of 5,000 psi at 28-days and rated for H-20 loading.

Manhole frame and cover shall be rated for H-20 loading and as shown on the details.

626.04 Method of Measurement

The following sentence is added:

4' X 6' Splice Box with Access Door shall be measured by each unit complete in place and accepted. Providing and installation electrical manhole frame and cover shall be considered incidental to pay item 626.13 and no measurement will be required.

626.05 Basis of Payment

The following sentence is added:

The accepted quantity of 4' X 6' Splice Box with Access Door will be paid for at the Contract Unit Price per each. Payment shall include furnishing and installing the precast concrete manhole, manhole frame and cover and all materials and labor needed to complete the work. Excavating and backfilling for manholes will be considered incidental to the pay item. Rock excavation, if required for installation will be paid under item 206.07 Structural Rock Excavation-Drainage and Minor Structures.

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
626.13 4' X 6' Splice Box with Access Door	Each

SPECIAL PROVISIONSECTION 626FOUNDATIONS, CONDUIT, AND JUNCTION BOXES
FOR HIGHWAY SIGNING, LIGHTING AND SIGNALS

(Horizontal Directional Drilled Conduit)

626.01 Description

Horizontal Directional Drilling (HDD) method shall be used for installation of non-metallic conduit for highway lighting, toll systems and traffic signals when specified on the project plans or approved by the Resident. It shall include furnishing of all materials, site preparation, equipment setup, pilot bore, conduit pulling through the drilled bore, installation of pull wire and fittings, site restoration, and incidental work necessary to satisfactorily install conduit at the required locations and depths.

626.02 Materials

Conduit for Horizontal Directional Drilling shall meet requirements of Section 715.03 for non-metallic conduit. Non-metallic conduit to be installed under roadways shall be Schedule 80 or greater. Non-metallic conduit to be installed in other locations shall be Schedule 80 or greater. Conduit sections shall be joined by methods suitable for installation by HDD. Joined conduit sections must have adequate strength and flexibility to withstand the installation stresses and overburden pressures without compromising the structural stability of the conduit wall. Conduit must be able to meet the bend radius required for the proposed installation. Conduit sections shall be joined in a manner resulting in the inner surfaces being flush and even.

626.03 Construction

Prior to commencing HDD work, the Contractor shall submit a drilling work plan to the Resident for approval addressing the following, at minimum:

- Profile of the proposed bore plotted at a scale appropriate for the crossing and acceptable to the Resident;
- HDD site layout including entry and exit points;
- Drilling fluid management plan, including drilling fluid types and specifications, cleaning and recycling equipment to be used, estimated flow rates, procedures for minimizing drilling fluid escape, and the method and location for final disposal of waste drilling fluids. Material safety data sheets shall be provided for all drilling fluid additives that will be used;
- Conduit storage and handling details;
- Summary of assembly and installation procedures to be used;
- Material safety data sheets of any other potentially hazardous substances to be used;
- Response plans for possible problems that may be encountered;
- Documentation and certification of the ability of the proposed conduit to withstand installation stresses and pressures.

The HDD drill rig and auxiliary pieces of equipment shall be appropriate for the diameter and length of conduit being installed. The power system shall provide sufficient pressure to power the drilling operations with a hydraulic system free from leakage. The directional drilling machine shall be anchored as necessary to stabilize it against excessive dislocation.

In order to minimize friction and prevent collapse of the bore hole, a soil stabilizing agent (drilling fluid) may be introduced into the annular bore space from the front end of the drill head to create a slurry. The drilling fluids shall be selected or designed for the site's specific soil and ground water conditions. The drilling fluid mixing system shall be self-contained and closed with sufficient size to mix and deliver drilling fluid to the drill head. The mixing system shall continually agitate the drilling fluid during drilling operations. The fluids delivery system shall be capable of pumping drilling fluid with sufficient volume and pressure from the mixing tank through the drill rods to the drill head.

Alignment of the bore shall be accomplished by proper orientation of the drill head as it is pushed through the ground by the drill rig. Orientation and tracking of the drill head shall be determined by using an acceptable tracking system from a transmitter located within the drill head. The HDD guidance system shall be capable of locating and tracking the drill head continuously and accurately both horizontally and vertically during the pilot bore. All equipment shall be properly calibrated before commencing the directional drilling operation.

Borehole diameter relative to the conduit diameter shall be minimized to limit potential damage from soil displacement, settlement, and heaving. When necessary, the pilot borehole may be enlarged by back reaming to accommodate conduit larger than the pilot borehole size. Back reaming may be accomplished ahead of or at the same time as pulling the conduit through the pilot borehole. The back-reamer shall be sized to create a large enough borehole to allow cuttings to transfer from the face of excavation to the surface with minimum soil displacement.

Escaping slurry or drilling fluids shall be confined at the ground surface during pull back or drilling. All drilling fluids shall be disposed of or recycled in a manner acceptable to the Maine Department of Environmental Protection. Upon completion of the HDD operation, the work site shall be cleaned of all excess slurry or spoils. Any damage caused by heaving, settlement, separation of pavement, escaping drilling fluid, or other damage from the directional drilling operation shall be repaired by the Contractor to the satisfaction of the Resident.

At the completion of the HDD conduit installation, the Contractor shall provide to the Resident marked up plans noting location, depth, and material type of all conduit installed by the Horizontal Directional Drilling method.

626.04 Method of Measurement

Horizontal Directional Drilled Conduit will be measured by the number of linear feet of conduit in place and accepted by the Resident.

626.05 Basis of Payment

Payment will be made for the total number of linear feet of Horizontal Directional Drilled Conduit and accepted at the contract price per linear foot. Payment shall include the cost of furnishing and installing the conduit; site preparation and restoration of drilling entry and exit points; removal of excavated material and drilling spoils; removal and disposal of drilling fluids and excess slurry; pull wire, fittings, grounding and bonding; test cleaning of conduit interior; and all other materials, labor, equipment, and incidentals necessary to complete the work.

Payment will be made under:

Pay Item

Pay Unit

626.223

Horizontal Directional Drilled Conduit

Linear Foot

SPECIAL PROVISION

SECTION 627

PAVEMENT MARKINGS

(Temporary Painted Pavement Markings)

627.01 Description

The following paragraphs are added:

This work shall consist of furnishing and placing temporary painted pavement markings at locations shown on the Plans or as approved by the Resident.

Lines on the turnpike and ramps shall be six inches wide. Lines on local roads shall be four inches wide.

Temporary raised pavement markers will not be allowed as a substitute for temporary painted pavement marking lines unless approved by the Resident for use as a transition between the existing pavement markings and the temporary painted pavement marking lines. Temporary raised pavement markings may be used as a substitute for temporary painted pavement markings when the markings are immediately adjacent to a concrete barrier or guardrail such that the markings will not be subject to traffic. The temporary raised pavement markers will be measured for payment as temporary painted pavement markings when their use has been approved by the Resident.

Materials

This Subsection is deleted in its entirety and replaced with the following:

Pavement marking paint shall be 100 percent acrylic, low VOC, fast drying, white and yellow waterborne traffic paint.

The paint shall be formulated and processed specifically for service as a binder for beads, in such a manner as to produce maximum adhesion, refraction, and reflection. Any capillary action of the paint shall not be such as to cause complete coverage of the beads. The binder shall be 100 percent acrylic, as determined by infrared analysis according to ASTM D2621. VOC levels shall comply with ASTM D3960. Lead percentage shall comply with ASTM D3335. The paint shall be rated as non-combustible.

627.04 General

The third paragraph is deleted and replaced with the following:

Broken lines shall consist of alternate 10 foot painted line segments and 30 foot gaps.

Dotted white lines (DWL) shall consist of alternate three foot painted line segments and nine foot gaps.

Method of Measurement

Painted pavement marking lines will be measured by the linear foot.

The second and third sentences in the second paragraph are deleted and replaced with the following:

The measurement of broken white lines, both permanent and temporary, will include the gaps when painted. Temporary Painted Pavement Marking lines will be measured for payment by the linear foot.

Removal of the Temporary Painted Pavement Marking lines will be measured for payment as Removing Existing Pavement Markings.

Basis of Payment

The following paragraphs are added:

The accepted quantity of Painted Pavement Marking lines will be paid at the Contract price per linear foot. This price shall include all labor and materials to furnish, install and maintain the paint markings.

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
627.681 Temporary 6 Inch Painted Pavement Marking Line – Yellow or White	Linear Foot

SPECIAL PROVISION

SECTION 627
PAVEMENT MARKINGS

(Temporary 6 Inch Pavement Marking Tape)
(Temporary 6 Inch Black Pavement Marking Tape)

627.01 Description

The following sentence is added:

This work shall also consist of furnishing, placing, maintaining and removing temporary pavement marking tape at locations shown on the Plans or as directed by the Resident.

This work shall also consist of furnishing, placing, maintaining and removing temporary black pavement marking tape at locations shown on the Plans or as directed by the Resident. Temporary 6 Inch Black Pavement Marking Tape shall be used to cover conflicting existing pavement marking paint.

627.02 Materials

The following paragraph is added:

Temporary pavement marking tape shall be Stamark Wet Reflective Removable Pavement Marking Tape Series 710 as manufactured by 3M of St. Paul, Minnesota or an approved equal.

Temporary pavement marking tape shall be Stamark Removable Black Line Mask Tape Series 715 as manufactured by 3M of St. Paul, Minnesota or an approved equal.

627.04 General

The following paragraphs are added:

Work under this item shall be in accordance with the manufacturer's recommendations. A factory representative from 3M shall be present for the first application of all temporary pavement marking tape to insure proper application and product performance.

The pavement markings shall be applied mechanically to clean dry pavement as recommended by the manufacturer and approved by the Resident.

Temporary pavement markings shall consist of applying six inch solid white, six inch broken white, and six inch yellow reflectorized pavement marking tape for traffic maintenance during construction as shown on the Plans or as directed by the Resident.

Temporary pavement marking tape that loses reflectivity, becomes broken, dislodged or missing during the life of the Contract shall be replaced by the Contractor at no additional cost to the Authority.

627.06 Application

The following paragraphs are added:

For application of the tape, when the pavement temperature is below 50°F, heat shall be applied to the pavement surface, if deemed necessary by the factory representative or as directed by the Resident, at no additional cost to the Authority. Proper primer for the temperatures shall be used as directed by the manufacturer.

The pavement mark tape shall be rolled over with a vehicle once application is complete and then scored every 20 feet when placed in long runs to prevent full length unraveling.

627.08 Removing Lines and Markings

The following sentence is added:

Removal of temporary pavement marking tape shall be accomplished without the use of heat, solvents, grinding or sandblasting and in such a manner that no damage to the pavement results.

627.09 Method of Measurement

The following paragraph is added:

Temporary Pavement Markings - Tape will be measured for payment by the linear foot. The measurement of broken lines will not include the gaps.

627.10 Basis of Payment

The following paragraphs are added:

Payment for the Temporary Pavement Markings - Tape will be made at the Contract bid price per linear foot, which price shall include furnishing, installing, maintaining and removing the temporary tape and all materials, labor, equipment and incidentals necessary to accomplish the work. Replacement of Temporary Pavement Markings - Tape, as described above, will be incidental and no separate payment will be made.

Payment for the Temporary 6 Inch Black Pavement Marking Tape will be made at the Contract bid price per linear foot installed, which price shall include furnishing, installing, maintaining and removing the temporary tape and all materials, labor, equipment and incidentals necessary to accomplish the work. Replacement of 6 Inch Black Temporary Pavement Marking Tape, as described above, will be incidental and no separate payment will be made.

Payment will be made under:

<u>Pay Item</u>		<u>Pay Unit</u>
627.73	Temporary 6 Inch Pavement Marking Tape	Linear Foot
627.731	Temporary 6 Inch Black Pavement Marking Tape	Linear Foot

SPECIAL PROVISION

SECTION 627

PAVEMENT MARKINGS

(Temporary Raised Pavement Markers)

627.01 Description

The following sentence is added:

This work shall consist of furnishing, placing and removing temporary raised pavement markers at locations as shown on the Plans or as directed by the Resident.

627.02 Materials

The second paragraph is deleted and replaced with the following:

The temporary raised pavement markers shall be white or yellow one way markers (Type Tom W-1, Y-1, Grade WZ) as distributed by Davidson Plastics Co. (DAPCO), Kent, WA, or an approved equal. Colors shall conform to 2009 MUTCD requirements.

627.04 General

The following sentences are added:

Temporary raised pavement markers shall be used to delineate travel lanes (BWLL) after placement of the surface course (HMA 12.5 mm).

Temporary raised pavement marker that lose reflectivity, becomes broken, dislodged or missing during the life of the Contract shall be replaced by the Contractor at no additional cost to the Authority.

The spacing and number of temporary pavement markers installed as edge lines shall be the same as shown for the BWLL on the Plans for Temporary Pavement Marking.

627.09 Method of Measurement

The following sentence is added:

Temporary Raised Pavement Markers will be measured by each unit, complete in place, maintained and accepted.

627.10 Basis of Payment

The following paragraphs are added:

The accepted quantity of Temporary Raised Pavement Markers white and/or yellow will be paid for at the Contract price each. This price shall include all labor and materials to furnish, install, maintain, and remove the markers.

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
627.812 Temporary Raised Pavement Markers	Each

SPECIAL PROVISION

SECTION 627

PAVEMENT MARKINGS

(Pavement Marking Tape)

(Pavement Marking Tape – Dotted White Lane Line, 6-inch Width)

627.01 Description

The following sentence is added:

This work shall consist of furnishing and placing reflective pavement marking tape in conformity with the Plans, as specified herein and as directed by the Resident.

The pavement marking tape shall be installed at all locations.

627.02 Materials

The following sentence is added:

For the Broken White Lane Line (BWLL), Pavement Marking Tape shall be 3M Stamark™ High Performance Tape Series 380AW – High Performance pavement marking tape, color- white, six (6) inch width, as manufactured by 3M of St. Paul, Minnesota.

For the Dotted White Lane Line (DWLL), Pavement Marking Tape shall be 3M Stamark™ High Performance Tape Series 380I ES – High Performance pavement marking tape, color- white, six (6) inch wide and twelve (12) inch wide, as manufactured by 3M of St. Paul, Minnesota.

3M Traffic Safety Systems Division
Mr. Michael D. Allen
Tel: (401) 368-0438
Email: mdallen@mmm.com

627.04 General

The following paragraphs are added:

The tape shall be used as a supplemental broken white lane line. The tape shall be installed between the painted Broken White Lane Line (BWLL) spaced eighty (80) foot center to center as shown on the Plans. The length of the tape shall be three (3) feet.

The tape shall also be used to mark a Dotted White Lane Line (DWLL) and shall be installed on parallel deceleration and acceleration lanes at locations as noted in the Plans. On deceleration lanes, the tape shall be installed from the beginning of the full width deceleration lane and shall extend to the theoretical gore markings. On acceleration lanes, the DWLL shall extend from the theoretical gore markings to a point one-half of the total length of the acceleration lane (including the lane taper length). Layout data is noted on the Plans. Dotted White Lane Line tape shall be

three (3) foot in length and shall be spaced nine (9) feet apart. Spacing from the Solid White Lane Line (SWLL) or the Theoretical Gore Markings shall be nine (9) feet.

627.05 Preparation of Surface

The following paragraph is added:

The Contractor shall mill a groove in the pavement for each tape length to be placed (“in-and-out” pattern). Continuous grooving for installation of the tape shall not be allowed. The groove length shall be the required tape length plus 12 inches on both ends. Tape length spacing shall be as shown on the plans. The groove width for inlaid tape pavement marking shall be the pavement marking width plus 1 inch, with a tolerance of $\pm \frac{1}{4}$ inch. The groove shall have a uniform depth of 150 Mils (± 20 Mils). Groove position shall be a minimum of 2 inches from the edge of the pavement marking to the longitudinal pavement joint. The bottom of the groove shall have a smooth, flat finished surface. The use of gang stacked Diamond cutting blades is required for asphalt pavement surfaces. The spacers between blade cuts shall be such that there will be less than a 10 mil rise in the finished groove between the blades.

Grooves shall be clean, dry and free of laitance, oil, dirt, grease, paint or other foreign contaminants. The Contractor shall prevent traffic from traversing the grooves, and re-clean grooves, as necessary, prior to application of the primer and pavement marking tape. Depth plates shall be provided by the contractor to assure that desired groove depth is achieved.

Reference is made to 3M Information Folder 5.18 Grooving Applications, May 2011, “Application Guidelines for Pavement Marking in Grooved Pavement Surfaces.”

627.09 Method of Measurements

The following paragraph is added:

The quantity of Pavement Marking Tape measured for payment will be the linear feet of tape in place and accepted. The measurement will not include the gaps.

627.10 Basis of Payment

The following paragraphs are added:

The accepted quantity of pavement marking tape will be paid for at the Contract unit price per linear foot which price shall include all material, pavement grooving, equipment, labor and incidentals necessary to complete the work.

Payment will be made under:

<u>Pay Item</u>		<u>Pay Unit</u>
627.94	Pavement Marking Tape	Linear Foot
627.941	Pavement Marking Tape – Dotted White Lane Line, 6-inch Width	Linear Foot

SPECIAL PROVISION

SECTION 627

PAVEMENT MARKINGS

(Recessed Pavement Marking Tape)

627.01 Description

The following sentence is added:

This work shall consist of furnishing and placing recessed, reflective pavement marking tape in conformity with the Plans, as specified herein and as directed by the Resident.

627.02 Materials

The following sentence is added:

Pavement Marking Tape for ramp lane reduction arrows shall be precut by the manufacturer, and shall be 3M Stamark Extended Season Tape Series 380IES– High Performance pavement marking tape, color- white, twelve (12) inch wide, as manufactured by 3M of St. Paul, Minnesota.

3M Traffic Safety Systems Division
Mr. Michael D. Allen
Tel: (401) 368-0438
Email: mdallen@mmm.com

627.04 General

The following sentences are added:

The recessed tape shall be installed as lane-reduction transition markings. The location of the markings is noted on the plans.

627.05 Preparation of Surface

The following paragraph is added:

The Contractor shall mill a rectangular groove in the pavement for each lane reduction arrow to be placed. The groove length or area shall be 18.75 feet. Tape lane reduction arrow spacing shall be as shown on the plans. The groove width for inlaid tape pavement marking shall be 6.25 feet. The groove shall have a uniform depth of 150 Mils (± 20 Mils).

The bottom of the groove shall have a smooth, flat finished surface. The use of gang stacked Diamond cutting blades is required for asphalt pavement surfaces. The spacers between blade cuts shall be such that there will be less than a 10 mil rise in the finished groove between the blades.

Grooves shall be clean, dry and free of laitance, oil, dirt, grease, paint or other foreign contaminants. The Contractor shall prevent traffic from traversing the grooves, and re-clean grooves, as necessary, prior to application of the primer and pavement marking tape. Depth plates shall be provided by the contractor to assure that desired groove depth is achieved.

Reference is made to 3M Information Folder 5.18 Grooving Applications, May 2011, "Application Guidelines for Pavement Marking in Grooved Pavement Surfaces."

627.09 Method of Measurements

The following paragraphs are added:

The accepted quantity of Pavement Marking Line - Recessed Tape will be measured for payment by the linear foot in place and accepted. The measurement will not include the gaps.

The accepted quantity of Pavement Markings - Recessed Tape - Words and Arrows will be measured for payment by the square foot in place and accepted.

627.10 Basis of Payment

The following paragraphs are added:

The accepted quantity of Pavement Marking Line - Recessed Tape will be paid for at the Contract unit price per linear foot which price shall include all material, pavement grooving, equipment, labor and incidentals necessary to complete the work.

The accepted quantity of Pavement Markings - Recessed Tape - Words and Arrows will be paid for at the Contract unit price per square foot which price shall include all material, pavement grooving, equipment, labor and incidentals necessary to complete the work.

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
627.944 Pavement Markings – Recessed Tape – Words, Arrows and Stop Bars	Square Foot

SPECIAL PROVISION

SECTION 631

EQUIPMENT RENTAL

631.02 General

The following sentences are added:

Jackhammer - To be included under category of air tool.

Bucket truck - Approved one man, able to reach 30 feet high bucket truck with 10 feet lateral extension.

Scissor Lift – Hydraulic scissors lift with a minimum capacity of three workers.

Electrician – Licensed by State of Maine.

Electrician's Apprentice – Enrolled in an accredited program.

Plumber – Licensed by State of Maine.

631.08 Basis of Payment

The following paragraphs are added:

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

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

The General Contractor will be allowed 10 percent overhead and profit on the subcontractor's cost of materials, and subcontractors rented equipment (not covered by miscellaneous unit items). The General Contractor shall include his markup on the Subcontractor's labor in the pay items.

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

Payment will be made under:

<u>Pay Item</u>		<u>Pay Unit</u>
631.50	Jackhammer (Air Tool Including Operator)	Hour
631.51	Bucket truck	Hour
631.52	Scissor Lift	Hour
631.53	Electrician	Hour
631.54	Electrician's Apprentice	Hour
631.55	Plumber	Hour

SPECIAL PROVISIONSECTION 632OVER HEIGHT VEHICLE DETECTION SYSTEM – EXIT 103 AREA

The following Section is added:

632.01 Description

The work consists of maintaining and expanding the Over Height Vehicle Detection System (OHVDS) for southbound Turnpike traffic north of and on Exit 103 in West Gardiner; this is a single direction installation. The current OHVDS was installed under the 2013.56 Solicitation and includes, for the southbound traffic only, at a minimum: a transmitter and receiver, cabinet, visual warning system, and a communication system to notify MTA headquarters when there is an alarm event. General locations for the detectors and related equipment of the current OHVDS are:

1. An OHVDS infrared beam at the Maple Street underpass;
2. An OHVDS warning sign with flashing beacons 900 ft. south of the Maple Street underpass;
3. An OHVDS warning sign with flashing beacons 100 ft. north of the Northern Avenue overpass;
4. An OHVDS warning sign with flashing beacons 500 ft. north of the Exit 103 off ramp gore; and
5. An OHVDS pull over area with warning sign with flashing beacons north of the West Gardiner I-295 toll plaza.

During the construction of 2019.04, the OHVDS must be maintained and revisions made to expand the system for the final condition. A new location will be added north of the SB Exit 103 bridge over mainline to indicate that the OHV must exit to the cash lanes. For each construction phase, temporary locations are identified on the Maintenance of Traffic Plans; however, specific locations shall be determined by the Contractor and approved by the MTA.

632.02 General

The Contractor shall submit the documentation for the Over Height Vehicle Detection System, including manufacturer equipment specifications (cut sheets) for all equipment identified in Section 632.05 to the Resident for approval prior to acquiring equipment.

The Contractor shall relocate the existing Over Height Vehicle sign and flashing beacons at the current pull over area to temporary locations during construction identified on the Maintenance of Traffic Plans and then a final location. These locations are:

- Location #1: Prior to beginning Phase 1 traffic pattern, the contractor shall widen shoulder from SB ORT Sta. 4499+50 to Sta. 4503+00 Rt. (SB inside shoulder) to provide a Temporary Pull Over Area. Contractor shall remove and reset existing OHVDS sign and flashing beacons as noted on the plans. The power supply shall be solar or from conduit in the median.
- Location #2: Contractor shall provide a temporary pull over location in the outside shoulder from SB ORT Sta. 4503+00 to Sta. 4505+00, Lt. during Phase 2. Contractor shall also provide a final pull over location in the same location prior to beginning Phase 4 traffic pattern. Contractor shall remove and reset existing OHVDS sign and flashing beacons as noted on the plans. The power supply shall be solar or from the roadway lighting conduit.
- Location #3: Contractor shall provide a temporary pull over location in the outside shoulder from SB ORT Sta. 21+00 to Sta. 22+00, Lt. during Phase 3. Contractor shall remove and reset existing OHVDS sign and flashing beacons as noted on the plans. Contractor shall also provide a final warning sign and flashing beacon system at SB ORT Sta. 22+00, Lt. prior to beginning Phase 4 traffic pattern. Final “Must Exit” warning sign shall be furnished by the contractor. The power supply at this location shall be solar.

At each location, the contractor shall install a fully tested and operational OHVDS sign and flashing beacons. The relocation of the existing sign and flashing beacons shall not cause the system to be non-operational for more than 4 hours. The modified Exit 103 OHVDS shall continue to operate in a similar manner that it currently does. Contractor shall adjust antennas as necessary. New antenna installed at Sta. 22+00, Lt. shall be able to communicate forward and back.

Solar installations are acceptable but are not required unless noted on the plans. Contractor shall provide a detailed description of how system will operate. The contractor shall submit to the MTA for approval, a sketch plan of equipment location including vertical poles, foundations, transmitter, receiver, cameras, signs, conduit, cabinets (pole or ground mounted), junction boxes, power connections, and any other equipment that the Contractor proposes. Sketch plan(s) shall be of a scale suitable to identify approximate location of all equipment proposed.

632.03 Operation

When an overheight object is detected, an “alarm event” shall be triggered. For each “alarm event” the following shall occur:

- The amber beacons on the warning signs shall flash for a specified amount of time adjustable from 15 seconds to 2 minutes.
- The amber beacons on the warning signs are located at sufficient distances from the detector such that a delay from time of detection to the start and end of beacon flash mode will be required. Each set of beacons will be assigned a preliminary length of delay to start flash mode that will be adjustable by plus or minus 2 minutes. Each set of beacons will also be assigned a preliminary duration of flash mode and will be adjustable as noted above. Preliminary start and stop times from moment of detection for the beacons are as follows:

Beacon Location	Start	End
o 1 st set at approx. 900 feet (Existing)	0 sec	12 sec
o 2 nd set at approx. 6,720 feet (Existing)	55 sec	76 sec
o 3 rd set at approx. 14,700 feet (Existing)	133 sec	167 sec
o 4 th set at pullover 17,900 feet (Proposed Location #3)	169 sec	203 sec
o 5 th set at pullover 19,600 feet (Proposed Location #1 & #2)	188 sec	222 sec

- Network components and equipment shall be located in an approved weather tight cabinet. Cabinet keys shall be No. 2 type and five copies of keys shall be provided to MTA upon final acceptance.

Meteorological Conditions: The equipment shall operate and meet all of the requirements under the following atmospheric conditions:

- o Temperature: -40 degrees F to +135 degrees F
- o Relative Humidity: 0 to 100%
- o Rain: 6 inches per hour rate
- o Snow: 5 inches per hour rate
- o Fog: 200 foot visibility
- o Wind Velocity: 0 to 90 miles per hour

632.04 Detection Units

The existing OHVDS is a Trigg Industries 3400-Z Detection system.

Mounting Hardware:

Each unit shall be provided with means for rigidly attaching the unit to a vertical pole without requiring any machining operation.

The attachment means shall not stress or deform the unit and shall prevent the movement of the unit in any direction by forces developed by wind.

All mounting hardware shall be stainless steel, or approved equal.

Warning system

The intent of the warning system is to visually warn a driver of an over height vehicle when an alarm event occurs. The warning system is defined as follows:

- Warning system shall consist of fixed warning signs and amber LED lights mounted on steel H-beam posts on breakaway devices and foundations; all of which shall be installed in accordance with MaineDOT standard specifications.
- Warning Signs will be installed in accordance with the MUTCD
- Lights will be 12" amber LED signals mounted in traffic signal housings spaced a minimum of 24 inches on center furnished and installed according to the MaineDOT standard specifications and in accordance with the MUTCD.
- Lights shall not be attached directly to fixed warning sign
- Flashers will conform to the NEMA flash rate and be of the 7 pin plug in variety.

- System shall be expandable to add an audible alarm if required in the future.

632.05 Equipment Requirements and Specifications

Contractor shall provide manufacturer equipment specifications (cut sheets). Manufacturer equipment specifications (cut sheets) shall be provided for the following items:

- Amber LED signals, signal heads and mounting hardware
- Flashers
- Cabinets (ground or pole mounted NEMA type of suitable size with locks)
- Conduit (if proposed)
- Brackets and mounts

Contractor shall provide equipment that meets industry standards and Maine weather conditions. Equipment shall meet MaineDOT standard specifications where applicable. System shall be compatible with and coordinated to work with MTA's existing OVHDS system for Exit 103.

632.06 Site Considerations

All equipment and components shall operate as per the objectives specified herein when subject to all environmental conditions encountered at the system installation site. The Contractor shall thoroughly investigate all environmental factors and vehicular traffic conditions that may affect the operation, reliability and life of the system to be provided under this contract.

632.07 Testing

The Contractor shall be responsible for developing and compiling detailed test procedures, demonstrating the material and performance specifications for each type of equipment, and for conducting the test procedure to verify satisfactory operation for the equipment. The test procedures shall be submitted to the MTA for approval prior to the test. A minimum of 10 business days shall be allowed for the MTA Staff review and approval of the test procedures.

The results of each test shall be compared with the objectives specified herein. Failure to conform to the objectives of any test shall be counted as defect, and equipment shall be subject to rejection by the MTA. Rejected equipment may be offered again for retest provided all non-compliances have been corrected and re-tested by the Contractor and evidence thereof submitted to the MTA.

Final acceptance/ payment for the system will not be made until the system has operated satisfactorily for a period of 30 days. This shall consist of successful completion of detailed test procedure and uninterrupted operation during the 30-day period and a test fault on or about the end of 30-day period.

632.09 Personnel

The contractor shall provide Maine licensed master or journeyman electricians and all electrical work shall be under the supervision of a Maine licensed master electrician.

632.10 Workmanship

All work will be done in accordance with the national electrical code, and the local authority having jurisdiction in a neat and workman like manner.

632.11 Utilities

Contractor will make all necessary arrangements with the local utilities for utility coordination purposes. Contractor shall be responsible for contacting Dig-Safe prior to excavating.

632.12 Right-of-Way

Contractor shall install all equipment within Maine Turnpike right-of-way. No equipment shall be allowed to be installed on private property. Contractor shall coordinate with Maine Turnpike Authority (871-7771) to confirm right-of-way limits.

632.13 Measurement and Payment

Over Height Vehicle Detection System will be paid for on a lump sum basis. The price shall include removing and resetting the existing Over Height Vehicle Detection System (OHVDS) as noted on the plans, adjusting existing system and testing to obtain a fully operational system for the entirety of the construction of 2019.04 and the final condition. Relocation and modification of existing sign and beacons, installation of new sign and beacons, foundations, providing power, testing, adjustment to existing system and any other tasks required for a fully operational system will be included under the lump sum item. The new modified OHVDS must include for the southbound traffic only, at a minimum a cabinet and visual warning system, together with all work incidental thereto, in accordance with this Contract Package and Specifications.

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
632.01 Over Height Vehicle Detection System: Exit 103 Area	Lump Sum

SPECIAL PROVISIONSECTION 633UTILITY TRENCH

(Propane Service Trench)

633.01 Description

Work shall consist of excavating, hauling, disposing, backfilling and compacting of all materials for the construction of a utility trench in accordance with the Specifications and in reasonably close conformity with the lines, grades, thickness and typical sections shown on the Plans. The utility trench shall be constructed for the installation of propane gas lines.

633.02 Materials

Backfilling shall consist of placing suitable material in all spaces excavated and not occupied by the utility lines up to the loam elevation. Backfill shall be excavated material or select backfill as directed by the engineer, placed at or near optimum moisture content and shall not contain stones larger than three inches, frozen lumps, chunks of clay, organic matter or other objectionable material.

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

633.03 Construction

The Contractor shall coordinate the construction of the utility trench with the Authority's current propane supplier, through the Resident. Backfill shall be in accordance with Section 206, Structural Excavation. Propane gas lines shall be furnished and installed by the Authority's propane gas supplier. Excavation, bedding and backfill shall be completed by the Contractor.

Warning tapes shall be a metallic/detectable type made of solid yellow film with continuously printed black-letter caption: "CAUTION—PROPANE GAS BURIED BELOW". The warning tape shall be acid and alkali-resistant polyethylene film warning tape manufactured for marking and identifying underground utilities, six inches wide and four mils thick, continuously inscribed with a description of the utility.

633.04 Method of Measurement

Propane Service Trench shall be measured by the linear foot along the centerline of the trench complete and accepted.

633.05 Basis of Payment

Payment shall be made for at the Contract unit price for the total number of linear feet of trench completed and accepted, which shall be full compensation for all excavation, backfill, compaction, coordination, materials, equipment and incidental items necessary to complete the work to the satisfaction of the Resident.

Payment will be made under:

Pay Item

Pay Unit

633.01 Propane Service Trench

Linear Foot

SPECIAL PROVISIONSECTION 633GAS UTILITY

(Propane Tank Supports)

633.01 Description

This work shall consist of furnishing and placing Portland Cement concrete for the propane tank supports in accordance with these Specifications and in conformity with the lines, grades, and dimensions shown on the Plans.

633.02 Materials

Materials shall meet the following requirements:

Concrete shall be Class "A" concrete (f'c-4000 psi).

Gravel shall meet the requirement for Section 703.06b.

Peastone shall conform to ASTM C33 Grading 7 (Peastone).

633.03 Propane Tank Supports

The Contractor shall coordinate the location and spacing of the supports for the tanks with the propane gas supplier prior to any excavation. The Contractor has the option of using precast or cast-in-place supports as dimensioned in the plans. The supports shall be constructed/placed on a six inch layer of peastone. After the supports have been set to line and grade the cavity shall be backfilled with aggregate subbase material. The aggregate material shall be firmly compacted in layers not more than eight inches, loose measure. Backfilling of the supports material shall conform to Subsection 206.03.

633.04 Method of Measurement

Propane Tank Supports satisfactorily placed and accepted shall be measured by each unit.

633.05 Basis of Payment

The accepted quantity of Propane Tank Supports will be paid for at the Contract unit price each for the number of units installed. Payment shall be full compensation for excavation, construction or placement of support, peastone and gravel, backfilling and all equipment, labor and incidentals necessary to complete the work.

The top six inches of peastone and weed control fabric will not be paid for under this item, but shall be paid for under Item 633.31, Propane Tank Pad.

Payment will be made under:

Pay Item

Pay Unit

633.21 Propane Tank Supports

Each

SPECIAL PROVISION

SECTION 633

GAS UTILITY

(Propane Tank Pad)

633.01 Description

This work shall consist of excavating, and placing peastone for the construction of a propane tank pad in accordance with these Specifications and in reasonably close conformity with the lines, grades and typical sections shown on the Plans or established.

633.02 Materials

Materials shall meet the following requirements:

Peastone shall conform to ASTM C33 Grading 7 (Peastone).

633.03 General

The Contractor shall excavate area for the pad to the dimensions shown on the Plans or as directed by the Resident. Weed control fabric shall be placed on the bottom and sides of the excavated area and shall be overlapped as recommended by the manufacturer. A layer of peastone shall then be placed on the fabric to the required depth as shown on the Plans.

633.04 Method of Measurement

The quantity of Propane Tank Pad will be measured by the number of square yards of surface covered, complete and accepted.

633.05 Basis of Payment

The Propane Tank Pad will be paid for at the Contract unit price per square yard, complete and accepted. Payment shall be full compensation for all excavation, peastone, weed control fabric, tools, equipment, labor and all incidentals necessary to complete the work.

The weed control fabric will not be measured separately for payment, but shall be incidental to this pay item.

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
633.31 Propane Tank Pad	Square Yard

SPECIAL PROVISION

SECTION 634

HIGHWAY LIGHTING

(Remove and Stack Light Standard)
(Remove High Mast Light Standard)
(Remove and Reset Light Standard)
(Conventional Light Standard with LED Fixture)

634.01 Description

The following paragraph is added:

This work shall consist of removing existing light standards, luminaires, and any breakaway devices, and their associated foundations. All existing standards, LED luminaires, and associated appurtenances, removed and not reset by the Contractor shall be delivered and stacked at the Authority's Sign Shop along the Turnpike Northbound at MM 58. All non-LED luminaires, unless otherwise noted, will be property of the contractor.

This work shall also consist of removing existing light standards, luminaires, and any breakaway devices and resetting with all associated appurtenances and wiring system on to new concrete foundations with new LED luminaires at locations as shown on the Plans.

This work shall also include installing new light standards with LED fixtures with all new associated appurtenances and wiring system at locations shown on the plans.

All new light standards will be 35 feet tall with 2-foot riser and an 8-foot offset arm, unless noted otherwise on the contract plans. All highway lights shall be installed so the LED fixture is centered over the shoulder lane line (right or left) for maintenance purposes.

Existing lighting is intended to remain operational until new luminaires are installed and operational. Existing luminaires, conduit and lighting standards shall be protected until approved by the Resident to be removed. Any temporary lighting that may be needed during removing and resetting of existing light standards or during the maintenance of traffic shall be incidental to Item 800.30 Toll Plaza and Bridge Demolition.

634.02 General

The following paragraphs are added:

All Contract work shall be overseen by a Maine licensed Master Electrician. The lead person for the field installations shall be either a Maine licensed Master Electrician, or a Maine licensed Journeyman Electrician. Apprentice Electricians, Helper Electricians, Journeyman-In-Training Electricians, and helpers may work under the Master or Journeyman Electrician as permitted under the law.

The Contractor shall comply with National Electrical Code (NFPA 70) as applicable to construction and installation of electrical cable, wire and connectors; provide electrical cable, wire and connectors, which have been listed and labeled by Underwriters Laboratories, and comply with National Electrical Manufacturers Association/Insulated Power Cable Authorities Association Standards publications pertaining to materials, construction and testing wire cable, where applicable.

At a minimum the Contractor shall provide the following field quality control:

- Prior to energizing, check wire for continuity of circuitry and for short circuits with ohmmeter type testing equipment. Correct malfunction when detected.
- Subsequent to wire hook-ups, energize circuitry and demonstrate functioning in accordance with requirements.

634.021 Materials

The following paragraphs are added:

Underground junction boxes shall be Quazite Junction Box (Item 626.122). Provide manufacturer's listed cover for each junction box with logo stating "LIGHTING".

Splices in junction boxes shall be made with ILSCO USPA-350-SS-DB Safetysub Watertight Direct Bury Splice Wire Range 350MCM-10-STR connectors for the appropriate wire count only. Splices in hand holes shall be Ideal SLK Disconnect Fuse Kit 30-S2212.

The Luminaire A (Standard Output) shall be the following:

- Model # ATB2-60BLEDE70-MVOLT-R3-NL-PCLL, as manufactured from American Electric Lighting

The Luminaire B (High Output) shall be the following:

- Model # ATB2-80BLEDE70-480VOLT-R3-NL, as manufactured from American Electric Lighting

The Contractor may submit an alternate LED fixture for review and acceptance or rejection. Any alternative LED fixture will need to meet or exceed the performance and efficiency of the specified fixtures. Should the Authority not accept the Contractor's proposed substitution the Contractor shall provide the specified fixture at no additional cost to the Authority.

The Manufacturer shall provide a minimum 5 year warranty on all fixtures, installed and spares, from the Project Completion date.

Each luminaire shall be provided with a 3 pin NEMA receptacle, a photocell and a shorting cap. All "spare" photocells and shorting caps shall become property of the Authority.

All fixtures shall be submitted and approved before the fixtures are ordered. Submittals shall include Product Data sheets clearly identifying the product and accessories being proposed, Test Reports and Certifications, and Product Warranties.

634.04 Cable Installation

The following paragraphs are added:

The reset light standards shall be wired with new wiring and shall be included in the payment of remove and reset light standard.

634.051 Removing Light Standards

The first paragraph is deleted and replaced with the following:

Before removing light standards, the luminaires shall be removed from the light standard and stacked.

The second paragraph is deleted and replaced with the following:

Care shall be exercised in removing, transporting and stacking the light standards and luminaires. The Contractor will be required to replace, at his own expense, all equipment damaged or destroyed by his operation.

At a minimum, existing light levels shall be maintained while new light standards are being installed and made fully operational. The Contractor will not be allowed to remove the existing light standards until all new foundations, wiring, conduits and junction boxes have been installed unless temporary lighting is provided at the contractor's expense. Breakaway devices shall be required on all light standards, unless noted otherwise on the contract plans. If breakaway devices do not exist on the existing light standard, new breakaway devices shall be supplied and installed. The Contractor will be allowed one (1) working day to remove and reset the light standards, including replacing luminaires and testing.

634.06 Luminaires

The second paragraph is revised to read:

The connections between the luminaires and connector kits shall be made with number 10 wires AWG copper stranded XHHW, minimum size. A 14 inch long Teflon sleeve shall be placed over each end of each conductor in the luminaire.

634.092 Method of Measurement

The following sentence is added:

Remove and Stack Light Standard, Remove High Mast Light Standard, Remove and Reset Light Standard, and Conventional Light Standard with LED Fixture will be measured by the single unit each, complete in place and accepted.

Basis of Payment

In the second sentence of the first paragraph, the words, "LED fixture, pole wiring" shall be added after the words, "bracket arm".

The following paragraphs are added:

Payment for Remove and Stack Light Standard will be made for the accepted quantity at the Contract unit price each, which shall include removing the light standard and delivering and stacking the standard and any LED luminaires that are not reset to MTA’s Sign Shop at Mile 58 NB, as well as removing and disposing of all foundation as per plans and specifications. Payment for the removal of the foundations will be made under item 626.36 – Remove or Modify Concrete Foundation.

Payment for Remove High Mast Light Standard will be made for the accepted quantity at the Contract unit price each, which shall include removing and disposing of the High Mast light standard and the removal, delivery and stacking of the High Mast luminaries, associated electrical equipment and head frame assembly, and carriage ring on top of the pole at the Authority’s Sign Shop along the Turnpike Northbound at MM 58. Payment for the removal of the foundations will be made under item 626.36 – Remove or Modify Concrete Foundation.

The accepted quantity of Remove and Reset Light Standard will be paid at the Contract unit price each for the number of units that are removed and reset. Payment shall be full compensation for the removal and resetting of the light standard, removing, delivering and stacking any removed LED luminaries to the MTA that are not reset, disposing of non-LED luminaires, resetting the breakaway device or installing a new breakaway device, new pole wiring to the new LED fixture and all incidentals necessary to complete the work.

Payment for furnishing and installing Conventional Light Standard with LED Fixture will be made for the accepted quantity at the Contract unit price each, which shall include a new LED fixture, or resetting a LED fixture from a Remove and Stack Light Standard, ballast, lamp and incidentals necessary to complete the work.

The fourth paragraph is deleted and replaced with the following:

All necessary appurtenances to provide the complete and working lighting system, as shown in the plans, shall be included in the payment for the pertinent lighting items. This work shall include full compensation for furnishing, installing and erecting: ballast, lamps, wiring in underground conduit, pole wiring, and all other wiring (except prewired conduit), transformer enclosures, luminaires (except luminaires for high mast lighting), break-away devices when applicable, all identification tags, and all materials, labor, equipment, tools, miscellaneous hardware and incidentals necessary to complete the work. Payment shall also include disposing of unused light standards, and for furnishing portable electric power units.

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
634.051 Remove and Stack Light Standard	Each
634.052 Remove High Mast Light Standard	Each
634.208 Remove and Reset Light Standard	Each
634.231 Conventional Light Standard with LED Fixture	Each

SPECIAL PROVISION

SECTION 639

ENGINEERING FACILITIES

(Field Office, Type A)

This Subsection is amended by the addition of the following:

639.01 Description

This work shall consist of providing, erecting, lighting, equipping and maintaining buildings to be used by the Resident as field offices. Upon completion of the work, the buildings and equipment shall remain the property of the Contractor.

Field Office, Type A shall be 12x50 in size.

Contractor shall provide temporary power to location of Field Office.

639.11 Basis of Payment

Payment will be made under:

<u>Pay Item</u>		<u>Pay Unit</u>
639.18	Field Office, Type A	Each

SPECIAL PROVISION

SECTION 643

TRAFFIC SIGNALS

(Lane Use Signal Installation)

643.01 Description

This work shall consist of supply and installation of lane use signals (Non- Flashing). All equipment, installation of equipment and other incidental work shall conform to the latest applicable provisions of: NEC, MUTCD, NESC, NEMA, and the ITE Standards for traffic control equipment. All work shall be done to the satisfaction of the Resident. The meaning of specific terms shall be as defined in MUTCD, NESC, and the ITE Standards for traffic control equipment.

643.02 Materials

The lane use signal heads shall be Trans-Tech DOT2424RG-175 or approved equal. See Appendix H for technical product details.

643.03 Installation

The new lane use signal housing and LED signal shall be installed and wired over the center of the new lane. New Pelco (or equal) mounting brackets may be needed and will be incidental to the installation of the new lane use signal. The contractor shall provide a 1-year warranty on all material and workmanship related to the installation of the new lane use signal. Installation of the Lane Use Signal shall also include the installation of the MTA provided canopy override switch (COS) and all needed wiring and incidentals from the power source to the COS and to the lane use signal.

643.04 Method of Measurement

Lane use signals will be measured by each unit, installed, and accepted.

643.05 Basis of Payment

Lane Use Signals will be paid for at the Contract unit price each which payment shall be full compensation for the furnishing and installation of new lane use signals, and all other materials, labor, tools, equipment, and incidentals necessary to complete the work.

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
643.711 Lane Use Signal Installation	Each

SPECIAL PROVISIONSECTION 643TRAFFIC SIGNALS

(Flashing Beacon – Solar Powered)

643.1 Description

The following paragraphs are added:

This special provision provides for the installation of two dual head flashing beacons at the end of each concrete barrier separating the cash lanes from the open road tolling lanes.

All provisions of Section 652, except as modified or changed below, shall apply.

1. Contractor shall furnish (12 inch) amber flashing beacons powered by solar panel with battery backup. Units shall have internal programmable timings for flash interval.
2. The beacons shall be mounted (11.5 feet) above the elevation of the adjacent edge of pavement.

643.18 Method of Measurement

The following paragraphs are added:

Flashing beacons will be measured by each unit authorized and installed on the Project.

The following list of major materials applies:

- 2 – P & K signal pole model SP-114 or approved equal.
- 2 – 12 inch amber flashing beacon powered by solar panel. Units shall be JSF Technologies FL Series -24 Hour Flashing Beacon FL -2400 or an approved equal.

643.19 Basis of Payment

The following paragraphs are added:

The accepted quantity of Flashing Beacon – Solar Powered will be paid for at the Contract unit price per unit. This price shall be full compensation for all labor, materials and equipment necessary to furnish and install Flashing Beacons.

Payment will be made under:

<u>Pay Item</u>		<u>Pay Unit</u>
643.712	Flashing Beacon – Solar Powered	Each

SPECIAL PROVISION

SECTION 645

HIGHWAY SIGNING

(Remove and Stack Sign)

(Remove and Reset Sign)

645.07 Demounting and Reinstalling Existing Signs and Poles

The following paragraphs are added:

At locations noted on the Plans, existing ground-mounted signs are designated to be removed and reset. This work shall consist of removing the sign panels, removing and resetting or disposing of the existing steel post and resetting the sign panels on a new steel post if required in the appropriate specified location. The Resident will determine if a new steel post is required.

At locations as shown on the Plans, existing ground-mounted signs are designated to be removed and stacked. This work shall consist of removing and stacking existing sign panels and posts at the Authority's Sign Shop along the Turnpike Northbound at MM 58 and the excavations shall be backfilled and ground restored to the satisfaction of the Resident.

Any existing signs not shown on the Plans are to remain in their existing condition unless directed otherwise by the Resident.

645.08 Method of Measurement

The following sentences are added:

Removing and Resetting existing ground-mounted signs shall be measured as complete units each, removed, reset and accepted.

Removing and stacking existing signs shall be measured as complete units each removed and stacked.

645.09 Basis of Payment

The following paragraphs are added:

The accepted signs removed and stacked shall be paid for at the Contract unit price each as specified. Such price shall include removing and stacking sign panels and supports at the Authority's Sign Shop along the Turnpike Northbound at MM 58.

The accepted signs Removed and Reset will be paid for at the Contract unit price each as specified. Such price will include removing and resetting sign panels, removing and resetting or disposing existing wood post and resetting the sign panels on the existing or new wood post and new hardware as required to complete the sign installation. Any signs or supports damaged by the

Contractor shall be replaced by him with new signs or supports conforming to the applicable Specifications at no additional cost to the Authority.

Payment will be made under:

<u>Pay Item</u>		<u>Pay Unit</u>
645.105	Remove and Stack Sign	Each
645.109	Remove and Reset Sign	Each

SPECIAL PROVISION

SECTION 645

HIGHWAY SIGNING

(Remove and Stack Canopy Mounted Sign)

645.01 Description

The following paragraph is added:

Existing canopy mounted signs are defined as signs fabricated from sheet aluminum and the electronic rotating signs as identified in the Plans. Each sign is mounted on framing supports on top of the toll plaza canopy with an attached luminaire. There are six static signs and two electronic rotating to be stacked at the MTA’s Sign Shop at Mile 58 NB.

Two existing canopy mounted electronic rotating signs will be removed from the West Gardiner Toll Plaza at Mile Marker 100.2.

645.08 Method of Measurement

The following sentence is added:

Remove and Stack Canopy Mounted Signs shall be measured as complete units each removed and stacked.

645.09 Basis of Payment

The following paragraphs are added:

The accepted Remove and Stack Canopy Mounted Signs shall be paid for at the Contract unit price each as specified. Such price shall include removing sign panels, luminaires, and hardware framing supports, gears, sign controllers and all electrical components associated with the electronic rotating signs and delivering to the MTA’s Sign Shop at Mile 58 NB. This includes all hardware, labor and equipment necessary to complete this task.

Two existing canopy mounted electronic rotating signs will be removed from the West Gardiner Toll Plaza at Mile Marker 100.2. The removal of these signs will be paid for at the Contract unit price each.

Any signs, luminaires, or supports damaged by the Contractor shall be replaced with new signs, luminaires, or supports conforming to the applicable Specifications at no additional cost to the Authority.

Payment will be made under:

<u>Pay Item</u>		<u>Pay Unit</u>
645.107	Remove and Stack Canopy Mounted Sign	Each

SPECIAL PROVISIONSECTION 645HIGHWAY SIGNING

(Canopy Mounted Dynamic Message Sign)

645.01 Description

This work shall consist of the installation of a canopy mounted dynamic message sign (DMS) located above each interior cash lane of the new Exit 103 toll plaza and West Gardiner I-95 Barrier toll Plaza at Mile Marker 100.2. All needed electrical and communication wiring will be included as part of the installation. Each sign is mounted on framing supports and mounted on brackets to the top of the toll plaza canopy.

The contractor shall provide existing power wiring and two (2) direct burial type, Category 5e cables and needed conduit. One will be routed from the canopy mounted DMS to the toll booth counter for lanes 3 and 10 (Exit 103) and lanes 2 and 7 (West Gardiner I-95 Barrier), and the other to the lane controller in the tunnel for lanes 3 and 10 (Exit 103) and lanes 2 and 7 (West Gardiner I-95 Barrier). Ten (10) feet of slack cable for routing of the cable within the booth shall be provided. At the West Gardiner I-95 Barrier, contractor shall be responsible for removing existing wiring and conduit and installing new conduit and wiring to canopy mounted sign. The contractor shall coordinate with the MTA Toll system and ITS manager for sign installation.

Two DMS will be furnished, delivered and installed to the West Gardiner Toll Plaza at Mile Marker 100.2.

645.02 Materials

The DMS to be installed at the new Exit 103 toll plaza will be the following:

Daktronics model VL-3350-48x160-19.8-RGB-SF, or approved equal,

Sign shall also include a DM-100 hand controller, or approved equal.

645.04 Method of Measurement

Canopy Mounted Dynamic Message Sign shall be measured as complete units each for provision and installations accepted by the MTA.

645.05 Basis of Payment

Canopy Mounted Dynamic Message Sign shall be full compensation for furnishing and the installation of the new DMS framing supports, brackets and for all other materials, labor tools, equipment and incidentals necessary to complete the work. Work shall also include removal of existing wiring and conduit at West Gardiner I-95 Barrier. The item also includes all necessary electrical and communication wiring.

Two DMS will be furnished, delivered and installed to the West Gardiner Toll Plaza at Mile Marker 100.2. Installation of the signs will be paid for at the Contract unit price each, for the complete and accepted work.

Payment will be made under:

<u>Pay Item</u>		<u>Pay Unit</u>
645.1092	Canopy Mounted Dynamic Message Sign	Each

SPECIAL PROVISION

SECTION 645

HIGHWAY SIGNING

(Canopy Mounted Sign)

645.01 Description

The following paragraph is added:

Canopy mounted signs are defined as signs fabricated from sheet aluminum as identified in the Plans. Each static sign is mounted on framing supports and mounted on brackets to the top of the toll plaza canopy with an attached luminaire.

The following Subsection is added:

645.08 Method of Measurement

The following sentence is added:

Canopy Mounted Signs will be measured by each complete unit of the kind specified and installed.

645.09 Basis of Payment

The following paragraphs are added:

The accepted quantity of Canopy Mounted Signs shall be paid for at the Contract unit price each as specified. Such price shall include all hardware, labor and equipment necessary to complete this task. The item also includes all necessary electrical wiring.

Payment will be made under:

<u>Pay Item</u>		<u>Pay Unit</u>
645.14	Canopy Mounted Sign	Each

SPECIAL PROVISIONSECTION 645HIGHWAY SIGNING

(Overhead Guide Sign)

(Cantilever Guide Sign)

645.09 Basis of Payment This subsection is amended by the addition of the following:

Payment will be made under:

<u>Pay Item</u>		<u>Pay Unit</u>
645.121	Overhead Guide Sign, NB 2 (Sta. 7450+00)	Lump Sum
645.122	Overhead Guide Sign, NB 3 (Sta. 7463+00)	Lump Sum
645.123	Overhead Guide Sign, NB 5 (Sta. 7477+25)	Lump Sum
645.124	Overhead Guide Sign, SB 1 (Sta. 4491+00)	Lump Sum
645.125	Overhead Guide Sign, SB 2 (Sta. 4508+75)	Lump Sum
645.126	Overhead Guide Sign, SB 3 (Sta. 27+00)	Lump Sum
645.127	Overhead Guide Sign, SB 4 (Sta. 43+00)	Lump Sum
645.151	Cantilever Guide Sign, NB 1 (Sta. 7427+25)	Lump Sum
645.152	Cantilever Guide Sign, NB 4 (Sta. 7471+75)	Lump Sum

SPECIAL PROVISION

SECTION 645

HIGHWAY SIGNING

(Variable Speed Limit Sign)

645.01 Description

The following sentence is added:

This work shall also include the fabrication and installation of new Variable Speed Limit Signs on the NB and SB Space Frame.

645.021 Materials

The following paragraph is added at the end of this Subsection:

The Variable Speed Limit Sign shall be manufactured by Daktronics, Vanguard model VS-5220 VSLS or approved equal. A detail will be provided in Appendix H.

Method of Measurement

The following sentence is added:

Variable Speed Limit Signs will be measured by each unit in place.

Basis of Payment

Payment will be made under:

<u>Pay Item</u>		<u>Pay Unit</u>
645.155	Variable Speed Limit Sign	Each

SPECIAL PROVISION

SECTION 645

HIGHWAY SIGNING

(Remove and Reset Mainline Sign)

645.07 Demounting and Reinstalling Existing Signs and Poles

The following paragraphs are added:

At locations noted on the Plans, existing ground-mounted signs are designated to be removed and reset. This work shall consist of removing the sign panels, removing and resetting or disposing of the existing wood post and resetting the sign panels on a new wood post if required in the appropriate specified location. The Resident will determine if a new wood post is required.

At locations as shown on the Plans, existing ground-mounted signs and overhead mounted signs are designated to be removed and stacked. This work shall consist of removing and delivering existing sign panels, posts, concrete foundations, steel bridge sign supports and breakaway devices to the MTA Sign Shop at Mile 58 NB. All aluminum sign support structures shall be disposed of by the Contractor.

Excavations shall be backfilled and ground restored to the satisfaction of the Resident. Existing foundations for overhead sign structures shall be abandoned by removing the foundation to 6 inches below finished grade and disposed.

Any existing signs not shown on the Plans are to remain in their existing condition unless directed otherwise by the Resident.

645.08 Method of Measurement

The following sentences are added:

Removing and Resetting existing ground-mounted signs shall be measured as complete unit each, removed, reset and accepted.

Removing and stacking existing signs, regardless of the type of sign stacked, shall be measured as complete units each removed and stacked.

645.09 Basis of Payment

The following paragraphs are added:

The accepted signs removed and stacked shall be paid for at the Contract unit price each as specified for each type of sign designated on the plans. Such price shall include removing and stacking sign panels and supports, and removing or abandoning foundations at the location specified.

The accepted signs Removed and Reset will be paid for at the Contract unit price each as specified. Such price will include removing and resetting sign panels, removing and resetting or disposing existing wood post and resetting the sign panels on the existing or new wood post and new hardware as required to complete the sign installation. Any signs or supports damaged by the Contractor shall be replaced by him with new signs or supports conforming to the applicable Specifications at no additional cost to the Authority.

Payment will be made under:

<u>Pay Item</u>		<u>Pay Unit</u>
645.501	Remove and Reset Mainline Sign Sta. 7401+23 (2 Signs)	Lump Sum
645.502	Remove and Reset Mainline Sign Sta. 7440+50 (1 Sign)	Lump Sum
645.503	Remove and Reset Mainline Sign Sta. 7467+00 (1 Sign)	Lump Sum
645.504	Remove and Reset Mainline Sign Sta. . 7470+29 (1 Sign)	Lump Sum
645.505	Remove and Reset Mainline Sign Sta. 3488+27 (1 Sign)	Lump Sum
645.506	Remove and Reset Mainline Sign Sta. 4474+00 (1 Sign)	Lump Sum
645.507	Remove and Reset Mainline Sign Sta. 789+50 (1 Sign)	Lump Sum
645.508	Remove and Reset Mainline Sign Sta. 8492+00 (1 Sign)	Lump Sum
645.509	Remove and Reset Mainline Sign Sta. 7515+00 (1 Sign)	Lump Sum

SPECIAL PROVISION

SECTION 645

HIGHWAY SIGNING

(Remove and Stack Overhead Sign Structure)

645.01 Description

The following paragraph is added:

This work shall consist of the removal, disassembly, and stacking of the overhead signs and supporting overhead sign structure as specified herein and as shown on the Plans. The existing sign structure is located at Station 805+35± on northbound I-295. This one overhead sign structure, mounted signs, hardware and supports shall be stacked at the MTA's Sign Shop at Mile 58 NB. This work includes completely removing the existing concrete foundations below existing grade and disposing of them.

The following Subsection is added:

645.08 Method of Measurement

The following sentence is added:

Remove and Stack Overhead Sign Structure shall be measured as complete units each removed and stacked.

645.09 Basis of Payment

The following paragraphs are added:

The accepted Remove and Stack Overhead Sign Structure shall be paid for at the Contract unit price each as specified. Such price shall include removing sign panels, hardware and supports, Disassembling the existing overhead sign support structure and delivering sign panels, hardware and supports, and existing overhead sign support structure to the MTA's Sign Shop at Mile 58 NB. This includes all hardware, labor and equipment necessary to complete this task, including completely removing the existing concrete foundations below existing grade and disposing of them.

Any signs, luminaires, or supports damaged by the Contractor shall be replaced with new signs, luminaires, or supports conforming to the applicable Specifications at no additional cost to the Authority.

Payment will be made under:

<u>Pay Item</u>		<u>Pay Unit</u>
645.601	Remove and Stack Overhead Sign Structure (NB ORT)	Lump Sum
645.602	Remove and Stack Overhead Sign Structure (SB Cash)	Lump Sum

SPECIAL PROVISION

SECTION 645

HIGHWAY SIGNING

(Protection of Signs with Type XI Sheeting)

645.04 Fabrication of Type I Guide Signs

The following paragraphs are added after the second paragraph in part b. Reflective Sheeting:

The Contractor and Sign Fabricator shall exercise all due caution to avoid any creases, bends, tears, punctures, or other damage to any Type XI sign sheeting, perceptible or not. Sign sheeting shall be protected at all times following application to the extruded aluminum surface. Any defect which becomes perceptible either under direct, indirect or no light conditions shall be cause for rejection of the sign panel.

Following the application of the sign legend and borders, the sign panel shall be protected from all hazards that may cause a defect to the sign sheeting (either background, legend or borders) in accordance with the manufacturer's recommendations. Fabricated signs shall not be stacked during storage, transport, or erection such that concentrated pressure is placed on one area of the sign face that is not uniform across the full sign face.

645.08 Method of Measurement

The fifth (5th) paragraph is deleted and replaced by the following paragraph:

The area of roadside guide signs, regulatory, warning, confirmation and route marker assembly signs of the respective types, will be measured by the area in square feet, computed to the nearest hundredth of a square foot (0.01 SF), as determined by the overall height multiplied area of the sign that becomes perceptible under direct, indirect, or no light conditions shall be cause for rejection of the whole sign panel.

SPECIAL PROVISIONSECTION 648FLAGPOLE648.01 Description

This work shall consist of furnishing and installation of a 30 foot aluminum flagpole, ground mounted spot light and concrete foundation in accordance with these Specifications, and in reasonably close conformity with the lines and grades shown on the Plans or as approved by the Resident.

648.02 Materials

Flagpole shall be by American Flagpole, Concord Industries Inc. or EMC, a Division of Eder Manufacturing Corp.

Flagpole shall be a six inch diameter, seamless cone tapered aluminum 6063-T6 alloy, 30' height (exposed) with a mechanical Class I clear anodized finish for two flags. All fittings, such as ball finial, double revolving truck, two halyard and four snap hooks, tow cleats, and pole mounting assembly shall be as manufactured by or recommended by the flagpole manufacture.

Concrete shall be Class "A" cement concrete (4000 PSI).

Reinforcing steel shall meet the requirements of Section 503.

Lighting shall meet the requirements of Part II Division 800.

648.03 General

When flagpole is to be stored on-site for an extended period before installation, all wrapping material shall be removed and pole stored in a dry place, off the ground.

648.04 Method of Measurement

The flagpole will be measured by each unit. Lighting, conduit and wiring is included under Pay Item 800.01 Administration Building.

648.05 Basis of Payment

The accepted quantity of flagpole will be paid for at the Contract unit price each which payment shall be full compensation for furnishing and installing flagpole, and all accessories, foundation including anchor bolts, reinforcing steel, rubbing, penetration sealer, excavation, backfill, compaction, tools, equipment, labor and all incidentals necessary to complete the work.

Payment will be made under:

Pay Item

Pay Unit

648.00 Install Flagpole

Each

SPECIAL PROVISIONSECTION 652MAINTENANCE OF TRAFFIC

(Specific Project Maintenance of Traffic Requirements)

This Specification describes the specific project maintenance of traffic requirements for this Project.

The following minimum traffic requirements shall be maintained.

These requirements may be adjusted based on the traffic volume when authorized by the Authority.

Maine Turnpike Traffic Control Requirements

This Section outlines the minimum requirements that shall be maintained for work on, over, or adjacent to the Maine Turnpike roadway. Operations are allowed as outlined below:

Bridge and overhead sign structure work directly over traffic or within six feet of a travel lane as measured from the painted pavement marking line or traffic control device will require a lane closure. This work includes but is not limited to the following:

1. Installing and removing shielding
2. Superstructure demolition
3. Unbolting structural steel
4. Removing structural steel
5. Erecting structural steel or concrete beams
6. Installing and removing deck and diaphragm forms
7. Erecting or moving sign panels on bridges
8. Bolting structural steel
9. Painting structural steel

When approved by the Resident, Items 3, 6 and 8 may be performed over traffic if a temporary floor is provided between the bottom flanges of the beams.

During the erection or removal of structural steel and overhead structures and signs, traffic shall be stopped and may be held for periods of up to 25 minutes during these operations. Traffic stoppage is allowed each night, Sunday through Saturday, between the hours of 10:00 p.m. to 5:00 a.m. the following day. Before the roadway is reopened, all materials shall be secured so they will not endanger traffic passing underneath. The Contractor will reimburse the Authority at the rate of \$2,500.00 per five-minute period for each roadway not reopened (northbound and southbound), in excess of the 25 minute limit. Total penalty shall be deducted from the next pay estimate.

Construction activities will require a combination of lane closures on the turnpike mainline, ramp area and on I-295. Maintenance of traffic control plans have been developed for Phases 1 thru 6 to facilitate the construction. For all other operations, standard lane or shoulder closures

shall be developed by the Contractor from the typical details provided and shall not conflict with traffic control setups for Phases 1 thru 6. This plan shall be approved by the Resident prior to start of work. All operations requiring lane or shoulder closures shall be approved by the Resident. Travel lanes may not be impeded by traffic control devices until the time frames specified for each activity. No lane closures are allowed during holidays as defined by Supplemental Specifications Section 101.2 without the Authority's approval.

The contractor shall maintain a minimum 14-foot roadway width during all temporary lane and shoulder closures with the exception of November 16, 2019 through April 15, 2020 and November 16, 2020 through April 15, 2021 during which a minimum 20-foot roadway width must be maintained as described in Section 107.4.7.

Temporary mainline, I-295 or toll lane closures shall be removed if construction is not ongoing. Unattended lane closures are not allowed unless included in the Contract language or approved by the Resident as a long-term traffic control operation.

Loading/unloading trucks shall not be closer than six feet from an open travel lane when being loaded or unloaded within the work zone.

Blasting of Ledge

Stoppages for blasting will be allowed Monday through Thursday between 9 AM and 3 PM and on Fridays between 9 AM and 12 PM (noon). The maximum time for which traffic may be stopped at any single time shall be six (6) minutes. This duration shall be measured as the time between the time that the last car passes the Resident, until the time the Resident determines that all travel lanes are cleared of blast debris. The Contractor shall reduce the size of the blast, change the design and method of the blast, use more mats, or otherwise alter the blasting so that the traffic is not stopped for more than six minutes. If, due to the throw of rock onto the highway or other blasting related activities, traffic is stopped for more than six minutes, the Contractor shall pay a penalty of \$1,000.00 per minute for every minute traffic is stopped in excess of the six minute limit. The penalty shall be measured separately on the northbound and southbound roadway (or eastbound and westbound roadway). Total penalties will be deducted from the next pay estimate. Whenever the volume of traffic is excessive such that a six minute interruption would cause objectionable congestion, in the opinion of the Authority, the hours during which blasting may occur may be further restricted.

Turnpike Mainline Traffic Control Requirements

Two lanes of traffic in each direction shall be maintained on the mainline in both northbound and southbound directions except when one lane of traffic is allowed by these Specifications and Plans.

When the speed limit on the Maine Turnpike has been reduced to 45 MPH temporary shoulder/lane closures cannot be set up and any currently in place shall be removed. Only work on the turnpike mainline that is behind temporary concrete barrier will be allowed when speed is reduced to 45 MPH.

For the Mainline Northbound lanes, south of station 5252+00, and for Mainline Southbound bound lanes, south of station 5263+00, as shown on the contract plans, temporary lane closures and temporary shoulders closures are allowed between the hours of 12:01 a.m. and midnight, Sunday through Saturday.

The Mainline Northbound north of station 5252+00 includes the I-295 Northbound ramp lanes. For the Mainline Northbound north of station 5252+00, the contractor shall maintain a minimum of three lanes of traffic except when two lanes lane of traffic is allowed by these Specifications and Plans. Any temporary lane and/or shoulder closures in this area north of station 5252+00 that provides two lanes, needs to provide a mainline lane and I-295 ramp northbound lane and are allowed in the time periods in the table below:

Mainline Northbound North of Station 5252+00			
Days of Week	Time of Day	Temporary Lane Closures	Temporary Shoulder Closures
April 1, 2019 to June 13, 2019 February 20, 2020 to June 11, 2020 February 18, 2021 to June 10, 2021			
Sunday	8:00 p.m. through midnight	Allowed	Allowed
Daily Monday through Thursday	12:01 a.m. to 7:00 a.m. and 8:00 a.m. to midnight	Allowed	Allowed
Friday	12:01 a.m. to 4:00 p.m. and 6:00 p.m. to midnight	Allowed	Allowed
Saturday	12:01 a.m. to midnight	Allowed	Allowed
June 14, 2019 to September 2, 2019 June 12, 2020 to September 7, 2020 June 11, 2021 to September 6, 2021			
Daily Monday through Thursday	12:01 a.m. to 3:00 p.m. and 6:00 p.m. to midnight	Allowed	Allowed
Friday	12:01 a.m. to 10:00 a.m. and 7:00 p.m. to midnight	Allowed	Allowed
Saturday	12:01 a.m. to 9:00 a.m. and 6:00 p.m. to midnight	Allowed	Allowed
Sunday	8:00 p.m. to midnight.	Allowed	Allowed
September 3, 2019 to November 21, 2019 September 8, 2020 to November 26, 2020 September 7, 2021 to November 25, 2021			
Daily Monday through Thursday	12:01 a.m. to 2:00 p.m. and 3:00 p.m. to midnight	Allowed	Allowed
Friday	12:01 a.m. to 2:00 p.m. and 6:00 p.m. to midnight	Allowed	Allowed
Saturday	12:01 a.m. to midnight	Allowed	Allowed
Sunday	8:00 p.m. to midnight.	Allowed	Allowed
November 22, 2019 to February 19, 2020 November 27, 2020 to February 17, 2021 November 26, 2021 to February 17, 2022			
Sunday Night through Saturday Night	8:00 p.m. Sunday through Thursday midnight.	Allowed	Allowed
Friday	12:01 a.m. to 4:00 p.m. and 6:00 p.m. to midnight	Allowed	Allowed
Saturday	12:01 a.m. to midnight	Allowed	Allowed

The Mainline Southbound north of station 5263+00 includes the I-295 Southbound ramp lanes. For the Mainline Southbound north of station 5263+00, the contractor shall maintain a minimum of three lanes of traffic except when two lanes lane of traffic is allowed by these Specifications and Plans. Any temporary lane and/or shoulder closures in this area north of station 5263+00 that provides two lanes, needs to provide a mainline lane and I-295 ramp northbound lane and are allowed in the time periods in the table below:

<u>Mainline Southbound North of Station 5263+00</u>			
Days of Week	Time of Day	Temporary Lane Closures	Temporary Shoulder Closures
April 1, 2019 to June 13, 2019 February 20, 2020 to June 11, 2020 February 18, 2021 to June 10, 2021			
Sunday Night through Thursday Night	8:00 p.m. Sunday through Thursday midnight.	Allowed	Allowed
Friday	12:01 a.m. to 4:00 p.m. and 6:00 p.m. to midnight	Allowed	Allowed
Saturday	12:01 a.m. to midnight	Allowed	Allowed
June 14, 2019 to September 2, 2019 June 12, 2020 to September 7, 2020 June 11, 2021 to September 6, 2021			
Daily Monday through Thursday	12:01 a.m. to 2:00 p.m. and 5:00 p.m. to midnight	Allowed	Allowed
Friday	12:01 a.m. to 1:00 p.m. and 6:00 p.m. to midnight	Allowed	Allowed
Saturday	12:01 a.m. to 9:00 a.m. and 3:00 p.m. to midnight	Allowed	Allowed
Sunday	8:00 p.m. to midnight.	Allowed	Allowed
September 3, 2019 to November 21, 2019 September 8, 2020 to November 26, 2020 September 7, 2021 to November 25, 2021			
Daily Monday through Thursday	12:01 a.m. to 3:00 p.m. and 6:00 p.m. to midnight	Allowed	Allowed
Friday	12:01 a.m. to 3:00 p.m. and 6:00 p.m. to midnight	Allowed	Allowed
Saturday	12:01 a.m. to midnight	Allowed	Allowed
Sunday	8:00 p.m. to midnight.	Allowed	Allowed
November 22, 2019 to February 19, 2020 November 27, 2020 to February 17, 2021 November 26, 2021 to February 17, 2022			
Sunday Night through Saturday Night	8:00 p.m. to midnight.	Allowed	Allowed

I-295 Traffic Control Requirements

Two lanes of traffic in each direction shall be maintained on I-295 in both northbound and southbound directions except when one lane of traffic is allowed by these Specifications and Plans.

During the final paving of the Exit 51 ramps, the ramps may be closed and traffic may be detoured. Ramp closures are allowed each night, Sunday through Saturday, between the hours of 10:00 p.m. to 5:00 a.m. the following day. Before the roadway is reopened, all materials shall be secured so they will not endanger traffic passing underneath. The Contractor will reimburse the Authority at the rate of \$2,500.00 per five-minute period for each roadway not reopened (northbound and southbound), in excess of the time limit above. Total penalty shall be deducted from the next pay estimate.

This Section outlines the minimum requirements that shall be maintained for work on, over, or adjacent to the I-295. For purpose of these traffic control requirements the limits of I-295 Northbound shall begin at station 7420+00 and extend northerly to station 7526+00 and I-295 Southbound shall begin at 4425+00 and extend northerly to station 47+00 as shown on the contract plans. The contractor shall maintain a minimum 14-foot roadway width during all temporary lane and shoulder closures. Operations are allowed as outlined below:

<u>I-295 Northbound</u>			
Days of Week	Time of Day	Temporary Lane Closures	Temporary Shoulder Closures
April 1, 2019 to June 13, 2019 February 20, 2020 to June 11, 2020 February 18, 2021 to June 10, 2021			
Sunday	8:00 p.m. to midnight.	Allowed	Allowed
Daily Monday through Thursday	12:01 a.m. to 7:00 a.m. and 8:00 a.m. to midnight	Allowed	Allowed
Friday	12:01 a.m. to 4:00 p.m. and 6:00 p.m. to midnight	Allowed	Allowed
Saturday	12:01 a.m. to midnight	Allowed	Allowed
June 14, 2019 to September 2, 2019 June 12, 2020 to September 7, 2020 June 11, 2021 to September 6, 2021			
Daily Monday through Thursday	12:01 a.m. to 3:00 p.m. and 6:00 p.m. to midnight	Allowed	Allowed
Friday	12:01 a.m. to 10:00 a.m. and 7:00 p.m. to midnight	Allowed	Allowed
Saturday	12:01 a.m. to 9:00 a.m. and 6:00 p.m. to midnight	Allowed	Allowed
Sunday	8:00 p.m. to midnight.	Allowed	Allowed
September 3, 2019 to November 21, 2019 September 8, 2020 to November 26, 2020 September 7, 2021 to November 25, 2021			
Daily Monday through Thursday	12:01 a.m. to 2:00 p.m. and 3:00 p.m. to midnight	Allowed	Allowed
Friday	12:01 a.m. to 2:00 p.m. and 6:00 p.m. to midnight	Allowed	Allowed
Saturday	12:01 a.m. to midnight	Allowed	Allowed
Sunday	8:00 p.m. to midnight.	Allowed	Allowed
November 22, 2019 to February 19, 2020 November 27, 2020 to February 17, 2021 November 26, 2021 to February 17, 2022			
Sunday Night through Thursday	8:00 p.m. Sunday through Thursday midnight.	Allowed	Allowed
Friday	12:01 a.m. to 4:00 p.m. and 6:00 p.m. to midnight	Allowed	Allowed
Saturday	12:01 a.m. to midnight	Allowed	Allowed

<u>I-295 Southbound</u>			
Days of Week	Time of Day	Temporary Lane Closures	Temporary Shoulder Closures
April 1, 2019 to June 13, 2019 February 20, 2020 to June 11, 2020 February 18, 2021 to June 10, 2021			
Sunday Night through Thursday Night	8:00 p.m. Sunday through Thursday midnight.	Allowed	Allowed
Friday	12:01 a.m. to 4:00 p.m. and 6:00 p.m. to midnight	Allowed	Allowed
Saturday	12:01 a.m. to midnight	Allowed	Allowed
June 14, 2019 to September 2, 2019 June 12, 2020 to September 7, 2020 June 11, 2021 to September 6, 2021			
Daily Monday through Thursday	12:01 a.m. to 2:00 p.m. and 5:00 p.m. to midnight	Allowed	Allowed
Friday	12:01 a.m. to 1:00 p.m. and 6:00 p.m. to midnight	Allowed	Allowed
Saturday	12:01 a.m. to 9:00 a.m. and 3:00 p.m. to midnight	Allowed	Allowed
Sunday	8:00 p.m. to midnight.	Allowed	Allowed
September 3, 2019 to November 21, 2019 September 8, 2020 to November 26, 2020 September 7, 2021 to November 25, 2021			
Daily Monday through Thursday	12:01 a.m. to 3:00 p.m. and 6:00 p.m. to midnight	Allowed	Allowed
Friday	12:01 a.m. to 3:00 p.m. and 6:00 p.m. to midnight	Allowed	Allowed
Saturday	12:01 a.m. to midnight	Allowed	Allowed
Sunday	8:00 p.m. to midnight.	Allowed	Allowed
November 22, 2019 to February 19, 2020 November 27, 2020 to February 17, 2021 November 26, 2021 to February 17, 2022			
Sunday Night through Saturday Night	8:00 p.m. to midnight.	Allowed	Allowed

SPECIAL PROVISIONSECTION 652MAINTENANCE OF TRAFFIC

(Temporary Toll Plaza Lane Closures)

The following minimum requirements shall be maintained:

Plaza lanes shall remain available for opening at all times except when the Contractor is performing work in, adjacent to or directly over the plaza lanes. A plaza lane closure is required when danger to the traveling public or turnpike employees may exist. The potential of any material falling onto the roadway shall be considered a potential danger. This shall include, but not necessarily be limited to, demolition debris, water, tools, equipment and material.

A plaza lane closure will be required whenever men or equipment will be present in a plaza lane. The Authority may also require adjacent lanes to be closed to protect the traveling public or turnpike employees. Temporary plaza lane closures will only be allowed from 8 pm to 6 am. These hours may be adjusted based on the traffic volume each day by the Resident. Plaza lane closures not completely removed by the ending time specified will be subject to a lane rental fee of \$100.00 per 10 minutes for every 10 minute increment beyond the specified ending time. Temporary plaza lane closures will not be allowed during periods of inclement weather as determined by the Authority. Temporary plaza lane closures may not be allowed on days or times when complete stoppages of traffic for other Authority projects are scheduled. The Authority reserves the right to order removal of approved plaza lane closures.

Requests for temporary traffic lane closures shall be submitted to the Resident for approval. The Resident is required to receive approval from the Maine Turnpike Authority's Plaza Supervisor for all plaza lane closures. The request shall be submitted to the Director of Fare Collections by the Resident at least one (1) working days prior to the day of the requested plaza lane closure. All requests must be received by 12:00 p.m. noon to be considered as received on that day. Requests received after 12:00 p.m. shall be considered as received the following day. The Contractor shall plan the work accordingly.

Some activities, which require plaza lane closures, will be considered favorably for night work. The Contractor shall submit a request in writing to the Resident. The approval of the request will be at the Resident's discretion and will not be unreasonably withheld.

Wide load lanes (Existing Lanes 1 and 7) may be closed any Monday to Friday from 8:00 p.m. to 6:00 a.m. The wide load lane closures must be scheduled one (1) week in advance, and occur outside of the various Holiday restrictions.

Work Directly Over Traffic

The Contractor shall not perform any of the following canopy extension work directly over lanes carrying traffic or within 15 feet of the centerline of an open plaza lane (20 feet of the centerline of the wide load lanes):

1. Canopy demolition
2. Welding, burning or grinding
3. Unbolting and removing structural steel
4. Erecting and bolting structural steel
6. Removing or erecting sign panels

Before the roadway is reopened, all materials shall be secured so they will not endanger traffic passing underneath or alongside.

Traffic Control and Plaza Safety

Appendix E identifies the various plaza traffic control scenarios required to accomplish the work and provide a safe working environment for turnpike employees and safe passage for turnpike patrons. The Contractor shall plan his work accordingly.

SPECIAL PROVISION
SECTION 652
MAINTENANCE OF TRAFFIC
(Truck Mounted Attenuator)

Section 652 of the Maine Turnpike Authority 2016 Supplemental Specifications is modified as follows:

652.1 Description

The following sentence is added:

When a pay item for a Truck Mounted Attenuator (TMA) is included in the contract at least one TMA will be required on the project and its use will be required. The truck mounted attenuator should be utilized in lane closures and other construction operations where workers are exposed to traffic and not protected by other positive means. The Contractor shall manage the utilization and operation of the TMA and if at least one is not used as described above then it will be considered a Traffic Control Plan violation and result in a reduction of payment as outlined in Section 652.

652.2.1 Truck Mounted Attenuator

This section is deleted in its entirety and replaced with the following:

The truck mounted attenuator system shall conform to the following requirements:

- Truck and attached attenuator shall conform to the NCHRP Report 350, Test Level 3 criteria
- A mounted revolving amber light or amber strobe light with 360-degree visibility.
- An arrow light bar fixed to the vehicle.
- The attenuator shall be mounted to a vehicle with a minimum weight of 10,000 lbs.

652.3.7 Operations

This section is deleted in its entirety and replaced with the following:

The Contractor shall manage the operation of the truck mounted attenuator. The truck mounted attenuator should be utilized in lane closures and other construction operations where workers are exposed to traffic and not protected by positive means. The operation of the vehicle shall be in accordance with the Manual of Uniform Traffic Control Devices and the manufacturer's recommendation.

Installation: The chart below identifies the distance from the work zone or hazard where the TMA shall be deployed. If the work zone is within a marked lane closure, the barrier truck distances shall apply and if the work is mobile, then shadow truck distances shall apply. The TMA

shall not be located in the buffer zone. When used as a barrier, the barrier truck shall be parked in low gear with brakes applied and the front wheels turned away from the work zone and the adjacent traffic lane. For placement details, reference the Manual of Uniform Traffic Control Devices (MUTCD).

Weight of Truck	Barrier Truck Distance from Work Zone of Hazard	Shadow Truck Distance from Work Vehicle or Work Zone
10,000 lbs	250 ft.	300 ft.
15,000 lbs	200 ft.	250 ft.
>24,000 lbs	150 ft.	200 ft.

652.7 Method of Measurement

The last paragraph is deleted and replaced with:

Truck mounted attenuator shall be measured for payment by the calendar day for each calendar day that a unit is used on a travel lane or shoulder on the project, as approved by the resident.

652.8.2 Basis of Payment

The last two paragraphs are deleted and replaced with:

The Truck Mounted Attenuator(s) will be paid for at the Contract unit price per each for each TMA used. This price shall include all costs associated with the use of the vehicle. Payment shall include operator, fuel, truck, maintenance, flashing lights, arrow board and all other incidentals necessary to operate the vehicle.

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
652.45 Truck Mounted Attenuator	Each

SPECIAL PROVISIONSECTION 652MAINTENANCE OF TRAFFIC

(Automated Trailer Mounted Speed Limit Sign)

652.1 Description

This special provision provides for furnishing, operating, and maintaining an Automated Trailer Mounted Radar Speed Limit Sign for project use. When a pay item for an Automated Trailer Mounted Radar Speed Limit Sign is included in the Contract at least one will be required on the project when there is a Work Zone Speed Limit in place. The Contractor shall furnish, operate, and maintain the Automated Trailer Mounted Radar Speed Limit Signs during the project operations.

652.1.1 Instruction and maintenance manuals shall be provided.

652.2 MaterialsAutomated Trailer Mounted Speed Limit Sign

Trailer mounted speed limit signs shall be self-contained units including sign assembly, flashing lights, directional radar to measure speed limits, a regulatory speed limit sign, and power supply specifically constructed to operate as a trailer-mounted sign. The preferred color of the unit shall be “construction orange”.

Signs

Base material for the regulatory speed limit signs shall be weather proof, rigid substrate specifically manufactured for highway signing and meet the retro-reflective sheeting application requirements of the sheeting manufacturer.

Sign text shall consist of the letters, digits and symbols either applied by stick-on or silk screen, to conform to the dimensions and designs indicated in the Contract, MUTCD and/or FHWA Standard Highway Signs. The materials and methods shall be in accordance with standard commercial processes.

“Work Zone” construction signs shall be mounted on the trailer unit above the regulatory speed limit sign.

Signs and secondary signs shall follow the MUTCD for minimum mounting heights.

Power supply

The power supply shall be either full battery power with solar panel charging (capable of maintaining a charged battery level) and 135 ampere, 12 volt deep cycle batteries, or diesel powered generator with a fuel capacity sufficient for 10 hours of continuous operation.

Flashing Lights

Each unit shall be equipped with two mono-directional flashing lights, placed in accordance with the MUTCD, with amber lenses and reflectors, which are visible through a range of 120 degrees when viewed facing the sign. The lights, either strobe, halogen, or incandescent lamps, shall be visible for a minimum distance of one mile under daylight conditions and shall have a minimum flash rate of 40 flashes per minute. An "On" indicator light shall be mounted on the back of the signs, which is visible for at least 500 feet to provide confirmation that the flashing lights are operating.

Radar

The directional radar shall monitor approaching traffic only. The radar shall be capable of measuring speeds from 5 to 70 MPH at a distance of up to 1500 feet and shall have a high speed cut off threshold.

CONSTRUCTION REQUIREMENTS

652.3.2 Responsibility of the Contractor

The Contractor shall furnish the Automated Trailer Mounted Speed Limit Sign as described in this Special Provision for this project.

All existing speed limit signs, which conflict with the construction zone trailer mounted speed limit signs shall be covered completely when the work zone speed limit is in place.

Automated Trailer Mounted Speed Limit Signs shall only be used when a work zone speed limit is in place. The Contractor shall manage the utilization and operation of the Automated Trailer Mounted Speed Limit Signs and if at least one is not used when work zone speed limits are in place then it will be considered a Traffic Control Plan violation and result in a reduction of payment as outlined in Section 652.

The Resident will record the actual time and location for the signs on a daily basis when the Automated Trailer Mounted Speed Limit Signs are in use.

The Automated Trailer Mounted Radar Speed Limit Sign may be placed as shown on the plans, or may replace the posted regulatory speed limit signs or may be placed at a location within the closed lane that has a reduced speed limit.

Automated Trailer Mounted Speed Limit Signs shall be delineated with retro-reflective temporary traffic control devices while in use and shall also be delineated by affixing a retro-reflective material directly on the trailer.

Upon delivery of the Automated Trailer Mounted Speed Limit Sign and before acceptance by the Authority, the Contractor shall have a representative of the manufacturer review the condition and notify the Resident in writing, of all deficiencies noted.

The Contractor shall arrange to have all necessary repairs performed at no cost to the Authority.

To avoid impairing driver vision, the Contractor shall dim the lighted speed limit readings by 50 percent during nighttime use, and restore full power lighting during daytime operation.

652.7 Method of Measurement

Automated Trailer Mounted Speed Limit Sign shall be measured for payment by the calendar day for each calendar day that the unit is used on a travel lane or shoulder on the project or per each for the continued use for the duration of the project. Payment shall include the Trailer, Radar Speed Limit Sign, flashing beacon amber lights, regulatory speed limit sign, fuel, necessary maintenance, and all checking of Radar Speed Limit Signs by manufacturer and all project moves including the transporting and delivery of the unit.

652.8 Basis of Payment

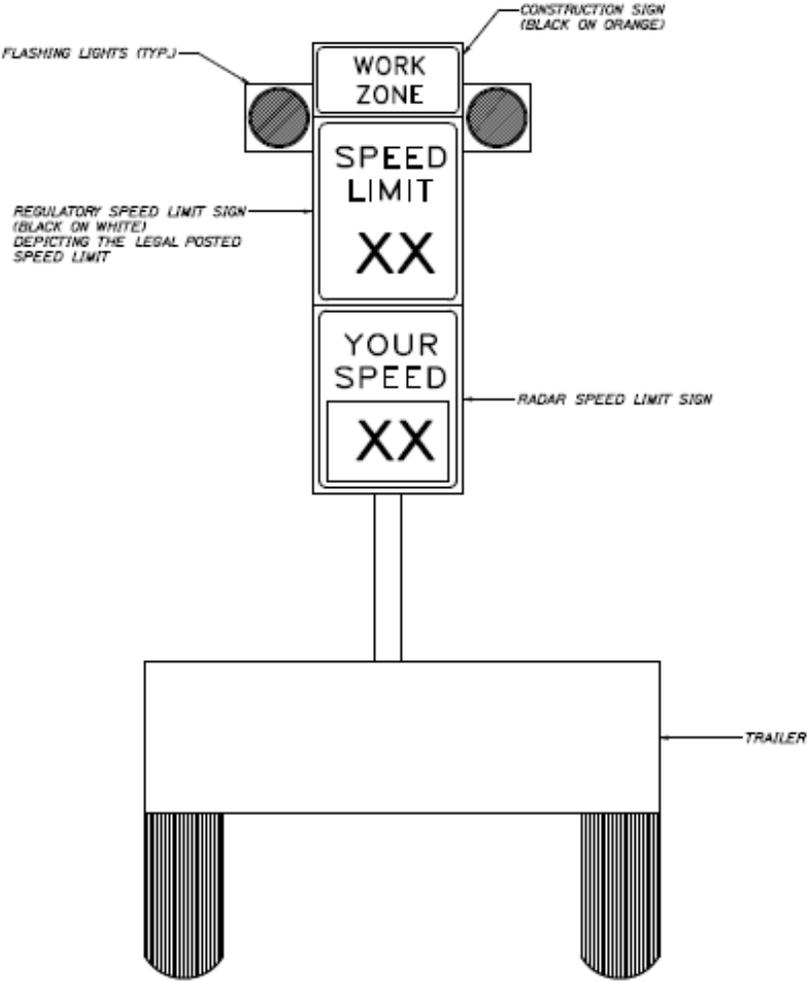
The Automated Trailer Mounted Speed Limit Sign(s) will be paid for at the Contract unit price per each. This price shall include all costs associated with the use of the Automated Trailer Mounted Speed Limit Sign.

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
652.451 Automated Trailer Mounted Speed Limit Sign	Each

Date: 2/13/2018

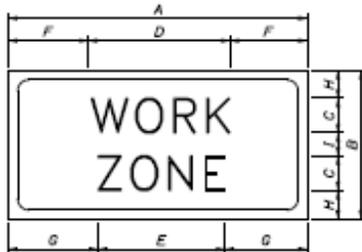
Filename: Trailer Mounted Speed Limit.dgn



HNTB
FEBRUARY 2018

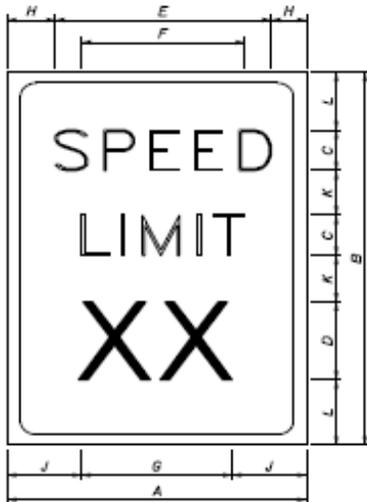
AUTOMATED TRAILER MOUNTED
SPEED LIMIT SIGN

Date: 2/13/2018



SIGN #1

1.25" BORDER, 0.75" INDENT,
BLACK ON ORANGE, BB GRADE PLYWOOD SIGN



SIGN #2

1.25" BORDER, 0.75" INDENT,
BLACK ON WHITE, BB GRADE PLYWOOD SIGN

DIMENSIONS (INCHES) / LETTER FONTS												
	A	B	C	D	E	F	G	H	I	J	K	L
*1	48	20	50	18 1/8	16 1/8	14 1/8	15 1/8	4	2	N/A	N/A	N/A
*2	48	60	8E	16E	30 1/4	29 1/4	29 1/2	4 1/8	9 3/8	9 1/4	8	6



Filename: Trailer Mounted Speed Limit.dgn



HNTB
FEBRUARY 2018

TRAILER MOUNTED CONSTRUCTION ZONE
SPEED LIMIT SIGN

SPECIAL PROVISION

SECTION 652

MAINTENANCE OF TRAFFIC

(Temporary Portable Rumble Strips)

652.01 Description

This work consists of furnishing and placing temporary portable rumble strips RoadQuake 2F TPRS or an approved equal.

652.02 Materials

Furnish a temporary portable rumble strip system, which includes a method to transport and move these to on-site locations where they will be used. The Contractor shall submit for approval, literature and all necessary certifications to the Maine Turnpike prior to procurement of the product.

652.03 General

Placement:

Provide rumble strips where the plans show or as directed by the Resident as follows:

Prior to placing rumble strips, clean the roadway of sand and other materials, that may cause slippage.

Place one end of the rumble strips 6 inches from the roadway centerline. Extend the strips perpendicular to the direction of travel. Ensure strips lay flat on the roadway surface.

Only one series of rumble strips, placed before the first work zone, is required per direction, of travel for multiple work zones spaced 1 mile or less apart. Work zones spaced greater than 1 mile apart require a separate series of rumble strips. Each lane shall use one group of temporary rumble strips.

Bracketed "Rumble Strip Ahead" signs shall be utilized and will be paid for under the respective construction sign pay items.

Maintenance:

Maintain rumble strips as follows:

If rumble strips slide, become out of alignment, or are no longer in the wheel path of approaching vehicles during the work period, thoroughly clean both sides of the rumble strips and reset on a clean roadway.

Repair or replace damaged rumble strips immediately.

652.04 Method of Measurement

The accepted quantity of temporary portable rumble strips shall be measured by the unit complete in place, per lane closure application. A unit shall consist of 1 group of 3 full-lane width of rumble strips. As shown in the plans, a maximum of 3 units may be used at each lane closure. A unit shall be measured for each group of rumble strips, each time they are used for a lane closure.

652.05 Basis of Payment

The accepted quantity of temporary portable rumble strips will be paid for at the contract unit price per group which shall include the transport device. Payment is full compensation for providing, relocating, maintaining or replacing, and removing temporary portable rumble strips.

If the pay item is not included in the contract quantities, then the Authority does not anticipate the use of this item on the contract. If contractor wishes to utilize temporary portable rumble strips and the item is not in the contract, then the contractor may propose use of them to the Authority for consideration.

<u>Pay Item</u>	<u>Pay Unit</u>
652.46 Temporary Portable Rumble Strip	Unit

SPECIAL PROVISION

SECTION 655

ELECTRICAL WORK

655.01 Description

All work shall be governed by the Standard Specifications except for that work which applies to those sections of the Standard Specifications which are amended by the following modifications, additions and deletions.

Specifically, for the electrical work (in addition to standards specified in individual work sections), the following standards are imposed, as applicable to the work in each instance:

- NEC, National Electrical Code (NFPA No. 70)
- NFPA No. 101, Life Safety Code
- ANSI C 2, National Electrical Safety Code
- ANSI C 73, Dimensions of Attachment Plugs and Receptacles
- NECA standards for installation
- NEMA standards for materials and products
- UL, Underwriters Laboratories

The Contractor will warranty the material supplied by them and their workmanship for a minimum of one (1) year from acceptance of the project.

655.02 General Provisions

RELATED DOCUMENTS

General provisions of this Contract, including General Provisions and Special Provisions, apply to work of this section.

SUMMARY

This Section specifies several categories of provisions for electrical work, including:

1. Certain adaptive expansions of requirements specified in the Special Provisions.
2. General performance requirements within the electrical systems.
3. General work to be performed as electrical work, because of its close association.

SUMMARY OF ELECTRICAL WORK

General Outline: The facilities and systems of the electrical work can be described (but not by way of limitation) as follows:

1. Installation of electrical control and power distribution systems, including the electrical connections to new equipment.
2. Installation of toll revenue collection systems hardware.
3. Installation of temporary and interim provisions.

Permits and Fees: This work shall include the procurement of and payment for any and all permits and fees required for the performance of the electrical work including those that may be required from local utilities for services.

COORDINATION OF ELECTRICAL WORK

Refer to Part II, Special Provisions for general coordination requirements applicable to the entire work. It is recognized that the Contract documents are often diagrammatic in showing certain physical relationships, which shall be established within the electrical work, and in its interface with other work including utilities and mechanical work, and that such establishment is the exclusive responsibility of the Contractor.

Arrange electrical work in a neat, well organized manner with conduit and similar services running parallel with primary lines of the building construction, and with a minimum of 7'0" overhead clearance where physical limitations permit.

Locate operating and control equipment properly and in accordance with the NEC, to provide easy access, and arrange entire electrical work with adequate access for operation and maintenance.

Coordination of Options and Substitutions: Where the Contract documents permit the selection from several product options, and where it becomes necessary to authorize a substitution, the Contractor shall not proceed with purchases until coordination of all interface requirements has been checked and satisfactorily established. Substitutions are subject to approval by the Authority or designated representative per the requirements of the Contract documents.

SUBMITTALS FOR ELECTRICAL WORK

For electrical work, submittals are required for each category of items listed below.

- Shop Drawings, Product Data, Certifications, Test Reports, Warranties, Guarantees, Installation Drawings, and Work Checklist in Appendix G.
- Installation Drawings shall be modified and submitted to reflect any changes during installation of electrical equipment.

The Contractor, prior to forwarding shop drawings and product data to the Resident, shall check all conditions, make all corrections and sign and date each set. No shop drawings will be reviewed by the Resident without the signature of the Contractor, which shall signify that he has checked the submittals.

PRODUCTS, ELECTRICAL WORK

Refer to Divisions 600 and 700 of the Standard Specifications for general requirements on products, materials and equipment. The following provisions expand or modify the requirements as applicable to electrical work:

Compatibility: Provide products, which are compatible with other products of the electrical work and with other work requiring interface with the electrical work, including electrical connections and control devices. For exposed electrical work, coordinate colors and finishes with other work.

FLOOR AND WALL PENETRATIONS

Where electrical materials penetrate walls or floors that are a part of a fire separation or assembly, the opening shall be effectively sealed to maintain separation integrity. Openings shall be closed using General Electric RTV850 Silicone RTV Foam, or approved equal to form a fire rated, water-tight seal, and be installed with automatic mixing only. The penetration seal materials shall pass ASTM E 814 (UL 1479) Standard Method of Fire Tests for Through Penetration Fire Stops up to the required fire resistance.

Where conduits penetrate a wall, floor or ceiling that is part of a weatherproof barrier, a non-shrink weatherproof type grout and or Sika 1A caulking shall be used, in accordance with manufacturer's installation instructions.

All work, materials, labor to fireproof or waterproof conduit penetrations shall be incidental to the various pay items.

EXCAVATING FOR ELECTRICAL WORK

The work of this article is defined to include whatever excavating and back-filling is necessary to install the electrical work. Coordinate the work with other excavating and back-filling in the same area, including de-watering; flood protection provisions, and other temporary facilities. Coordinate the work with other work in the same area, including other underground services (existing and new), paving, and concrete work. Coordinate with weather conditions and provide temporary facilities needed for protection and proper performance of installations, excavating and back-filling.

General Standards: Except as otherwise required, comply with the applicable provisions of Divisions 600 and 700 of the Standard Specifications for information related to electrical-work excavating and back-filling. Refer instances of uncertain applicability to the Resident for resolution before proceeding.

ELECTRICAL WORK CLOSEOUT

Construction Equipment: After completion of performance testing with the Authority's representative, remove Contractor's tools, test facilities, construction equipment and similar devices and materials used in execution of the work but not incorporated in the work.

ELECTRICAL SYSTEM TEST

The Contractor shall submit certification of the adequacy of each power and/or communications circuit for the following sub-systems, where applicable:

- ORT Lane Controller Cabinets
- Cash Lane Controller (LC) System
- Automatic Vehicle Identification (AVI) Readers
- Automatic Vehicle Identification (AVI) Antennas
- Digital Video Audit System (DVAS)
- Traffic Control Pedestal (TCP)
- Vehicle Capture and Recognition System (VCARS)
- Canopy Override Switch (COS)
- Manual Lane Terminal (MLT)
- Receipt Printer (RP)
- OPUS

Verification of the electrical system should be done by turning on/off assigned circuit breakers prior to attachment of equipment to validate panel schedule and that proper voltage is present at termination.

COMMUNICATIONS SYSTEMS

Provide outlets, wireways, device plates, etc., in conformance with the applicable sections of this specification, as may be required.

Wireways shall be in accordance with "Wireways" part of the Technical Specifications and NEC and the following special conditions:

- Minimum size shall be 1-inch unless otherwise noted.
- No more than two standard factory 90-degree bends per 100 feet or three 90 degree 24-inch radius bends are permitted and these bends must adhere to minimum manufacturers bend radiuses on data cables.

655.03 Electrical Wireways

RELATED DOCUMENTS

General provisions of the Contract, including General Provisions and Special provisions, apply to work of this section.

SUMMARY

The requirements of this section apply to electrical wireway work specified elsewhere in these Specifications.

The types of electrical wireways required for the project may include the following:

- Electrical metallic tubing.
- Intermediate metal conduit.
- Liquid tight metallic flexible conduit.
- Galvanized rigid metal conduit.
- Nonmetallic conduit. (PVC)
- Surface metal wireways or Non-metallic wireway.

QUALITY ASSURANCE

Manufacturers: Firms regularly engaged in manufacture of electrical wireways of types and capacities required, whose products have been in satisfactory used in similar service for at least three years

Contractor: A firm with at least three years of successful installation experience on projects with electrical wiring installation work similar to that required for the project. Under this definition, Contractor can also be a subcontractor to the General Contractor for the Project.

NEMA Compliance: Comply with applicable portions of National Electrical Manufacturers Association standards pertaining to nonmetallic duct and fittings for underground installation.

UL Labels: Provide electrical wireways, which have been listed and labeled by Underwriters Laboratories.

NEC Compliance: Comply with National Electrical Code (NFPA No. 70) as applicable to construction and installation of electrical wireways.

PRODUCT DELIVERY, STORAGE AND HANDLING

Provide color-coded end-cap thread protectors on exposed threads of threaded metal conduit. Handle conduit and tubing carefully to prevent bending and end-damage and to avoid scoring finish. Store pipe and tubing inside and protect from weather. When necessary to store outdoors, elevate well above grade and enclose with durable, watertight wrapping.

MATERIALS AND COMPONENTS

For each electrical wireway system required, provide a complete assembly of conduit or tubing with fittings including, but not necessarily limited to, connectors, nipples, couplings, elbows, expansion fittings, supports, and other components and accessories as needed to form a complete system for the type required.

Metal Conduit, Tubing and Fittings: Provide metal conduit, tubing and fittings of type, grade, size and weight (wall thickness) required for each service. Where type and grade are not indicated, provide proper selection determined to fulfill wiring requirements, and comply with National Electrical Code for electrical wireways.

Rigid Steel Conduit: FS WW-C-581 and ANSI C80.1.

Intermediate Steel Conduit: FS WW-C-581 and ANSI C80.1.

EMT – Electrical Metallic Tubing: FS WW-C-563A, ANSI C80.3 and UL 797. Installation shall comply with NEC Article 348. Provide high quality, hot dip galvanized, electrical metallic tubing conduit and fittings of type, size and weight (wall thickness) required for each application. EMT shall only be used in enclosed areas that are not subject to possible collision or interference. Where type and grade are not indicated, provide proper selection determined to fulfill wiring requirements, and comply with National Electrical Code. Rain-tight compression type connectors shall be used in all cases. Set-screw type conduit connections or fittings shall not be used.

Galvanized Rigid Metal Conduit Fittings: FS W-F-408, Type and Classes as required.

Liquid-tight Flexible Metal Conduit: Provide liquid-tight flexible metal conduit comprised of single strip, continuous, flexible interlocked, double-wrapped steel, galvanized inside and outside; forming smooth internal wiring channel; with liquid-tight jacket of flexible polyvinyl chloride (PVC).

Liquid-tight Flexible Metal Conduit Fittings: FS W-F-406, Type as required.

Nonmetallic Conduit and Fittings (PVC): Provide nonmetallic conduit and fittings of type, size and weight (wall thickness) required for each service. Where type and grade are not indicated, provide proper selection determined to fulfill wiring requirements, and comply with National Electrical Code for electrical wireways, and with type selected in accordance with applicable standards.

Metallic or Nonmetallic (PVC) Surface Mounted Wireways: Provide wireways for surface mounting as required. Wireways shall be of rectangular cross section of size as required by the National Electrical Code (NFPA No. 70) for conductor fill. Wireways shall be of a design to accommodate wiring devices required. All wireway fittings shall be manufacture provided and not field fabricated.

Conduit and Tubing and Wireway Accessories: Provide conduit, tubing and wireway accessories including straps, hangers, angles expansion and deflection fittings as recommended by conduit, tubing and wireway manufacturers.

Mounting strut materials and hardware: Provide corrosion-resistant hot-dip galvanized strut members and stainless-steel hardware for all equipment and cabinet mounting applications.

INSTALLATION

Install conduit and tubing products as required, in accordance with manufacturer's written instructions, applicable requirements of NEC and National Electrical Contractors Association's

"Standard of Installation", and in accordance with recognized industry practices to ensure that products serve intended function.

Complete the installation of electrical wireways before starting installation of cables within wireways.

Where conduit is installed in earth, it shall be Polyvinyl Chloride (PVC) conduit as specified in the Plans.

PVC conduit shall be used in concrete slabs on grade and where noted in the Plans. Metallic conduit is not permitted in the concrete slabs or in substitution of any PVC conduit locations specified on the Plans without specific authorization by the Authority.

Wherever possible, install horizontal wireway runs above water and steam piping.

Install surface metal wireways and accessories as required on elevations. Carefully coordinate with interior finishes and furnishings.

At any point where a conduit crosses an expansion joint, or where movement between adjacent sections of conduit can be expected, bronze or alloy expansion fittings shall be installed equal to Type AX as made by the O.Z. Electrical Manufacturing Co., Inc., or equivalent by Hope or Spring City unless such locations are within conduit specified as non-metallic. Such locations shall be handled with a non-metallic equivalent or as specified in Plans.

The Contractor shall submit a proposed method of attaching all ancillary components to the space frame to the Resident for approval. The proposed attachment method shall not require drilling, welding or other attachment methods that will damage the space frame or its galvanized coating. Any areas of galvanized coating that are damaged by the Contractor during installation of ancillary components shall be repaired in accordance with ASTM A780.

655.04 Wires and Connectors

RELATED DOCUMENTS

The general provisions of the Contract, including General Provisions and Special Provisions, apply to the work specified in this section.

SUMMARY

The requirements of this section apply to the wire work specified elsewhere in these Specifications.

The applications for wire and connectors required on the project may include the following:

- Power distribution circuitry.
- Lighting circuitry.
- Appliance and equipment circuitry.

QUALITY ASSURANCE

Manufacturers: Firms regularly engaged in the manufacture of electrical products of the types and ratings required, whose products have been in satisfactory use in similar service for at least three years.

Contractor: A firm with at least three years of successful installation experience on projects with electrical wiring installation work similar to the work required for the project. Under this definition, Contractor can also be a subcontractor to the General Contractor for the Project.

NEC Compliance: Comply with National Electrical Code (NFPA 70) as applicable to construction and installation of electrical cable, wire and connectors.

UL Labels: Provide electrical cable, wire and connectors, which have been listed and labeled by Underwriters Laboratories.

NEMA/ICEA Compliance: Comply with National Electrical Manufacturers Association/Insulated Power Cable Authorities Association Standards publications pertaining to materials, construction and testing wire cable, where applicable.

PRODUCT DELIVERY, STORAGE AND HANDLING

Provide factory-wrapped water-proof flexible barrier material for covering wire and cable on wood reels, where applicable; and weather resistant fiberboard containers for factory-packaging of cable, wire and connectors, to protect against physical damage in transit. Do not install damaged cable, wire or connectors. Damaged materials must be removed from project site as soon as possible after damage is discovered.

Store wire and connectors in factory-installed coverings in a clean, dry indoor space which provides protection against the weather and elements.

MANUFACTURERS

Provide products produced by one of the following or approved equal (for each type of cable, wire and connectors):

Cable and Wire:

- Anaconda Wire and Cable Co.
- Belden Corp.
- General Cable Corp.
- Phelps Dodge Cable and Wire Co.
- Wire and Cable Dept., General Electric Co.
- Rome Cable Corp.

Connectors:

- AMP Inc.
- Burndy Corp.

- Minnesota Mining and Mfg. Co.
- OZ/Gedney Co.
- Thomas & Betts Co.

WIRE AND CONNECTORS

Except as otherwise required, provide wire and connectors of manufacturer's standard materials, as required by published product information and designed and constructed as recommended by the manufacturer as required for the installation.

Wire: Provide factory-fabricated wire of the size, rating, material and type as required for each service. Where not indicated, provide proper selection as determined by Installer to comply with installation requirements and with NEC standards. Select from only the following types, materials, conductor configurations, insulations, and coverings for 120/208 Volt circuits for a 3-phase system:

UL Type: THW. (Sizes #6 AWG wire and larger)

UL Type: THHW. (Sizes up to #4 AWG wire)

UL Type: USE. (Underground installation)

Material: Copper.

Conductors: (AWG wire 20 to AWG wire 16).

Note: All low voltage signal conductors (including CAT5e and CAT6 data cables) shall be stranded. Conductors for underground, below grade, or in conduit to lane devices shall be OSP grade, gel filled. Interior building communications cables may be plenum rated for interior wall or cable tray applications.

Concentric-lay-stranded (standard flexibility) (AWG wire 14 and larger).

Interconnection for data communication shall be performed with cables that shall be submitted for approval. The general cable types are designated on the Plans/ Specifications. Minimum bend radius should meet the requirements of the manufacturer and the requirements of the system.

Wire shall be color-coded as noted in the wiring schedules provided in the Plans.

Lead-in cables to extend loop detectors shall be IMSA Type 50-2. Loop lead-in cables shall be manufactured with a size of #14 AWG.

Klik-Its (Power & Tel Enterprise Part #C8820) shall be used at all loop wire splice locations. All splices must be twisted, soldered and shrink-wrap waterproofed before enclosure is placed.

Authority's preference is to use home run cables. The use of shielded cable is acceptable, provided neither end is grounded.

All cable labeling shall be coordinated with the requirements of the Authority's Toll System Integrator (SI).

INSTALLATION

Install electrical wire and connectors as required, in accordance with the manufacturer's written instructions, the applicable requirements of NEC and the National Electrical Contractors Association's "Standard of Installation", and in accordance with recognized industry practices to ensure that products serve the intended functions.

Coordinate cable and wire installation work with electrical wireway and equipment installation work, as necessary for proper interface.

All wire and cable shall be in first class condition when installed. Lo-leak lubricants manufactured for the purpose of a pulling lubricant may be used when necessary.

All wires shall be continuous from outlet and there shall be no unnecessary slack in the conductors.

FIELD QUALITY CONTROL

Prior to energizing, check wire for continuity of circuitry and for short circuits with ohmmeter type testing equipment. The Contractor shall correct any malfunctions when they are detected.

Subsequent to wire hook-ups, energize circuitry and demonstrate functioning in accordance with requirements.

655.05 Electrical Boxes and Fittings

RELATED DOCUMENTS

The general provisions of the Contract, including General Provisions and Special Provisions, apply to the work specified in this section.

SUMMARY

The types of electrical boxes and fittings required for the project may include the following:

- NEMA 4X Cabinet for ORT AVI Readers
- Outlet boxes
- Junction boxes
- Pull boxes
- Floor boxes
- Conduit bodies
- Bushings
- Locknuts

QUALITY ASSURANCE

Manufacturers: Firms regularly engaged in the manufacture of electrical units of types and sizes required, whose products have been in satisfactory use in similar service for at least three years.

Contractor: A firm with at least three years of successful installation experience on projects with electrical installation work similar to that required for the project. Under this definition, Contractor can also be a subcontractor to the General Contractor for the Project.

NEC Compliance: Comply with National Electrical Code (NFPA 70) as applicable to construction and installation of electrical boxes and fittings.

U.L. Labels: Provide boxes and fittings, which have been listed and labeled by Underwriters Laboratories.

NEMA Compliance: Comply with National Electrical Manufacturers Association standards as applicable to nonmetallic fittings for underground installation.

NECA Standard: Comply with applicable portions of the National Electrical Contractors Association's "Standard of Installation".

MANUFACTURERS

Provide products produced by one of the following or approved equal (for each type of box and fitting):

ORT Control Cabinet:

- Hammond Manufacturing (provided by SI and installed by the Contractor)

Interior Outlet Boxes:

- Appleton Electric Co.
- Arrow Conduit and Fittings Corp.
- National Electric Products Co.
- OZ/Gedney Co.
- Steel City, Midland-Ross Corp.

Junction and Pull Boxes:

- Arrow-Hart, Inc.
- General Electric Co.
- OZ/Gedney Co.
- Square D Co.
- Unitil

Conduit Bodies:

- Appleton Electric Co.
- Crouse-Hinds Co.
- Killark Electric Mfg. Co.
- Pyle-National Co.

Bushings, Knockout Closures and Locknuts:

- Allen-Stevens Conduit Fittings Corp.
- Allied Metal Stamping, Inc.
- Appleton Electric Co.
- Carr Co.
- Raco, Inc.
- Steel City, Midland-Ross Corp.
- Thomas and Betts Co., Inc.

MATERIALS

ORT Control cabinet: shall be provided by the Authority's Toll System Integrator (SI) and installed by the Contractor. The following information is provided to assist the Contractor with planning for the associated conduit and wiring work. The ORT Control Cabinet shall have the following dimensions:

Height 6'-0"

Width 6'-0"

Depth 1'-6"

FABRICATED MATERIALS

Interior Outlet Boxes: Provide galvanized steel interior outlet wiring boxes, of the type, shape and size, including depth of box, to suit each respective location and installation; constructed with stamped knockouts in back and sides, and with threaded holes with screws for securing box covers or wiring devices.

Interior Outlet Box Accessories: Provide outlet box accessories as required for each installation, including mounting brackets, wallboard hangers, extension rings, fixture studs, cable clamps and metal straps for supporting outlet boxes, compatible with outlet boxes being used and meeting requirements of individual wiring situations. Choice of accessories is Installer's option. All covers for outlet boxes to be stainless steel.

Junction and Pull Boxes: Provide galvanized sheet steel, PVC or concrete junction and pull boxes as called for in the Plans with screw-on covers; of the type shape and size, to suit each respective location and installation; with welded seams and equipped with stainless steel nuts, bolts, screws and washers.

Conduit Bodies: Provide galvanized cast-metal conduit bodies, of the type, shape and size, to suit each respective location and installation, constructed with threaded conduit ends, removable cover, and corrosion-resistant screws.

Bushings, Knockout Closures and Locknuts: Provide corrosion-resistant punched-steel box knockout closures, conduit locknuts and malleable iron conduit bushings of the type and size to suit each respective use and installation.

Mounting strut materials and hardware: Provide corrosion-resistant hot dipped galvanized members and stainless-steel hardware for all equipment mounting applications. Where strut

material is exposed to the weather, and less than 10 feet off the ground, struts shall be stainless steel. If any galvanized strut member or hardware is cut or the galvanizing is compromised, the affected area shall be wire brushed and cleaned to bare metal and the area shall be given two coats of cold galvanizing (following application instructions).

INSTALLATION OF BOXES AND FITTINGS

Install all equipment cabinets in compliance with NEC requirements, in accordance with the manufacturer's written instructions, and with recognized industry practices to ensure the boxes and fittings serve the intended purposes. Contractor shall coordinate all associated conduit, wiring and related work with the Resident and SI to confirm appropriate placement in coordination with ORT Control cabinet installation. Given the final installation of the ORT Control cabinets will likely take place several weeks following the placement of the cabinets in the plaza tunnel, the Contractor shall work with the Resident to provide adequate protection of the cabinets until they are mounted in their final location.

Install electrical boxes and fittings in compliance with NEC requirements, in accordance with the manufacturer's written instructions and with recognized industry practices to ensure that the boxes and fittings serve the intended purposes:

Provide weatherproof outlets for interior and exterior locations exposed to weather or moisture.

Provide knockout closures to cap unused knockout holes where blanks have been removed
Locate boxes and conduit bodies to ensure accessibility of electrical wiring.

All boxes shall be rigidly secured in position unless otherwise directed by the Resident.

Where standard boxes are not suitable, provide boxes of special design to suit space and function.

Conduit bushings shall be used on the end of all pipes terminated in a raceway or boxes.

The Contractor shall submit a proposed method of attaching all ancillary components to the space frame to the Resident for approval. The proposed attachment method shall not require drilling, welding or other attachment methods that will damage the space frame or its galvanized coating. Any areas of galvanized coating that are damaged by the Contractor during installation of ancillary components shall be repaired in accordance with ASTM A780.

655.06 Wiring Devices

RELATED DOCUMENTS

The general provisions of the Contract, including General Provisions and Special Provisions, apply to the work specified in this section.

SUMMARY

Wiring devices are defined as single discrete units of electrical distribution systems, which are intended to carry but not utilize electric energy.

The types of electrical wiring devices required for this project include the following:

- Receptacles
- Switches
- Wall plates
- Plugs
- Connectors
- Breakers

QUALITY ASSURANCE

Manufacturers: Firms regularly engaged in manufacture of wiring devices, of types and ratings required, whose products have been in satisfactory use in similar service for at least three years.

Contractor: A firm with at least three years of successful installation experience on projects with electrical installation work similar to that required for the project.

NEC Compliance: Comply with National Electrical Code (NFPA No. 70) as applicable to construction and installation of electrical wiring devices.

UL Labels: Provide electrical wiring devices, which have been tested, listed and labeled by Underwriters Laboratories.

NEMA Compliance: Comply with National Electrical Manufacturers Association standards for general- and specific-purpose wiring devices.

MANUFACTURERS

Provide products produced by one of the following:

- Arrow-Hart, Inc.
- Bell Electric Co.
- Bryant Electric Co.
- Crouse-Hinds Co.
- Cutler-Hammer, Inc.
- General Electric Co.
- Gould, Inc.
- Harvey Hubbell Inc.
- Pass and Seymour, Inc.
- Slater Electric, Inc.
- Square D Co.
- Hunt Electronics
- Lutron
- Intermatic
- Paragon
- Unitil

FABRICATED DEVICES

Provide factory-fabricated wiring devices, in type and electrical rating for the service required.

Receptacles: Comply with NEMA Stds. Pub. No. WD1 and as follows:

General-Duty Duplex: Provide duplex general-duty type, spec. grade, receptacles, 2-pole, 3-wire grounding, with green hexagonal equipment ground screw, ground terminals and poles internally connected to mounting yoke, 15-ampere, 125-volts, with metal plaster ears, screw terminal connectors, NEMA configuration 5-15R unless otherwise required.

Heavy-Duty Duplex: Provide duplex type, spec. grade, receptacles, 2-pole, 3-wire grounding, with green hexagonal equipment ground screw, 20-ampere, 125-volts, with metal plaster ears, screw terminal connectors, NEMA configuration L5-20R unless otherwise required. Provide twist lock outlets as required for the UPS connections, twist locks to be L5-20R.

Switches: Comply with NEMA Stds. Pub. No. WD1 and as follows:

Provide general-duty flush toggle switches, 20-ampere, 120/277VAC, with mounting yoke insulated from mechanism, equipped with plaster ears, and side-wired screw terminals as follows:

Single pole switches	Double pole switches
Three Way switches	Four Way switches

Breakers: Breakers shall be compatible with panel circuits. All breakers necessary will be incidental to the Contract pay items.

WIRING DEVICE ACCESSORIES

Wall Plates: Provide single switch and duplex outlet wall plates for wiring devices, with ganging and cutouts as required, provide with metal screws for securing plates to devices, screw heads colored to match finish of plate, and wall plates possessing the following additional construction features:

Material and Finish: 0.04-inch thick, satin finished stainless steel.

INSTALLATION OF WIRING DEVICES

Install wiring devices where required, in accordance with manufacturer's written instructions, applicable requirements of NEC and National Electrical Contractors Association's "Standard of Installation", and in accordance with recognized industry practices to ensure that products serve intended function.

Delay installation of devices until wiring is completed.

Install receptacles and switches only in electrical boxes that are clean and free from excess building materials, debris, etc.

PROTECTION OF WALL PLATES AND RECEPTACLES

Upon installation of wall plates and receptacles, Contractor shall use caution regarding the use of convenience outlets. At time of completion, replace those items which have been damaged, including those burned and scored by faulty plugs.

TESTING

Test wiring devices to ensure electrical continuity of grounding connections, and after energizing circuitry, to demonstrate compliance with requirements.

655.07 Grounding

SUMMARY

Furnish labor and material to provide grounding facilities for the entire electrical installation as required by all inspecting and jurisdictional authorities as herein specified. The following are included, but not limited to, as items requiring grounding:

- Electrical service neutral conductor.
- Neutral conductor of all transformer secondary.
- Conduits, boxes and other conductor enclosures. Neutral or identified conductor of interior wiring system.
- Distribution panels, power and lighting panel boards.
- Non-current - carrying parts of fixed equipment, such as transformers, motors, starters, control cabinets, disconnects, lighting fixtures, stand-by generator, etc.
- Metallic cabinets and auxiliary systems cabinets.

EQUIPMENT

Furnish and install all boxes and/or access plates required for installation and inspection of grounding connections to cold water piping system or other made electrodes.

Provide brass identifying tags on all ground clamps.

INSTALLATION

Ground connections made to metallic cold-water piping system at such locations as will be readily available for inspection. Provide jumper connections around all meters and shut off devices.

Where cold water piping is not available for ground connections, use other available or made electrodes as described in NEC Sections 250-81 or 250-83.

Conduit Grounding: All grounding bushings within all enclosures, including equipment enclosures, shall be wired together and connected internally to the enclosure grounding lug or grounding bus with bare copper conductor. Grounding conductors sized in accordance with NEC shall be used with all grounding bushings.

Equipment Grounding: All electrical equipment shall be grounded. Most other equipment will be furnished with grounding pads or grounding lugs. All ground connections shall be cleaned immediately prior to connection. The Contractor shall provide all grounding material required but not furnished with the equipment.

No grounding conductor shall be smaller than 12 AWG wire unless it is a part of an acceptable cable assembly.

SPECIAL PROVISIONSECTION 655ELECTRICAL

(Installation of ORT Lane Control Cabinet)

RELATED DOCUMENTS

Examine Drawings, Contract Conditions and all other Sections of the Specifications for requirements which affect work of this Section whether or not such work is specifically mentioned in this Section.

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

Description

The purpose of this section is to provide information related to the work required to prepare the location of the lane controller cabinets as well as mount and install the ORT control cabinets. A concrete pad shall be installed as designed in the Plan drawings.

Mounting cleats which are supplied by the SI shall be attached to the tunnel wall. Conduit, wires and cables shall be pulled to the ORT Control and looped. Once the ORT Control is placed and connections to the cabinet have been made the SI will terminate all wiring. The Contractor may be required to be present when the SI terminates to perform any additional work necessary. All work shall be coordinated with the Resident and SI.

Installation

The Contractor shall install and connect all conduit, wireway, power and data wires associated with the proposed ORT Control Cabinets. The SI shall terminate all toll equipment wiring in the ORT Control Cabinets. The Contractor shall install a concrete pad as detailed in the Plan drawings for each of the ORT Control cabinets to be mounted on.

The Contractor will be required to:

- a. Install concrete pads as detailed in the Plan drawings, including reinforcement.
- b. Install SI provided mounting cleats to tunnel wall and cabinets in accordance with manufacturer and SI standards.
- c. Terminate clean power into three quadplex receptacles or provide alternate termination as shown on the Plans or directed by the Resident and SI. Power termination requirements to be confirmed in the field. The quadplex receptacles shall be white with stainless steel covers.
- d. Pull data/power from lane equipment into the ORT Control Cabinets with a 36-inch service loop for all data lines (including 120 volt data);
- e. Label each wire coming into the ORT Control Cabinets with numbered tags per wiring schedules and subject to approval as directed by the Resident and SI at the

start of the project. Tags shall be neat, legible, waterproof, and approved by the SI/ the Resident.

- f. Cap or otherwise prep the ends of all conduit and wiring associated with the proposed lane controller such that these components will be sealed from any damage due to the elements prior to installation of the ORT Control Cabinet.

Basis of Payment

Measurement and payment for mounting and installation work associated with the ORT Lane Control cabinets as shown on the Plan drawings and described herein will be per each item. Installation of receptacles and completion of all conduits and wiring associated with the cabinet shall be incidental.

Pulling power wires and data cables as required for the new ORT Control Cabinet and associated equipment as shown on the Plan drawings will be incidental. All new conduit, wireway, wires and data cables installed will be paid under its appropriate pay item.

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
655.01 Installation of ORT Lane Controller Cabinet	Each

SPECIAL PROVISIONSECTION 655ELECTRICAL

(Installation of Cash Lane Controller Cabinet)

RELATED DOCUMENTS

- A. Examine Drawings, Contract Conditions all other Sections of the Specifications for requirements which affect work of this Section whether or not such work is specifically mentioned in this Section.
- B. Coordinate work with that of all other trades affecting, or affected by work of this Section. Cooperate with such trades to assure the steady progress of all Project work.

Description

The purpose of this section is to provide information related to the work required to prepare the location for the proposed lane controller (LC) cabinet to be installed by the Contractor. This section provides information on how the work by the Contractor will take the LC into consideration. All work shall be coordinated with the Resident and SI.

Submittals

A minimum of five days prior to the installation of the LC cabinet, the Contractor will be required to submit three copies of a neat line sketch of the proposed lane controller cabinet location detailing proposed conduit/wireway runs (calling out conduit/wireway sizes and the specific cables/wires in each conduit/wireway) to the LC, AVI, Sensor loops, TCP, DVAS, MLT, RP, Proximity Reader, COS and OPUS (As shown in the Plans). Included with this sketch will be the Plaza Work checklist from Appendix G that the Contractor must complete. This sketch must indicate which cables will be routed into the new LC, how much slack is required in each of these cables, and any extra work that is required. The Resident/SI will have three working days to review the submittal. Work done for this submittal will be incidental to mobilization. After this submittal the exact location of the LC installation will be confirmed by the Resident and the SI. Also to be confirmed by the Resident and the SI will be the number, size and location of the conduits entering the LC cabinet, conduit/wireway layouts in pit/tunnel and entering the pit/tunnel, canopy and booth, islands, under slabs, etc.

Installation

The Contractor shall install all conduit/wireway and power, and data wires, associated with the proposed LC within the LC cabinet so as to be able to connect proposed peripherals to the new LC at the time of installation by the SI.

The Contractor will be required to:

- a. Terminate clean power into the Cash LC cabinet or provide alternate termination as directed by the Resident and the SI. Power termination requirements to be confirmed in the field;
- b. Pull data/power from lane equipment into the Cash LC cabinet with a 36-inch service loop for all data lines (including 120-volt data);
- c. Label each wire coming into the Cash LC cabinet with numbered tags as directed by the Resident and the SI at the start of the project. Tags shall be neat, legible, waterproof, and approved by the SI/ Resident.

Basis of Payment

Measurement and payment for preparation work associated with the Cash LC cabinet as shown on the Plan drawings and described herein will be per each item. Installation of the Cash LC cabinet, installation of receptacles, completion of all conduits and wiring associated with the cabinet shall be incidental.

All new conduit/wireway installed will be paid under its appropriate pay item.

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
655.012 Installation of Cash Lane Controller Cabinet	Each

SPECIAL PROVISION

SECTION 655

ELECTRICAL

(DVAS Mount Installation)

Description

The Contractor shall mount a Pelco EM2200 hook to the underside of the space frame or canopy to accept a Costar CHG3000S enclosure for the DVAS camera. The Pelco hook shall be supplied by the SI. The Contractor will be responsible for mounting the hook. The mounting hardware shall be mounted directly to the space frame or under canopy. Final location shall be approved by the Authority. Any additional hardware required will be incidental to the pay item.

Basis of Payment

Measurement and payment for work the DVAS mount installation as shown on the Plan drawings and described herein will be per each item.

Payment will be made under:

<u>Pay Item</u>		<u>Pay Unit</u>
655.02	DVAS Mount Installation	Each

SPECIAL PROVISION

SECTION 655

ELECTRICAL

(VCARS Mount Installation)

Description

The Contractor shall mount a 3-inch outside diameter round Galvanized Ridged Metal Conduit using the long-tangent U-bolts supplied by the SI in the VCARS mounting kit. The Contractor must leave three feet of clearance between the bottom of the space frame and the top of the mounting pipe for the VCARS unit.

Basis of Payment

Measurement and payment for work the VCARS mount installation as shown on the Plan drawings and described herein will be per each item. All materials not provided in the mounting kit, labor and hardware are incidental to the pay item.

Payment will be made under:

<u>Pay Item</u>		<u>Pay Unit</u>
655.03	VCARS Mount Installation	Each

SPECIAL PROVISION

SECTION 655

ELECTRICAL

(Installation of Sensor Loops)

Description

The Contractor shall sawcut any concrete pavement slab as directed by the Resident and according to Plans and detailed manufacturer’s instructions provided prior to installation. Given the proprietary nature of the loop installation requirements, the manufacturer’s instructions will only be provided to the awarded Contractor. Loop installation will involve multiple sawcuts within the limits indicated on the Plans and per manufacturer provided templates. Templates for loop cutting outlines shall be provided by the SI. No loop installation activities shall be done without the SI representative on-site. The SI will also provide the required materials for sealing the loops, including but not limited to, the required epoxy, pump and related injection equipment prior to the Contractor placing sensor loops. The Contractor shall be responsible for obtaining and operating required sawcutting equipment.

NOTE: All dust must be contained so that no silica reaches Authority employees or patrons. This may be accomplished by using wet saws, advanced air filter systems or by building an enclosure around the work area. The Contractor shall provide the Resident a 5-day notice prior to any sawcutting activities.

Basis of Payment

Payment to be made as lump sum for all associated Sensor loops shown on Plan drawings. Sawcutting of pavement, installation of epoxy and loops will be incidental to item.

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
655.04 Installation of Sensor Loops	Lump Sum

SPECIAL PROVISION

SECTION 655

ELECTRICAL

(Installation of AVI Antennas)

Description

The Contractor shall pick up AVI antennas and mounting equipment at the Maine Turnpike headquarters or a nearby maintenance yard as coordinated by the Resident. The Contractor shall install antennas and mounts in accordance with the manufacturer’s instructions. Antenna wires shall be installed and looped, the Contractor or SI will terminate equipment wiring while the Contractor is onsite. If the vendor requires additional work during termination and testing the Contractor must be present to assist.

Basis of Payment

Measurement and payment for work associated with the installation of AVI antennas as shown on the Plan drawings and described herein will be per each item. The Contractor will not pay for the purchase of antennas or presence of the AVI equipment vendor to terminate and tune equipment.

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
655.05 Installation of AVI Antennas	Each

SPECIAL PROVISION

SECTION 655

ELECTRICAL

(Installation of AVI Readers)

Description

The Contractor shall pick up AVI readers at the Maine Turnpike headquarters or a nearby maintenance facility or delivered by the SI as coordinated by the Resident. The Contractor shall install readers in NEMA 4X cabinets mounted on space frame pedestals or in the tunnel as shown on the Plans. AVI readers shall be installed in accordance with the manufacturer’s instructions with oversight by the SI onsite as needed (to be determined by Resident). Reader wires shall be installed and looped. The vendor will arrive to terminate wiring while the Contractor is onsite. If the AVI equipment vendor requires additional civil or electrical work during termination and testing, the Contractor must be present to assist.

Basis of Payment

Measurement and payment for work associated with the installation of AVI readers as shown on the Plan drawings and described herein will be per each item. The Contractor will not pay for the purchase of readers or the presence of the AVI equipment vendor to terminate wiring and tune equipment.

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
655.06 Installation of AVI Readers	Each

SPECIAL PROVISION

SECTION 655

ELECTRICAL

(Traffic Control Pedestal Preparation Work)

Basis of Payment

Measurement and payment for preparation work for the Traffic Control Pedestals (TCP) as shown on the Plan drawings and described herein will be per each item. Note the procurement and installation of the TCP will be by the SI. Preparation work shall include drilling and installing threaded rods with adhesive and protection of associated wiring for the TCP in advance of installation of the TCP by the SI. The Contractor shall provide the following items or approved equivalents for the TCP anchorage system:

- 4 each - 1/2" x 6-1/2" Hilti HAS 304SS threaded rods, nuts (double nut), flat and lock washers.
- 4 each - Hilti HVU adhesive capsules.
- 4 each – 1/2" SS nuts and fender washers for shimming and leveling the pedestal base.

Steps involved in installation of threaded rods are as follows:

1. Using the Pedestal Base detail in as a template (provided by System Integrator), layout and drill four 9/16" holes for the 1/2" threaded rods.
2. Using a compressor and wire brush blow gun, clean out the anchor holes of any dust or debris.
3. Use the shop vacuum to clean up all the concrete dust and metal shavings.
4. For all concrete island installations, install the four 1/2-inch Hilti HAS 304SS threaded rods (using HVU adhesive capsules according to the manufacturer's instructions).

Final location of TCP and alignment of threaded rod pattern layout shall be confirmed by the Resident, the Authority and the SI prior to threaded rod installation.

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
655.07 Traffic Control Pedestal Preparation Work	Each

SPECIAL PROVISION

SECTION 655

ELECTRICAL

(OPUS Mount Installation)

Description

The Contractor shall mount a 2.5-inch nominal diameter round Galvanized Ridged Metal Conduit using U-bolts supplied by the SI, with the lowest point of its hood flange 17'-6" above the roadway surface. The Contractor must leave three feet of clearance between the bottom of the space frame and the top of the mounting pipe for the OPUS unit.

Basis of Payment

Measurement and payment for work the OPUS mount installation as shown on the Plan drawings and described herein will be per each item.

Payment will be made under:

<u>Pay Item</u>		<u>Pay Unit</u>
655.08	OPUS Mount Installation	Each

SPECIAL PROVISION

SECTION 655

ELECTRICAL

(Armored Cable – 10/3)

Description

This task shall include the providing and installation of armored cable wire, as described herein for clean and dirty power wiring, and other locations called for in the Plans and Specifications.

Wire: as previously specified in the technical provisions of wires & conductors.

Basis of Payment

Measurement and payment for the installation of armored cable wire as described herein will be per foot, to the nearest 10-foot interval per run. It shall include the furnishing, installation, routing, termination, splices and connection of the wire per the wiring schedule.

Payment will be made under:

<u>Pay Item</u>		<u>Pay Unit</u>
655.09	Armor Cable – 10/3	Linear Foot

SPECIAL PROVISION

SECTION 655

ELECTRICAL

(AWG Wire)

Description

This task shall include the providing and installation of the AWG wire, as described herein for clean and dirty power wiring, for grounding wires (where applicable) and other locations called for in the Plans and Specifications. All wire installed in conduit must be burial grade, suitable for wet locations.

Basis of Payment

Measurement and payment for the installation of the AWG wire as described herein will be per foot, to the nearest 10-foot interval per run. It shall include the furnishing, installation, routing, termination, splices and connection of the wire per the wiring schedule.

Payment will be made under:

<u>Pay Item</u>		<u>Pay Unit</u>
655.100	#2/0 AWG Wire	Linear Foot
655.1001	#1/0 AWG Wire	Linear Foot
655.1004	#4/0 AWG Wire	Linear Foot
655.101	#1 AWG Wire	Linear Foot
655.102	#2 AWG Wire	Linear Foot
655.104	#4 AWG Wire	Linear Foot
655.106	#6 AWG Wire	Linear Foot
655.11	#10 AWG Wire	Linear Foot
655.12	#12 AWG Wire	Linear Foot

SPECIAL PROVISION

SECTION 655

ELECTRICAL

(4pr/24 (Category 5e) Cable)

Description

This task shall include the providing and installation of the Category 5e cable shown on the Plan drawings and described herein.

Cable: 4 pair, 24 AWG, Category 5e, twisted pair cable. Conductor material shall be bare copper, inner jacket material shall be PVC, cable shall be insulated and unshielded. Must be direct burial type suited for harsh conditions 4pr/24 category 5e cable, as approved.

Basis of Payment

Measurement and payment for the installation of the 4pr/24 category 5e cable will be by linear foot to the nearest 10-foot interval per cable run. It shall include the furnishing, installation and routing of the cable per the wiring schedule.

Payment will be made under:

<u>Pay Item</u>		<u>Pay Unit</u>
655.14	4pr/24 (Category 5e) Cable	Linear Foot

SPECIAL PROVISION

SECTION 655

ELECTRICAL

(LMR 400 Cable)

Description

This task shall include the providing and installation of the LMR 400 cable shown on the Plan drawings and described herein. The contractor will terminate the LMR 400 Cable with the RF Male-RFN-100631 and RF Female-RFN-1028-SI. The male terminal end is at the antenna and the female terminal end is at the AVI Reader. The contractor shall solder the end of the terminal end pins instead of crimping.

Cable: LMR 400 cable, as approved.

Basis of Payment

Measurement and payment for the installation of the LMR 400 cable will be by linear foot to the nearest 10-foot interval. It shall include the furnishing, installation, routing of the cable per the wiring schedule and terminating.

Payment will be made under:

<u>Pay Item</u>		<u>Pay Unit</u>
655.15	LMR 400 Cable	Linear Foot

SPECIAL PROVISIONSECTION 655ELECTRICAL

(Fiber Optic Cable – 6 Fiber)

Description

This task shall include providing and installation of both 62.5/125-micron multimode (OM1) and, 9/125-micrometer single mode (OS2) fiber optic cable as shown on the Plan drawings and described herein for all toll equipment application. All fiber terminations and testing will be completed by a technician certified to perform this work and shall be the responsibility of the contractor. All fiber optic cable hardware will be

A. Fiber Optic Cable:

1. Multimode 6-Fiber, Indoor/Outdoor Plenum Rater, ST (Male) Connection, as approved.
2. Single Mode 6-Fiber, Indoor/Outdoor Plenum Rater, ST (Male) Connection, as approved.

Corning fiber shall be the only fiber optic cable used for installation. Cable from other manufacturers will NOT be considered. All cable installed must be accepted by Authority prior to installation.

B. Specifications: Fiber installed must meet or exceed the following Specifications:

1. Comply with ICEA S-104-696 for mechanical properties.
2. Comply with TIA-568-C.3 for performance specifications.
3. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for Plenum Rated, Nonconductive - Type OFNP, dry water blocking, complying with NFPA 262.
4. Cable cordage jacket, fiber, unit, and group color shall be according to TIA-598-B

C. Fiber Optic Cable Hardware:

Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

1. Corning Cable Systems
2. Hubbell Premise Wiring
3. Molex Premise Networks; a division of Molex, Inc.
4. Ortronics/Legrand
5. Panduit

D. Cross-Connects and Patch Panels:

Rack mounted (or wall mounted) modular panels housing multiple-numbered, duplex ST cable connectors. Bi-directions sliding draws for both front and rear access to fibers and fiber optic splice trays.

1. Number of Connectors per Field: One for each fiber of cable or cables assigned to field, plus 25 percent spare and blank positions.

Patch Cords: Factory-made, single fiber patch cables, with ST connectors, in the following quantities and lengths:

1. Multimode - Ten (10) – 2-meter lengths and 5-meter lengths, and Five (5) – 10-meter lengths Orange.
2. Single Mode - Ten (10) – 2-meter lengths and 5-meter lengths, and Five (5) – 10-meter lengths – Yellow.

E. Fiber Optic Cable Pigtails: OS2 Single Mode and OM1 Multimode single fiber 900Mm pigtails.

1. Factory-made.
2. Furnish, and fusion splice, one for each strand of each fiber optic cable for termination onto fiber patch panels.
3. Comply with TIA-568-C.3 performance requirements.
4. ST to pigtail.
5. ST connector housing and boot colors follow TIA-568-C.3 suggested color identification scheme.
6. Insertion loss per connection: 0.15dB typical, 0.25dB maximum.

F. Fiber Optic Cable Connecting Hardware:

1. Comply with Optical Fiber Connector Intermateability Standards (FOCIS) specifications of TIA-604-2, TIA-604-3-A, and TIA-604-12. Comply with TIA-568-C.3.
2. Quick-connect, simplex and duplex, Type ST connectors. Insertion loss not more than 0.75 dB.

G. Fiber Optic Cable Installation and Testing:

At no time shall more than 675 N of tension be placed on any fiber cable while it is being pulled through tray or conduit. It is preferred that all fiber cable be pulled with hand power only. If power winches or mechanical advantage devices are used to pull cable, a tension meter must be used to ensure that maximum tension is not exceeded. Alternatively, a "mechanical fuse" rated at 675 N may be included in the linkage. Torsion shall be avoided using a swivel at the cable end. While under tension, a minimum bend radius of 20 times the outside cable diameter will be maintained using pulleys and sheaves where required. After pulling, no bend may have a radius, at rest, of less than 10 times the outside cable diameter.

Each cable is to be permanently labeled at each end with a unique cable number. In addition, labels shall be affixed to the cable at every transition of a vault, hand hole, riser closet, or major pull box. Labels must be neat, legible, and waterproof.

Each fiber optic strand shall be labeled with a unique identifier at the ST coupler. All labels must be neat, legible and waterproof.

Fiber ends are to be terminated in ST-type connectors. No splices will be permitted. The cable shall be continuous run from lane controller to server room fiber switch location.

At each end of the cable, sufficient slack (25' minimum) shall be left to facilitate reasonable future relocation of the fiber switch or lane controller. Slack shall be mounted on walls or upper ladder racks.

Testing: Contractor shall test all long reels with an OTDR for length and transmission anomalies while on the reel prior to installation. It is suggested that each individual fiber in a cable regardless of length should be tested with an OTDR for length and transmission anomalies while on the reel before it is installed.

All fiber strands shall be tested end-to-end for bi-directional attenuation, 850 nm/1300 nm for multimode and 1310 nm/1550 nm for single mode. Tests should be conducted in compliance with EIA/TIA-526-14 or OFSTP 14, Method B, according to the manufacturer's instructions for the test set being utilized.

Tests must ensure that the measured link loss for each strand does not exceed the "worst case" allowable loss defined as the sum of the connector loss (based on the number of mated connector pairs at the EIA/TIA-568 B maximum allowable loss of 0.75 dB per mated pair) and the optical loss (based on the performance standard above, 2.1.1 and 2.2.1).

After termination, each fiber shall be tested with an ODTR for length, transmission anomalies, and end-to-end attenuation. Results are to be recorded and supplied to Authority in the form of hard-copy printouts or photographs of screen traces.

After termination, each terminated fiber is to be tested for end-to-end loss with a power meter/light source. As above, results are to be recorded and supplied to Authority.

The Contractor shall review all end faces of field terminated connectors with a fiber inspection scope following the final polish. Connector end faces with hackles, scratches, cracks, chips and/or surface pitting shall be rejected and repolished or replaced if repolishing will not remove the end face surface defects. The recommended minimum viewing magnifications for connector ends are 100X for multimode fiber and 200X for single mode fiber.

Basis of Payment

Measurement and payment for the installation of the Fiber Optic cable will be by linear foot to the nearest 10-foot interval. It shall include the furnishing, installation, termination and routing of the cable per the wiring schedule.

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
655.161 Multimode Fiber Optic Cable – 6 Fiber	Linear Foot
655.162 Single Mode Fiber Optic Cable – 6 Fiber	Linear Foot

SPECIAL PROVISION

SECTION 655

ELECTRICAL

(IVIS Homerun Loop Cable (IMSA 50-2 #14))

Description

This task shall include the providing and installation of the IVIS homerun loop cable (IMSA 50-2 #14) shown on the Plan drawings and described herein.

Cable: IMSA 50-2 #14 cable loop detector wire shall be as follows:

- Conductors: Solid or stranded tin copper
- Insulation: Polyethylene
- Conductor Configuration: Twisted pair
- Shield: Aluminum/Mylar tape
- Outer Jacket: Low-density polyethylene

Cable shall have two conductors, #14 AWG, 19 strand. Cable must be direct burial grade suitable for installation in the tunnel, beneath the roadway, within the barrier and any other locations shown on the Plan or described within the design documents. All loop sensor homerun cables shall have tape with length markings.

Basis of Payment

Measurement and payment for the installation of the IMSA 50-2 #14 cable will be by linear foot to the nearest 10-foot interval. It shall include the furnishing, installation and routing of the cable per the wiring schedule.

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
655.17 IVIS Homerun Loop Cable (IMSA 50-2 #14)	Linear Foot

SPECIAL PROVISION

SECTION 655

ELECTRICAL

(PVC Conduit)

Description

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

Joints shall be made in accordance with ASTM D 2855. Solvent cement shall meet the requirements of ASTM D 2564 with particular attention paid to matching the viscosity to the conduit size.

Joint adhesives shall be in accordance with ASTM D2517.

All conduit runs shall be watertight. Slope conduit to drain into junction boxes.

All empty conduits shall have a labeled pull string. Pull strings shall have length markings and should be used for long conduits over 50 feet or for all underground installations. Clean, plug and seal conduit ends after installation.

Basis of Payment

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

Payment will be made under:

<u>Pay Item</u>		<u>Pay Unit</u>
655.2001	3/4" Schedule 40 PVC Conduit	Linear Foot
655.2002	1" Schedule 40 PVC Conduit	Linear Foot
655.200	1½" Schedule 40 PVC Conduit	Linear Foot
655.2003	2" Schedule 40 PVC Conduit	Linear Foot
655.201	3" Schedule 40 PVC Conduit	Linear Foot
655.202	4" Schedule 40 PVC Conduit	Linear Foot
655.2021	1" Schedule 80 PVC Conduit	Linear Foot
655.203	1½" Schedule 80 PVC Conduit	Linear Foot
655.2031	2" Schedule 80 PVC Conduit	Linear Foot
655.204	3" Schedule 80 PVC Conduit	Linear Foot
655.205	4" Schedule 80 PVC Conduit	Linear Foot
655.2052	5" Schedule 80 PVC Conduit	Linear Foot
655.2051	6" Schedule 80 PVC Conduit	Linear Foot

SPECIAL PROVISION

SECTION 655

ELECTRICAL

(Galvanized Rigid Metal Conduit)

Description

This task shall include providing and the installation of Galvanized Rigid Metal Conduit (RMC) as shown on the Plan drawings and described herein. All fittings shall be threaded, or approved compression type (approved by the engineer and compatible with the conduit), and waterproof. Conduit shall be installed and grounded per NEC regulations. All supports shall be hot dipped galvanized or stainless steel (approved by the engineer and compatible with the conduit).

Basis of Payment

Measurement and payment for furnishing and installing the Galvanized RMC as shown on the plan drawings, where necessary, and described herein will be per foot. It shall include the furnishing, installing, supporting and connection of the conduit and misc. hardware necessary for the installation.

Payment will be made under:

<u>Pay Item</u>		<u>Pay Unit</u>
655.2061	3/4" Galvanized Rigid Metal Conduit	Linear Foot
655.206	1" Galvanized Rigid Metal Conduit	Linear Foot
655.207	1½" Galvanized Rigid Metal Conduit	Linear Foot
655.2071	2" Galvanized Rigid Metal Conduit	Linear Foot
655.208	3" Galvanized Rigid Metal Conduit	Linear Foot

SPECIAL PROVISION

SECTION 655

ELECTRICAL

(Liquid Tight Metallic Flexible Conduit)

Description

This task shall include providing and the installation of Liquid Tight Metallic Flexible Conduit as shown on the Plan drawings and described herein. All conduit shall be watertight with flexible PVC coating over galvanized steel flex tubing. Conduit shall be installed and grounded per NEC regulations. All supports for shall be hot dipped galvanized or stainless steel. Connections shall be specialized fittings to be compatible with adjoining conduit and watertight.

Basis of Payment

Measurement and payment for installing the Liquid Tight Metallic Flexible Conduit as shown on the Plan drawings and described herein will be per linear foot furnished, installed, and accepted at the Contract price per linear foot. This price shall include the cost of: furnishing and installing the conduit; pull string, fittings, groundings and bonding; test cleaning interiors of conduits and all materials, labor, equipment and incidentals necessary to complete the work.

Payment will be made under:

<u>Pay Item</u>		<u>Pay Unit</u>
655.209	½” Liquid Tight Metallic Flexible Conduit	Linear Foot
655.210	¾” Liquid Tight Metallic Flexible Conduit	Linear Foot
655.2101	1½” Liquid Tight Metallic Flexible Conduit	Linear Foot
655.2102	2” Liquid Tight Metallic Flexible Conduit	Linear Foot

SPECIAL PROVISION

SECTION 655

ELECTRICAL

(Electrical Metallic Tubing Conduit)

Description

This task shall include the installation of the Electrical Metallic Tubing Conduit (EMT) as shown on the Plan drawings and described herein. All fittings shall be an approved compression type (approved by the engineer and compatible with the conduit). Conduit shall be installed and grounded per NEC regulations. All supports for conduit shall be galvanized steel (with similar or better galvanizing than the tubing). Fittings are to be joined using couplings as recommended by the manufacturer.

Basis of Payment

Measurement and payment for installing the EMT as shown on the Plan drawings and described herein will be per foot furnished, installed, and accepted at the Contract price per linear foot. This price shall include the cost of: furnishing and installing the conduit; pull string, fittings, groundings and bonding; test cleaning interiors of conduits and all materials, labor, equipment and incidentals necessary to complete the work.

Payment will be made under:

<u>Pay Item</u>		<u>Pay Unit</u>
655.211	1½” Electrical Metallic Tubing Conduit	Linear Foot
655.212	2” Electrical Metallic Tubing Conduit	Linear Foot
655.213	3” Electrical Metallic Tubing Conduit	Linear Foot
655.214	4” Electrical Metallic Tubing Conduit	Linear Foot
655.215	¾” Electrical Metallic Tubing Conduit	Linear Foot

SPECIAL PROVISIONSECTION 655ELECTRICAL

(Installation of Pull Boxes)

Description

This task shall include providing and installing:

- The type A pull box for interior, dry locations as shown on the Plan drawings and detailed herein, or where used elsewhere.
 - Materials: 4" x 4" x 2" steel; equal to Appleton 4SD1 or better.
- The type C pull box as shown on the Plan drawings and detailed herein. The C pull box shall be installed in booth pits, or building utility pits, booth curtain walls or where PVC conduit is used.
 - Materials: 18" x 18" x 6", NEMA 3R; PVC.
- The type D pull box as shown on the Plan drawings and detailed herein, or where used elsewhere.
 - Materials: 6" x 6" x 4" NEMA 4X.
- The type E pull box as shown on the Plan drawings and detailed herein. The E pull box shall be installed in booths/buildings in dry locations to pull communications cables, or shown elsewhere on the Plans, or where needed to complete the work.
 - Materials: 6" x 6" x 6" steel, indoor rated; equal to Hoffman A-606CH or better.
- The type F pull box as shown on the Plan drawings and detailed herein. The F pull box shall be installed in booth pits, or building utility pits, or where this size is to be used in a wet location or in an exterior location.
 - Materials: 4" x 4" x 4" plastic, medium duty; equal to or better than Appleton JIC-2

If equipment is to be installed at a later date, insure adequate slack in the junction box for termination and additional 4-inch for possible re-termination. For pass through junction boxes no slack is required. For specific equipment, the following guidelines apply:

- Sensor Loops: A single slack loop of 12" – 24" for convenience of splicing.
- DVAS: Slack loop to allow for distance to mounting location of camera plus an additional 3 feet.
- LC: 4 feet of slack at LC mounting location.

Basis of Payment

Measurement and payment for installing the pull boxes as shown on the Plan drawings and described herein will be per each item. It shall include the furnishing, installation, mounting of the box, and the drilling of holes into the box for conduits.

Payment will be made under:

<u>Pay Item</u>		<u>Pay Unit</u>
655.221	Type A Pull Box Inside	Each
655.222	Type C Pull Box in Tunnel/Booth Pit	Each
655.223	Type D Pull Box Outdoor Canopy	Each
655.224	Type E Pull Box Steel in Booth	Each
655.225	Type F Pull Box Outside	Each

SPECIAL PROVISION

SECTION 655

ELECTRICAL

(Galvanized Steel Junction Box)

Description

This task shall include providing and installing galvanized steel watertight junction boxes measuring 12” x 12” x 6” or 18” x 18” x 6” to provide an access point from rigid metal conduit to tolling equipment mounted to the space frame as shown in the Plan drawings. Junction boxes must be approved by Resident.

Basis of Payment

Measurement and payment for installing the junction boxes as shown on the Plan drawings and described herein will be per each item. It shall include the furnishing, installation, mounting of the box, and the drilling of holes into the box for conduits.

Payment will be made under:

<u>Pay Item</u>		<u>Pay Unit</u>
655.30	12” x 12” x 6” Galvanized Steel Junction Box	Each
655.31	18” x 18” x 6” Galvanized Steel Junction Box	Each

SPECIAL PROVISION

SECTION 655

ELECTRICAL

(18" x 24" x 12" Junction Box)

Description

This task shall include providing and installing 18" x 24" x 12" watertight junction boxes to be cast-in-place into the barrier as shown in the Plan drawings. Junction box shall be nonmetallic (Quazite or equivalent) and able to be placed in concrete. Access must be provided through the top cover which shall be flush with the top of barrier after placement. Junction boxes must be approved by Resident.

Basis of Payment

Measurement and payment for installing the junction boxes as shown on the Plan drawings and described herein will be per each item. It shall include the furnishing, installation, mounting of the box, and the drilling of holes into the box for conduits.

Payment will be made under:

<u>Pay Item</u>		<u>Pay Unit</u>
655.40	18" x 24" x 12" Junction Box	Each

SPECIAL PROVISION

SECTION 655

ELECTRICAL

(36" x 30" x 20" NEMA 4X Cabinet)

Description

Provide and install NEMA 4X stainless steel equipment cabinets as designated on the Plan drawings to house the AVI Readers. Cabinets shall provide a 19" EIA rack mounting rails as appropriate and shall provide sufficient space for the enclosed equipment. Doors for the equipment cabinets shall be secured with standard interchangeable cylinder locks that match the existing (BEST) system presently in use by Authority. A closed cell neoprene gasket shall be utilized to prevent water entry at the door. A handle controlled latching system shall be included to simplify access to the cabinets. The door shall be able to be opened and closed without need for separate latching hardware. Two 120-Volt single-phase three-wire circuit shall be furnished and installed for clean power and dirty power to a quadplex receptacle (Type 5-15R – half clean/half dirty power - white for clean / brown for dirty) that shall be provided within each cabinet as shown on the Plans. The quadplex receptacles shall be white/brown with stainless steel cover.

AVI Reader cabinets shall be NEMA-4X with minimum dimensions of:

- o Height 36"
- o Width 30"
- o Depth 20"

AVI Reader cabinets shall be fabricated with internal pieces of aluminum angle that is positioned to support the reader and provide 19-inch wide rack mounting with minimum depth of 15 inches. The AVI Reader and associated contiguous RF rack height is 21.05 inches. Mounting shall be configured per RS-310 (EIA rack spacing).

Basis of Payment

Measurement and payment for installing the NEMA 4X Cabinets as shown on the Plan drawings and described herein will be per each item. It shall include the furnishing, installation, mounting of the box, and the drilling of holes into the box for conduits. Installation of receptacles and completion of all conduits and wiring associated with the cabinet shall be incidental.

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
655.42 36" x 30" x 20" NEMA 4X Cabinet	Each

SPECIAL PROVISION

SECTION 655

ELECTRICAL

(60 AMP 3 Phase Panelboard Cabinet)

Description

Provide and install 60-amp 3 phase panelboard cabinet as designated on the Plan drawings and schedule. Panelboard cabinet shall be of the dead-front, safety type with space for 30 single pole breakers. Breakers shall be provided as per the panel schedules in Appendix I. Cabinet shall be constructed of zinc coated sheet steel and shall conform to Underwriters Laboratories, Inc., Standard for Cabinet and Boxes.

Panelboard cabinet height shall not exceed 72-inch and shall be mounted so that the distance from the floor to center of the top circuit breaker will not exceed 6 feet. Cabinet shall be provided with trims having adjustable trim clamps. Trims, unless otherwise noted, shall be fitted with hinged doors. A panel schedule will be provided.

Basis of Payment

Measurement and payment for installing the panelboard cabinet as shown on the Plan drawings and described herein will be per each item. It shall include the furnishing, installation, mounting of the cabinet, and the drilling of holes into the box for conduits.

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
655.43 60 AMP 3 Phase Panelboard Cabinet	Each

SPECIAL PROVISION

SECTION 655

ELECTRICAL

(100 AMP 3 Phase Panelboard Cabinet)

Description

Provide and install 100-amp 3 phase panelboard cabinet as designated on the Plan drawings and schedule. Panelboard cabinet shall be of the dead-front, safety type with space for 30 single pole breakers. Breakers shall be provided as per the panel schedules in Appendix I. Cabinet shall be constructed of zinc coated sheet steel and shall conform to Underwriters Laboratories, Inc., Standard for Cabinet and Boxes.

Panelboard cabinet height shall not exceed 72-inches and shall be mounted so that the distance from the floor to center of the top circuit breaker will not exceed 6 feet. Cabinet shall be provided with trims having adjustable trim clamps. Trims, unless otherwise noted, shall be fitted with hinged doors. A panel schedule will be provided.

Basis of Payment

Measurement and payment for installing the panelboard cabinet as shown on the Plan drawings and described herein will be per each item. It shall include the furnishing, installation, mounting of the cabinet, and the drilling of holes into the box for conduits.

Payment will be made under:

<u>Pay Item</u>		<u>Pay Unit</u>
655.44	100 AMP 3 Phase Panelboard Cabinet	Each

SPECIAL PROVISION

SECTION 655

ELECTRICAL

(150 AMP 3 Phase Panelboard Cabinet)

Description

Provide and install 150-amp 3 phase panelboard cabinet as designated on the Plan drawings and schedule. Panelboard cabinet shall be of the dead-front, safety type with space for 30 single pole breakers. Breakers shall be provided as per the panel schedules in Appendix I. Cabinet shall be constructed of zinc coated sheet steel and shall conform to Underwriters Laboratories, Inc., Standard for Cabinet and Boxes.

Panelboard cabinet height shall not exceed 72-inches and shall be mounted so that the distance from the floor to center of the top circuit breaker will not exceed 6 feet. Cabinet shall be provided with trims having adjustable trim clamps. Trims, unless otherwise noted, shall be fitted with hinged doors. A panel schedule will be provided.

Basis of Payment

Measurement and payment for installing the panelboard cabinet as shown on the Plan drawings and described herein will be per each item. It shall include the furnishing, installation, mounting of the cabinet, and the drilling of holes into the box for conduits.

Payment will be made under:

<u>Pay Item</u>		<u>Pay Unit</u>
655.45	150 AMP 3 Phase Panelboard Cabinet	Each

SPECIAL PROVISION

SECTION 655

ELECTRICAL

(PVC Conduit Condulets)

Description

This task shall include the installation of PVC condulets where called for on the plans, or where called for on installation drawings. Fittings for PVC condulets are to be joined using couplings and approved solvent, as recommended by the manufacturer. Types of condulets include, but are not limited to “LB”, “T”, “LR”, “LL”. All openings shall have rubber gaskets.

Basis of Payment

Measurement and payment for installing the PVC condulets as described herein will be per item. It shall include the furnishing, installation and mounting of the conduit, and all associated hardware.

Pay Items are as follows:

<u>Pay Item</u>		<u>Pay Unit</u>
655.50	2” PVC Conduit Condulets	Each
655.51	4” PVC Conduit Condulets	Each

SPECIAL PROVISION

SECTION 655

ELECTRICAL

(Rigid Metal Conduit Condulets)

Description

This task shall include the installation of Rigid Metal Conduit Condulets where called for on the plans, or where called for on installation drawings. The condulets shall be hot dipped galvanized and waterproof, with threaded couplings or approved compression type couplings (if recommended by the manufacturer and compatible with adjoining conduit). Types of condulets include, but are not limited to “LB”, “T”, “LR”, “LL”. All openings shall have rubber gaskets.

Basis of Payment

Measurement and payment for installing the condulets as described herein will be per item. It shall include the furnishing and installation and of the condulet, and all associated hardware.

Pay Items are as follows:

<u>Pay Item</u>		<u>Pay Unit</u>
655.511	¾” Rigid Metal Conduit Condulets	Each
655.52	1” Rigid Metal Conduit Condulets	Each
655.53	1½” Rigid Metal Conduit Condulets	Each
655.54	2” Rigid Metal Conduit Condulets	Each

SPECIAL PROVISION

SECTION 655

ELECTRICAL

(Electrical Metal Tubing Condulets)

Description

This task shall include the installation of Electrical Metal Tubing (EMT) condulets where called for on the plans, or where called for on installation drawings. The condulets shall be hot galvanized steel and waterproof, with approved compression type couplings (if recommended by the manufacturer and compatible with adjoining conduit). Types of condulets include, but are not limited to “LB”, “T”, “LR”, “LL”. All openings shall have rubber gaskets.

Basis of Payment

Measurement and payment for installing the condulets as described herein will be per item. It shall include the furnishing, installation and mounting of the condulet, and all associated hardware.

Pay Items are as follows:

<u>Pay Item</u>		<u>Pay Unit</u>
655.55	3” Electrical Metal Tubing Condulets	Each
655.56	2” Electrical Metal Tubing Condulets	Each
655.57	1½” Electrical Metal Tubing Condulets	Each
655.58	¾” Electrical Metal Tubing Condulets	Each

SPECIAL PROVISION

SECTION 655

ELECTRICAL

(Plastic Wireway)

Description

This task shall include providing and the installation of plastic wireway in the tunnel as shown on the Plan drawings and/or described herein. Wireways shall be plastic NEMA 4R, and shall be installed and grounded per NEC regulations. All supports for wireways shall be hot dipped galvanized or stainless steel.

Basis of Payment

Measurement and payment for installing the Plastic Wireways as shown on the Plan drawings and described herein will be per foot, to the nearest 2-foot increment above the final installed segment. It shall include the furnishing, installing, supporting and connection of the wireway and all misc. hardware necessary for the installation. It shall also include all end caps, covers, drilling of holes for conduits, fabrications for 90-degree bends, etc. All coupling, fitting, caps, covers and 90-degree bends shall be factory supplied and not fabricated on site.

Payment will be made under:

<u>Pay Item</u>		<u>Pay Unit</u>
655.63	4-inch x 4-inch Plastic NEMA 4R Wireway	Linear Foot
655.64	6-inch x 6-inch Plastic NEMA 4R Wireway	Linear Foot
655.65	8-inch x 8-inch Plastic NEMA 4R Wireway	Linear Foot
655.66	12-inch x 12-inch Plastic NEMA 4R Wireway	Linear Foot

SPECIAL PROVISIONSECTION 655ELECTRICAL

(Concrete Encased Conduit)

Description

This work shall consist of encasing all conduit within the limits of the proposed conduit raceway section between the penetration from the tunnel to the structural slab infill opening. This work shall be completed in accordance with the Specifications, in reasonably close conformity with the lines and grades shown on the Plans or as approved by the Resident.

Materials

Concrete shall conform to Section 502, Structural Concrete, using ¾-inch (19 mm) maximum size coarse aggregate (Class AAA).

PVC spacers shall be the interlocking type of strength and spacing to hold raceways straight and true with spacing between raceway outside diameter of no less than 3 inches, horizontal. Conduit must be laid out and spaced as depicted in the Plan drawings.

Duct-sealing compound shall be non-hardening, safe for contact with human skin, not deleterious to cable insulation, and workable at temperatures as low as 35°F. It shall be capable of withstanding temperature of 300°F without slump and of adhering to clean surfaces of plastic ducts, metallic conduits, conduit coatings, concrete, masonry, lead, cable sheaths, cable jackets, insulation materials, and common metals.

Waterproof membrane used for sealing duct bank penetration into tunnel shall be Tremco – Paraseal Membrane or an approved equivalent. A waterstop will be used in conjunction with the membrane and shall be Tremco Parastop or an approved equivalent. Both membrane and waterstop will be installed as per manufactures guidelines.

Execution

All raceways shall be securely fastened in place during construction and progress of the work. Concrete wall penetrations shall be plugged to prevent seepage of grout, water, or soil into the tunnel.

Trenches for conduit may be excavated manually or with mechanical trenching equipment where practical. Walls of trenches shall be essentially vertical so that a minimum of shoulder surface is disturbed. The Contractor shall ascertain the type of soil or rock to be excavated before bidding. All excavation shall be incidental to concrete encased conduit construction.

Saw cutting for the tunnel and slab penetrations shall be considered incidental. Excavation limits of the concrete encased conduit will in accordance with the details shown on the Plans, unless otherwise approved by the Resident to provide access to the outer tunnel wall.

Basis of Payment

Measurement and payment for work associated with the concrete encased conduit as shown on the Plan drawings and described herein will be per cubic yard of concrete, based on the concrete encased conduit section dimensions detailed with no deduction for the space occupied by the conduit.

All work and materials necessary to install the concrete encased conduit will be incidental to the item, including excavation and saw cutting of concrete tunnel wall penetrations and the structural slab infill locations. All new conduit, wireway, wires and data cables installed will be paid under its appropriate pay item.

Payment will be made under:

<u>Pay Item</u>	<u>Unit</u>
655.75 Concrete Encased Conduit	Cubic Yard

SPECIAL PROVISIONSECTION 655ELECTRICAL

(Lightning Suppression System)

Description

This task shall include furnishing and installing the lightning protection system for the ORT and canopies. This work shall be completed in accordance with the Specifications, in reasonably close conformity with the lines and grades shown on the Plans or as approved by the Resident.

The task also includes obtaining a UL Master Label Certificate for the completed lightning protection as a UL Class I ordinary structure.

Submittals

1. Product Data: For air terminals and mounting accessories, grounding conductors, grounding electrodes, and ground connection equipment.
2. Shop Drawings: Detail lightning protection system, including air-terminal locations, conductor routing and connections, and bonding and grounding provisions. Include indications for use of raceway, data on how concealment requirements will be met, and calculations required by NFPA 780 for bonding of grounded and isolated metal bodies.
3. Qualifications: Qualification data for firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include data on listing or certification by an NRTL or LPI.
4. Inspection: Field inspection reports indicating compliance with UL Master Label Certification.

Quality Assurance

1. Installer Qualifications: Engage an experienced installer who is an NRTL or who is certified by LPI as a Master Installer/Designer. Installer shall be UL listed as a lightning protection installer.
2. Listing and Labeling: All system components utilized in the installation shall comply with the Standard for Lightning Protection Components, UL 96A.

Coordination

Coordinate installation of lightning protection with installation of other tolling systems and components, including electrical wiring, supporting structures and materials, metal bodies requiring bonding to lightning protection components, and finishes.

Coordinate installation of air terminals attached to space frame with space frame manufacturer.

Products

Subject to compliance with requirements, provide products by one of the following manufacturers or approved equal:

Automatic Lightning Protection.
ERICO International Corporation.
Harger Lightning Protection, Inc.
Heary Bros. Lightning Protection Co. Inc.
Independent Protection Co.
Robbins Lightning Inc.
Thompson Lightning Protection, Inc.

Air Terminals shall be NFPA Class I, solid copper, 3/8" diameter, by 24" tall or 10" tall, as indicated on the Contract Drawings. Main roof conductors as down conductors shall be bare copper in sizes as indicated on the Contract Drawings. Grounding electrodes shall be copper-clad steel, 3/4" diameter by 10'-0" long.

Execution

All work shall conform to the requirements contained in the latest edition of UL 96A, Installation Requirements for Lightning Protection Systems, and in the latest edition of NFPA 780 Standard for the Installation of Lightning Protection Systems.

Install conductors with direct paths from air terminals to ground connections. Conductors shall be supported for their entire length without travel through free air. No bend of a conductor shall form an included angle of less than 90 degrees or have a radius of bend less than 8 inches.

Conductors shall not be directly attached to aluminum or galvanized steel. Do not combine materials that can form an electrolytic couple that will accelerate corrosion in the presence of moisture unless moisture is permanently excluded from junction of such materials.

Main conductors shall be fastened at intervals not exceeding 3 feet.

Down conductors shall be installed within Schedule 80 PVC conduit for physical protection.

Cable Connections: Use UL listed connectors or approved exothermic-welded connections for all conductor splices and grounding connections.

UL Inspection: Provide inspections as required to obtain a UL Master Label Certification for the system.

LPI Certification: Provide an inspection by an inspector certified by LPI to obtain an LPI certification.

Method of Measurement

Lightning Suppression Systems will be measured by lump sum for complete system installation as shown in the plans.

Basis of Payment

The accepted quantity of Lightning Suppression System will be paid for at the Contract unit price of lump sum which shall include excavation, air terminals, grounding rods, quazite grounding wells, heavy duty ground test wells with covers, copper wire, and all associated hardware, conduit and junction boxes for a complete operational system.

Payment will be made under:

<u>Pay Item</u>	<u>Unit</u>
655.80 Lightning Suppression System	Lump Sum

SPECIAL PROVISION

SECTION 655

ELECTRICAL

(Key Switch)

Description

A key switch similar to key switches in use within the toll system shall be installed in line between clean power panel and power lead for each pair of VES cameras and each DVAS camera.

Basis of Payment

Work shall include furnishing all materials and hardware, and labor and equipment to install. All conduit and wires will be paid under separate pay items.

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
655.81 Key Switch	Each

SPECIAL PROVISION

SECTION 655

ELECTRICAL

(Receptacle Boxes)

Description

A convenience duplex outlet of NEMA type 5-15R may be required near new ORT lane controllers at a location to be determined by the Resident and the SI and in new toll booths. Covers shall be stainless steel.

NEMA type 5-15R receptacles are required for the Cash Lanes where shown on the Plan drawings and installation instructions. Additional receptacle locations may be determined by the Resident and SI. Covers shall be stainless steel.

A Quadplex receptacle is two NEMA type 5-15R may be required near new ORT lane controllers and near Cash Lane controllers at a location to be determined by the Resident and the SI and in new toll booths. Covers shall be stainless steel.

NEMA type 5-15R receptacles will be one of two colors, brown for dirty power and white for clean power.

Basis of Payment

Work shall include furnishing all materials and hardware, and labor and equipment to install. All conduit and wires will be paid under separate pay items.

Payment will be made under:

<u>Pay Item</u>		<u>Pay Unit</u>
655.82	Duplex Receptacle	Each
655.83	NEMA L5-30R Receptacle	Each
655.84	Quadplex Receptacle	Each

SPECIAL PROVISIONSECTION 655ELECTRICAL

(Space Frame Lighting)

Description

This task shall include furnishing, mounting and wiring the space frame lighting and FAA Style photoeye sensors, Ripley 6390-FAA or equivalent, in accordance with these Specifications, and as shown on the Plans or as approved by the Resident.

Materials

Lighting fixtures shall be Cree Edge TSP or similar containing a minimum of 120 LEDs with a drive current of 525 mA. Driver housing and light fixture casing shall be watertight. Lighting fixtures shall be compatible with a universal voltage supply, 120-277 VAC, 50/60 Hz input. The lighting units shall come with a 10-year warranty and have an expected life minimum of 100,000 hours. Lighting fixtures shall be approved by the Resident. Each space frame lighting circuit shall be equipped with a photocell sensor.

Design of the mounting connections to attach the lighting fixtures to the space frame and of the photocell to the structure shall be provided by the contractor once the details of the space frame are known and provided. The connections must be approved by a licensed engineer in the State of Maine prior to installation. Final locations and mountings to be approved by the Resident and the SI prior to installation of lighting and associated power conduits.

Execution

Lighting fixtures shall be installed as per; manufactures recommendations, NEC Standards, Plans, and Specifications.

The Contractor shall submit a proposed method of attaching all ancillary components to the space frame to the Resident for approval. The proposed attachment method shall not require drilling, welding or other attachment methods that will damage the space frame or its galvanized coating. Any areas of galvanized coating that are damaged by the Contractor during installation of ancillary components shall be repaired in accordance with ASTM A780.

Basis of Payment

The space frame lighting will be paid for at the Contract unit price which shall include all associated hardware and mounting equipment required for a complete operational system. Conduit and wiring shall be paid for under the respective items.

Payment will be made under:

Pay Item

Pay Unit

655.90 Space Frame Lighting

Lump Sum

SPECIAL PROVISION

SECTION 655

ELECTRICAL WORK

(LED Canopy Light Fixture)

Description

This work shall consist of furnishing and installing two (2) new LED lights (surface mounted) per lane in the toll plaza canopy in accordance with these Specifications, and as shown on the Plans or as approved by the Resident.

General

The Contractor shall submit a shop drawing for installing new LED fixtures for approval.

Materials

Provide products produced by:

- CREE Inc. – 304 Series - PKG-304-40-DM-06-E-UL-BZ-350-J-40K

Method of Measurement

LED canopy light fixtures will be measured by each unit, installed, and accepted.

Basis of Payment

LED canopy light fixtures will each be paid for at the Contract unit price. Payment shall be full compensation for furnishing and installation of the new light fixture, and all other materials, labor, tools, equipment and incidentals necessary to complete the work.

Payment will be made under:

<u>Pay Item</u>	<u>Unit</u>
655.92 LED Canopy Light Fixture	Each

SPECIAL PROVISION

SECTION 655

ELECTRICAL WORK

(LED Bumper Beacon)

Description

This work shall consist of furnishing and installing one (1) new LED yellow flashing signal head on the center of the front cash lane bumper (surfaced mounted) per lane in the toll plaza cash lanes in accordance with these Specifications, and as shown on the Plans or as approved by the Resident.

General

The Contractor shall submit a shop drawing for installing new LED fixtures for approval.

Materials

Provide the following products per cash lane Bumper Beacon:

- Single section traffic signal 12” housing – Federal Yellow (Black Face), polycarbonate – McCain or equal
- Standard 12” signal tunnel visor – Federal Yellow, polycarbonate – McCain or equal
- Dual Circuit Mushroom Flasher unit (1 NB and 1 SB)- Federal Yellow – McCain or equal
- Single 12” LED yellow signal 120V – GE GTx LED Signal Module or equal

Method of Measurement

LED Bumper Beacon will be measured by each unit, installed, and accepted.

Basis of Payment

LED Bumper Beacon will each be paid for at the Contract unit price. Payment shall be full compensation for furnishing and installation of the new Bumper Beacon, and all other materials, labor, tools, equipment and incidentals necessary to complete the work.

Payment will be made under:

<u>Pay Item</u>	<u>Unit</u>
655.99 LED Bumper Beacon	Each

SPECIAL PROVISIONSECTION 656STORMWATER FILTER SYSTEM

(Gravel Wetland Filter 1)

(Gravel Wetland Filter 2)

656.01 Description

This work shall consist of constructing a gravel wetland stormwater filter to treat stormwater runoff. All work shall be done in accordance with these Specifications and as shown on the Plans, to provide a complete and operating system and as approved by the Resident.

656.02 Materials

Impermeable liner: 30 Mil. Linear low-density polyethylene (LLDPE) meeting the following properties:

Property	Test Method	Requirement
Density, g/cm ³ , min.	ASTM D1505	0.92
Tensile Properties – Each Direction		
Tensile Strength at Break, lbs/in	ASTM D6693	114
Elongation at Break, %	(Type IV)	800
Tear Resistance, lbs	ASTM D1004	16
Puncture Resistance, lbs	ASTM D4833	42
Carbon Black, %, min.	ASTM D1603	2
Carbon Black Dispersion	ASTM D5596	Cat 1-2

Crushed Stone: ¾” diameter meeting MDOT specification 703.13.

Transitional Gravel: 3/8” filter aggregate (pea gravel) meeting the following gradation requirements:

Sieve Size	Percent Passing
3/8 inch	100
No. 4	90-100
No. 10	45-90
No. 40	5-35
No. 200	0-3.5

Wetland Soil: The wetland soil can be manufactured, using compost, sand, and fine soils, into a blend with more than 15% organic matter. It should contain more than 15% silt (passing the #200 sieve), but with a clay size portion less than 2%. The hydraulic conductivity shall be between 0.1-0.01 ft/day.

Clay or low permeability soil: Soil to be used as a clay barrier shall consist of glaciomarine silt-clay material with a hydraulic conductivity of less than 10⁻⁵ (0.0001) cm/sec. Soil barrier material shall be free of organic material, debris, ice, snow, and other deleterious material, with no stone larger than one inch. Unless approved otherwise by the Resident, materials used for the impermeable soil barrier shall contain greater than 90 percent silt and clay content (minus No. 200 U.S. Std. Sieve) by dry weight, a Liquid Limit greater than or equal to 28, and a Plasticity Index greater than or equal to 11.

Outlet Control Structure: Per MaineDOT Specification Section 604.

Underdrains: Per MaineDOT Specification Section 605.

Wetland Plants: Gravel wetlands are to be planted with native plant species tolerant to inundation with water, including but not limited to reeds (juncus effusus), cattails (typha latifolia), and bulrush (scirpus).

656.03 Method of Measurement

The gravel wetland filter will be measured for payment as lump sum, complete, and accepted for each gravel wetland.

656.04 Basis of Payment

The accepted quantity for Gravel Wetland Filter will be paid for at the Contract lump sum price per gravel wetland. Sediment forebays, perforated riser pipes, perforated underdrain, cleanouts, aggregates, impermeable liner, soils, wetland plants, outlet control structure, and outlet pipe are included in the lump sum cost for each Gravel Wetland Filter. Payment shall be full compensation for providing and installing all materials.

Excavation of the gravel wetland filter will be paid for under Item 203.20 Common Excavation.

Payment will be made under:

<u>Pay Item</u>		<u>Pay Unit</u>
656.41	Gravel Wetland Filter 1	Lump Sum
656.42	Gravel Wetland Filter 2	Lump Sum

SPECIAL PROVISION

SECTION 670

SEWAGE DISPOSAL SYSTEM

(Sewage Disposal System)

The following Section is added:

670.01 Description

This work shall consist of construction of a gravity feed subsurface wastewater disposal system to serve the Toll Administration Building. The work shall include furnishing and installing all materials required for proper construction of the proposed subsurface wastewater disposal system as designed. This includes piping, proprietary-type distribution system (chambers, piping, fittings, adapters, etc.), septic tank, and suitable fill materials. The work shall also include all testing and all other work necessary to complete the construction, all in accordance with these Specifications and as shown on the Plans and as detailed in the State of Maine Subsurface Wastewater Disposal Rules, dated August 3, 2015 (Rules).

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

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

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

The contractor will coordinate work with that of all other trades affecting, or affected by work of this Section. They will also cooperate with such trades to assure the steady progress of all Project work.

670.02 Submittals

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

Certificates of Compliance for all pipe and precast concrete structures.

670.03 Pipe and Fittings

Gravity sewer pipe (solid), joints and fittings shall comply with Section 6M of the Rules.

Concrete chambers, distribution piping, fittings, and adapters for the disposal field shall be as an approved equal as determined by the septic system design and as approved by the Rules.

670.06 Special Fill for Disposal Bed

Soil fill material beneath, above and adjacent to the concrete chamber system, including fill extensions, shall meet the requirements of the Rules.

670.7 Insulation

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

670.8 Bedding Material

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

670.09 General Construction

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

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

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

670.10 Excavation

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

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

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

670.11 Backfilling

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

670.14 Disposal Bed

The disposal bed shall be constructed as detailed on the Plans, as defined by the Rules. If unsuitable material is encountered and removed at and below the disposal bed surface, granular fill shall be placed and compacted to bring the grade up to the required bed elevation. The LPI shall inspect and approve the prepared disposal field before placement of fill covering the disposal field. Fill shall be placed below and adjacent to the chambers as detailed on the Plans.

670.15 Installation of Pipe

Pipe and fittings shall be installed in conformance with Section 6M of the Rules, as detailed on the drawings and per manufacturer recommendations. Pipe shall be laid on a firm compacted gravel borrow foundation at the line and grade designated. A recess shall be excavated to receive the bell or coupling at each joint if necessary. The piping shall be jointed as specified by the manufacturer to form a watertight joint.

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

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

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

Wherever water piping must cross sewer piping, a vertical separation of 12 inches shall be maintained. In no case shall a water pipe cross under a sewer pipe.

670.15 Testing

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

In case leakage exceeds the above specified amount, the Contractor shall locate the leaks and shall repair them at his own expense. Pipelines with shear-type breaks, fishmouths or damaged gaskets, cracked bells or couplings, hairline fractures, or structural damage of any type shall be replaced in kind. Mechanical sleeve couplings, poured concrete collars or similar repairs are not permitted. The use of pressure grouting repair techniques will not be allowed.

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

670.16 Method of Measurement

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

670.16 Basis of Payment

Payment will be made for the accepted Sewage Disposal System, including all excavation, bedding material, special fill, pipes, fittings, septic tank, backfill, and associated work at the Contract lump sum price, which price shall be full compensation for all labor, materials, equipment and incidental work necessary for the satisfactory completion of the work.

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

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
670.01 Sewage Disposal System	Lump Sum

SPECIAL PROVISION

SECTION 719

SIGNING MATERIAL

719.01 Reflective Sheeting

This Subsection is deleted in its entirety and replaced with the following:

Retroreflective sheeting for signs shall meet at a minimum the requirements for, ASTM 4956 – Type VII, Type VIII or Type XI (Prismatic), for all signs. All Type 1 Guide Signs shall meet at a minimum the requirements for ASTM 4956 –Type XI (Prismatic) sheeting.

Reflective sheeting, used in sign construction, shall have been manufactured within the six months immediately prior to the fabrication of each sign. Upon delivery at the job site of each shipment of signs, a letter of certification shall be provided that the reflective sheeting conforms to the requirements.

For Type 1 Guide Signs, all reflective sheeting shall be color matched on each sign unit.

All warning signs shall be fluorescent yellow except for Ramp Advisory Speed signs which shall be yellow.

All Construction Series signs that use orange backgrounds shall be fluorescent orange.

All Pedestrian Signs shall be fluorescent yellow-green.

EZ-PASS Purple shall conform to the FHWA Purple color block.

719.02 Demountable High Intensity Reflectorized Letters, Numerals, Symbols, and Borders

This Subsection, including the title, is deleted in its entirety and replaced with the following:

719.02 Direct Applied Reflectorized Letters, Numerals, Symbols, and Borders

Direct applied letters, numerals, symbols and borders shall consist of cut out sheeting shall meet at a minimum the requirements for ASTM 4956 – Type VII, Type VIII or Type XI (Prismatic) sheeting.

All Type 1 Guide Signs shall meet at a minimum the requirements for ASTM 4956 –Type XI (Prismatic) sheeting.

SPECIAL PROVISIONSSECTION 800TOLL ADMINISTRATION BUILDING800.1 Description

Division 800 specifies materials, procedures and requirements for the construction of the Toll Administration Building, complete with all appurtenances, including any and all associated utilities and services within the limits as shown on the Drawings.

The Contractor shall submit to the Resident for approval a cost breakdown of the major components of work for the Toll Administration Building. This breakdown will be used as a basis for monthly pay estimates.

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

The Contractor shall ensure and be responsible for the total and complete coordination of all work in the Administrative building. The Contractor shall generate coordination drawings for the Mechanical Room of the Administration Building. Coordination drawings shall:

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

800.2 Work Included

Toll Administration Building construction includes, but is not necessarily limited to, the following:

- Excavating, filling and backfilling for building utilities, services, foundations and the adjacent concrete retaining walls.
- Construction of reinforced concrete footings, foundation walls, slabs-on-grade and retaining walls.
- Construction of the Toll Administration Building proper, including all equipment and interior and exterior finishes.
- Furnishing and installing plumbing, heating, ventilating, air conditioning, electrical,

and telephone, complete with all appurtenances and accessories.

- Coordinating with the utility to provide a transformer and connections.
- Furnishing and installing secondary power conduit and wiring from the nearby utility transformer to the building including trenching and backfilling, conduit, wire, supports, brackets, junction boxes, etc. required to provide all work.
- Furnishing and installing flagpole lighting.
- Furnishing and installing power wires and conduit from panels DP and CP in the new Toll Administration Building to panels DP1, DP2, DP3, CP1, CP2, CP3, and TP in the tunnel, complete with all appurtenances and accessories.

Note: the conduits outside of these limits are paid for separately

800.3 Method of Measurement

The Toll Administration Building will be measured for payment by the lump sum, complete and accepted.

The horizontal pay limit shall be 5'-0" from the outside of the Toll Administration Building. The vertical pay limit for this work shall be above the bottom of footing level or bottom of footing subbase, if required.

All work within this pay limit, including utilities, excavation, backfilling, etc., will be included in this pay item. Work outside of the horizontal pay limit shall be performed under other portions of the Contract documents with the exception of:

- All work associated with the installation of the utility transformer and secondary service line into the building.
- All work associated with the installation of the flag pole lighting.
- Furnishing and installing power wires and conduit from panels DP and CP in the new Toll Administration Building to panels DP1, DP2, DP3, CP1, CP2, CP3, and TP in the tunnel, complete with all appurtenances and accessories.
- All work associated with construction of the concrete retaining walls that extend from the west and north faces of the building, including the metal railings.

The work described above which shall be included in the Toll Administration Building pay item.

800.4 Basis of Payment

Toll Administration Building construction will be paid for at the lump sum price bid which shall be full compensation for the cost of furnishing all materials, equipment, supplies, tools, incidentals, labor and supervision necessary to satisfactorily complete the work in all respects, to the satisfaction of the Resident.

Mobilization shall not be within the lump sum pay limit but will be paid for and meet the specifications of pay item 659.10.

Payment will be made under:

<u>Pay Item</u>		<u>Pay Unit</u>
800.01	Toll Administration Building	Lump Sum

SPECIAL PROVISIONSECTION 800TOLL ADMINISTRATION BUILDING

(Electrical Demolition)

800.11 Description

This work shall consist of furnishing and installing materials and components to remove conduit, wires, wireways, cables, outlets, panels, lighting, overhead lighting and all other related electrical equipment show in the plans. Work shall be completed in a phased manner.

The Contractor shall adhere to lockout/tagout procedures noted in the Supplemental Specifications.

All electrical systems shall remain operational unless noted in the plans.

Work shall include contractor submitting a demolition plan noting the sequence of electrical demolition to the Resident for approval prior to beginning demolition work. Electrical demolition work will occur during all phases. The Contractor shall coordinate installation of proposed work and electrical demolition.

Abandoned wireways, junction boxes, conduit identified to remain shall be tagged or capped as appropriate.

The work in this item generally includes, but is not limited to demolition and removal of, or portions thereof, the following:

- a. Toll Booths and Toll Islands: Associated electrical, communication systems, and structural components as noted on the plans, *including but not limited to*: booth power, bumper mounted flashing beacons, switches, wiring, conduits, junction boxes, electrical outlets, pulleys, cables, controllers, communication lines, talk boxes, hangers, posts, and braces.
- b. Bridge Mounted Items: Associated electrical, communication systems, and related structural components, *including but not limited to* lane lighting, mounted red/green lights, mounted sign lighting, heat tapes, portions of the lightning suppression system, overhead sensors and AVI antennas.
- c. Salvaged Items: Certain items shall be salvaged and delivered to various locations as noted in the Plans.

800.12 Basis of Payment

Payment to be made as lump sum for all electrical demolition required including the delivery of specified items noted in the Plans. All labor and materials required will be incidental to this item.

Payment will be made under:

<u>Pay Item</u>		<u>Pay Unit</u>
800.10	Electrical Demolition	Lump Sum

SPECIAL PROVISION

SECTION 800

MISCELLANEOUS INCIDENTALS

(Mechanical Demolition)

800.21 Description

This work shall consist of removing mechanical systems as well as all other related mechanical equipment shown in the Plans. Work shall be completed in a phased manner.

Contractor shall adhere to lockout/tagout procedures noted in the General Provisions.

This item generally includes, but is not limited to demolition and removal of, or portions thereof, the following:

- a. Toll Booths and Toll Islands: Associated mechanical and control systems and structural components, *including but not limited to* booth heaters, hot water supply and return piping, valves, rollers, framing, bracing, actuators, thermostats, controllers, talk boxes, and hangers.

Work shall include Contractor submitting a demolition plan noting the sequence of mechanical demolition to the Resident for approval prior to beginning demolition work. Mechanical demolition work will occur during all Phases. Contractor shall coordinate installation of proposed work and mechanical demolition.

800.22 Basis of Payment

Payment to be made as lump sum for all mechanical demolition required. All labor and materials required will be incidental to this item.

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
800.20 Mechanical Demolition	Lump Sum

SPECIAL PROVISIONSECTION 800MISCELLANEOUS INCIDENTALS

(HVAC and Electrical Tunnel and Booths)

800.23 Description

This work shall consist of furnishing and installing materials and components for all electrical, mechanical, control and HVAC systems as well as all other related electrical and mechanical equipment described in the Plans and Specifications.

The contractor shall perform site visit(s) as needed prior to bid preparation to familiarize with and/or field verify the existing conditions to the extent that all incidental work required to complete the project scope is included in the base bid. The contractor shall also review the plans of the existing Toll Plaza Facility.

The work in this item generally includes, but is not limited to installation of, or portions thereof, the following:

a. Toll Booths:

- Associated HVAC system and components, including but not limited to heaters, piping, framing, bracing, and thermostat.
- Associated electrical system and components, including but not limited to conduit, wire, supports, brackets, junction boxes, lighting, receptacles, safety switches, plug strips, Cable TV RG-6 cable, and 3CAT 5e Cables for radio, phone, and panic button.

b. Tunnel:

- Mechanical and HVAC system components associated with toll booths, booth islands and canopy including but not limited to all mechanical supports, HVAC mechanical components, duct work, actuators, valves, dampers, heating coils, vents, control system components, and thermostats.
- Associated electrical system and components, including but not limited to conduit, wire, supports, brackets, junction boxes, lighting, occupancy sensors, receptacles, safety switches, smoke detectors, alarm indicating devices, and fire alarm pull stations.

Electrical, Mechanical, HVAC, and plumbing work is included in this item and is shown on the Plan drawings. Any subsidiary structural and/or architectural work required to complete the electrical, mechanical, HVAC, or plumbing work as shown or noted on the respective drawings shall be incidental to this pay item.

800.24 Basis of Payment

Payment to be made as lump sum for all electrical and HVAC work for the tunnel and booths required as noted in the Plans. All labor and materials required will be incidental to this item.

Payment will be made under:

<u>Pay Item</u>		<u>Pay Unit</u>
800.22	HVAC and Electrical Tunnel and Booths	Lump Sum

SPECIAL PROVISIONSECTION 800MISCELLANEOUS INCIDENTALS

(Toll Plaza and Bridge Demolition)

800.31 Description

This work shall consist of furnishing and installing materials and components to demolish the toll plaza and bridge as shown on the plans or described herein. Work shall not commence until all Cash Lanes have been commissioned and the MTA can occupy the new administrative building. Work shall be completed in a phased manner during Phases 4 and 5. The work in this item generally includes, but is not limited to the following:

1. The Contractor shall remove signs, flashing beacons and all related toll equipment mounted to concrete toll plaza islands, bridge columns and booths and shall deliver all salvaged items as directed by the Resident and Toll Systems Manager to the Maine Turnpike Sign Shop at Mile Marker 58.3.
2. The contractor shall remove and reset the bridge mounted signs during construction phases as needed to match the cash and EZ Pass layout in the phasing plans. Any needed signs shall be provided by the Turnpike and picked up the at the Turnpike sign shop.
3. All equipment shall be removed and given to TransCore for reuse.
4. Removal of the toll booths including the tunnel to the limits indicated on the Plans.
5. Removal of the bridge and substructure to the limits indicated on the Plans.
6. Any necessary shielding or temporary support during the demolition phasing to ensure structure stability and public and toll worker safety.
7. When the material from an existing structure is specified on the plans to be retained by the Authority the Contractor shall carefully dismantle it, and all materials, except those that may be specified to be reused in the new structure, shall be loaded on trucks, transported and neatly stacked by the Contractor at the location specified on the plans.

Items not included in this item are:

1. Removal of bridge mounted signs will be paid under Item 645.107.
2. Removal of concrete toll islands, bumpers, toll enclosures, structural slabs, and tunnel will be paid under Item 202.17 Removing Existing Structural Concrete.
3. Removal of mechanical and electrical components will be paid under Items 800.10 Electrical Demolition and 800.20 Mechanical Demolition.

The Contractor shall ensure that traffic will be protected from debris and construction operations. Care shall be taken not to damage existing toll booths, electrical and mechanical systems.

800.32 Construction Requirements

Construction requirements shall be in accordance with National Electric Code (latest version), International Building Code (latest Version), ASTM standards (latest version), or best industry standards and practices when not addressed in any of the above references.

Prior to starting any demolition work on the bridge, the Contractor shall submit a demolition plan to the Resident for approval. The demolition plan shall be stamped by a Professional Engineer licensed in the State of Maine. The demolition plan shall consider the effect of construction equipment, methods of operation, and sequence of work on the capacity and stability of the bridge. The capacity of the structure shall be calculated to demonstrate the proposed work activities will not result in unacceptable overstress in the structure.

No demolition will be permitted until the approved method of shielding is completely installed. Traffic will not be permitted to use the travelway directly under the demolition work; a lane closure will be required.

All materials removed as part of this work shall become the property of the Contractor unless otherwise noted. The Contractor shall provide the Resident with an affidavit stating the final location of all disposed material and that the material was disposed of in accordance with the Maine Department of Environmental Protection Solid Waste Regulations.

800.33 Materials

All material proposed by the Contractor to be used in the demolition of the toll plaza shall be submitted to the Resident for approval prior to the start of the demolition work.

800.34 Method of Measurement

The phased toll plaza facility demolition and restoration will be measured for payment as one lump sum unit, complete, and accepted.

800.35 Basis of Payment

The accepted quantity of Toll Plaza and Bridge Demolition will be paid for at the Contract lump sum price. All labor and materials required will be incidental to this item.

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
800.30 Toll Plaza and Bridge Demolition	Lump Sum

SPECIAL PROVISIONSSECTION 800BUILDING AND STRUCTURES

(New Toll Booth Installation)

800.1 Description

Division 800 specifies materials, procedures, and requirements for the construction of the Toll Facilities, comprised of: installation of four toll booths and all associated utilities and services within the limits shown on the Drawings. The work shall be phased as noted on the Plans and outlined in the Specification.

Toll Booth installation includes, but is not limited to the following:

1. Pick up, transport and installation of six (6) toll booths complete with aluminum subframes, floors, doors, windows, counters, etc. Caulking and sealing of booths to concrete is part of the installation. Weather-stripping to be furnished by others.
2. Cutting, patching, and sealing as required to complete the work per Plans and Specifications.
3. The toll booth shall be supported by galvanized steel support angles 5" x 3-1/2" x 3/8" (8 ea. @ 12' and 8 ea. @ 4'-8"). The angles shall be installed using 1/2" x 5-1/2" stainless steel wedge anchors (56 each).
4. The top face of the galvanized steel angles that the aluminum booth framing will be bearing on need to be covered with ice/water shield or asphaltic paint to create a barrier between the dissimilar metals.
5. The dimensions of the interior faces of the booth barrier walls are a total of 1" greater than the dimensions of the prefabricated toll booths leaving approximately a 1/2" gap along the sides of the barrier. Install backer rod and Sika-Flex 1A between the booth and top of barrier. Install 1-1/2" x 1-1/2" x 1/4" aluminum angle over the caulked gap; apply a bead of silicone caulking prior to installing the aluminum angle. The provided lengths of aluminum angle are longer than the cut lengths to allow for mitered corners. The 1-1/2" aluminum angle shall be attached using self-drilling hex head stainless steel screws.
6. Provide and Install 6" wide Eterna Bond EPDM tape to the heat pump roof cassette penetration and the aluminum roof skin - see attached detail An approved equal will be considered for the EDPM tape.
7. The steel support angle under the toll booth electrical chase will need to be notched for conduit.

All material associated with Toll Booths installation is included in this item and is shown on the Plan drawings and described in this Special Provision. Electrical and communication items associated with the toll system will be paid for under the specific item. Furnishing and installing plumbing, heating, ventilating, and electrical items in the toll booths will be paid for under Item 800.22 HVAC and Electrical Tunnel and Booths.

Installation includes setting provided aluminum thresholds in non-shrink grout and sealing perimeter of threshold to concrete island with Sika-Flex 1A or approved equal.

800.2 Method of Measurement

The Toll Booth installation will be measured for payment by the lump sum, complete, in-place for the Toll Booth installations.

The MTA will supply the toll booths for installation. The contractor shall transport toll booths from Authority’s Sign Shop Facility Mile 58.3 northbound. The installation will include all electrical, mechanical and toll systems required as described in the Plans and within this specification, and all labor, material and equipment needed to provide a fully functioning toll booth will be incidental to this item.

800.3 Basis of Payment

Toll Booths will be paid for at the lump sum price bid which shall be full compensation for the cost of furnishing all materials, equipment, supplies, tools, incidentals, and labor and supervision necessary to satisfactorily complete all work prescribed in Division 800 of these Special Provisions.

Payment will be made under:

<u>Pay Item</u>		<u>Pay Unit</u>
800.40	New Toll Booth Installation	Lump Sum

SPECIAL PROVISIONS

SECTION 800

BUILDING AND STRUCTURES

(Stairway Enclosures)

800.01 Description

The work shall consist of furnishing and installing materials and components as needed to provide the completed tunnel stair entrances at Island B & E, as shown on the plans or described herein. The following work in this item generally includes, but is not limited to the following:

The Contractor shall furnish and install all structural metal framing and architectural finishes as detailed on the Plans. This shall include, but is not limited to aluminum store front panels, windows, doors, roofing system and appurtenances.

800.02 Method of Measurement

The stair enclosures will be measured for payment as one lump sum unit, complete, and accepted.

800.03 Basis of Payment

Payment will be made for work completed and accepted for tunnel stair enclosures at the Contract Lump Sum price. All labor and materials required will be incidental to this item.

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
800.41 Stair Enclosures & Installation	Lump Sum

SPECIAL PROVISIONS

SECTION 800

BUILDING AND STRUCTURES

(Generator Pad)

800.1 Description

The work shall consist of installing a concrete pad for the backup generator as detailed in the project plans and these specifications.

800.2 Materials

Concrete shall be Class “A” concrete (4000 PSI) and shall meet the requirements of Section 502.

Reinforcing steel shall meet the requirements of Section 503.

800.3 Method of Measurement

The Generator Pad will be measured for payment by the lump sum, complete, in-place for the Generator Pad installation.

800.4 Basis of Payment

Generator Pad will be paid for at the lump sum price bid which shall be full compensation for the cost of furnishing all materials, equipment, ground rods, grounding conductors, terminations, supplies, tools, incidentals, and labor and supervision necessary to satisfactorily complete all work.

Payment will be made under:

<u>Pay Item</u>		<u>Pay Unit</u>
800.90	Generator Pad	Lump Sum

SPECIAL PROVISIONS

SECTION 800

BUILDING AND STRUCTURES

(Transformer Pad)

800.1 Description

The work shall consist of installing a precast concrete pad for the 3-phase Transformer as detailed in the project plans and these specifications and meeting the requirements of Central Maine Power.

800.2 Materials

Concrete shall be Class "A" concrete (4000 PSI) and shall meet the requirements of Section 502.

Reinforcing steel shall meet the requirements of Section 503.

800.3 Method of Measurement

The Transformer Pad will be measured for payment by the lump sum, complete, in-place for the Transformer Pad installation.

800.4 Basis of Payment

Transformer Pad will be paid for at the lump sum price bid which shall be full compensation for the cost of furnishing all materials, equipment, ground rods, grounding conductors, terminations, supplies, tools, incidentals, and labor and supervision necessary to satisfactorily complete all work.

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
800.91 Transformer Pad	Lump Sum

SPECIAL PROVISION

SECTION 803

UTILITY TEST PITS

(Test Pits)

Description:

This work shall consist of excavating and back filling test holes to locate existing utilities at locations shown on the plans or as directed by the Resident.

Construction Requirements:

The work shall be done in a manner that provides safe passage of the traveling public at all times. Coordination with the utilities is required prior and during the test pit activities. An authorized representative from the utility shall be present during the test pit activity. Test pits shall be completed in a manner that does not damage any utilities. Any damage to utilities or other roadway features by the test pit operations shall be repaired by the Contractor at no additional cost and shall be to the Resident’s satisfaction.

The Contractor shall coordinate with the Department’s surveyor on locating the utilities once exposed.

Once the location work is complete, the Contractor shall backfill the hole, place gravel and pavement over the test pits in a manner consistent with the existing conditions and in accordance with the standard specifications for backfilling.

Method of Measurement:

Test Pits will be measured for payment by each.

Basis of Payment:

The accepted quantity of Test Pits will be paid for at the contract unit price per each, which shall be full compensation for all labor, materials, tools, equipment, and incidentals necessary to the complete the work. Associated traffic control will not be paid for separately and is considered incidental to the test pit item.

Payment will be made under:

<u>Pay Item</u>		<u>Pay Unit</u>
803.01	Test Pits	Each

SPECIAL PROVISION

SECTION 832

BOLLARD

(Type A Steel)

832.01 Description

This work shall consist of furnishing and installation of Type A Steel Site Bollards with cast in place concrete base and LDPE bollard sleeves in accordance with these Specifications, and as shown on the Plans or as approved by the Resident.

832.02 Materials

Bollards shall 6” Diameter Schedule 40 steel tube as shown on the plans, Concrete shall be Class “A” cement concrete (4000 PSI). Reinforcing steel shall meet the requirements of Section 503. Bollard Sleeve shall be ¼” thick Low Density Polythene

832.03 General

LDPE sleeve shall be a minimum ¼” thick, pre manufactured bollard sleeve, color Osha Safety Yellow.

832.04 Method of Measurement

Bollards will be measured by each unit complete and in place.

832.05 Basis of Payment

The accepted quantity of bollards will be paid for at the Contract unit price each which payment shall be full compensation for furnishing and installing bollards, bollard sleeves, concrete base and bollard infill, excavation, backfill, compaction, tools, equipment, labor and all incidentals necessary to complete the work.

Payment will be made under:

<u>Pay Item</u>	<u>Pay Unit</u>
832.41 Type A Steel Site Bollard	Each

MAINE TURNPIKE AUTHORITY

SPECIFICATIONS

PART III – DIVISION 800

CONTRACT 2019.04

INTERCHANGE 103 BARRIER TOLL PLAZA
OPEN ROAD TOLLING CONVERSION
MILE 103.0

DIVISION 800

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SECTION 031000
CONCRETE FORMWORK

PART 1 - GENERAL

1.01 SUMMARY

- A. Furnish, construct, and remove formwork to produce cast-in-place concrete structures as indicated and specified.
- B. Use formwork to cast all concrete structures including foundation mats, base slabs, and footings, but excluding fence and sign post footings.
- C. Furnish, construct, and remove formwork for all structures as indicated and specified in other Sections.
- D. Any form system such as Spanall Shoring system that may cause notches in the formed concrete requiring mortar or grout fill after the form removal shall not be used.

1.02 RELATED WORK

- A. Section 032000: Concrete Reinforcing.
- B. MTA Specification Section 520: Structural Concrete.

1.03 REFERENCES

- A. American Concrete Institute (ACI):
 - 1. ACI Guide to Formwork for Concrete, ACI 347R.
 - 2. ACI-117 standard tolerances for concrete construction and materials.
- B. U.S. Product Standard PS 1 for Construction and Industrial Plywood.
- C. 310 CMR 7.25U Best Available Controls for Consumer and Commercial Products.

1.04 DEFINITIONS: N/A

1.05 SYSTEM DESCRIPTION: N/A

1.06 SUBMITTALS

- A. Submit formwork design, stamped and sealed by a Structural Engineer Registered in the State of Maine.

1.07 QUALITY ASSURANCE

- A. Produce working drawing showing details of form type, methods of form construction and erection, location of form joints, form ties, and shoring. Keep a copy of drawings in field office during form erection.
- B. Notify the Owner's Representative a minimum of four (4) hours before the closure of forms, which would make subsequent inspection unfeasible.
- C. Construct formwork in accordance with ACI-347 and as specified.
- D. Comply with the requirements in ACI-117 for tolerances of formed surfaces except as specified in Table 1 at the end of this section.
- E. Check vertical and horizontal alignment of formwork by means of transit or theodolite before placing concrete. Permit the Owner's Representative to examine formwork with the set up instrument, if requested. Adjust formwork to maintain the concrete tolerances specified after placing concrete.
- F. Do not remove formwork before the minimum time limitations, as specified in Paragraph 3.03, are met.
- G. Do not leave wood, metal or plastic formwork in place. Remove all formwork from concrete.
- H. Formwork shall be designed by in conformance with the requirements of this section.

1.08 DELIVERY, STORAGE, AND HANDLING: N/A

1.09 PROJECT/SITE CONDITIONS: N/A

1.10 SEQUENCING AND SCHEDULING: N/A

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Formwork Design Requirements:
 - 1. Provide and design formwork to support vertical loads and lateral pressure resulting from placement and vibration of concrete in accordance with ACI-347.
 - 2. Provide and design formwork to locate bracing, which will maintain form stability, to comply with the tolerances specified.
 - 3. Provide and design formwork to anticipate deflection and creep due to weight and pressure of fresh concrete and construction loads.
 - 4. Provide temporary openings in wall and column forms, to facilitate cleaning and inspection.

5. Provide and design forms with openings allowing placement of concrete without segregation. Provide drop chutes or drop pipes to prevent accumulation of hardened concrete on forms and reinforcement above fresh concrete and to prevent concrete segregation.
6. Provide and design forms to conform with expansion and construction joint locations indicated, and to match architectural lines.

B. Wood Forms:

1. Provide forms for concrete surfaces, which will not be exposed to view in finished work, of lumber, which will not deflect beyond finish tolerances specified.
2. Provide forms for concrete surfaces which are exposed to view or painted in the finish work with material that is not reactive with concrete and which will produce surfaces equivalent in smoothness and appearance to that produced by new plywood panels conforming to U.S. Product Standard PS 1, Exterior Type Grade B-B. Provide forms, which will not deflect beyond, finish tolerances specified. Provide 4 x 8 foot panels or larger to reduce form seam lines, except where restricted by location of openings, architectural lines, joints, or shape of the structure.
3. Provide bracing secured to forms, which will prevent deflection and maintain the tolerances specified.

C. Steel Forms:

1. Provide forms for concrete, which produce surfaces equivalent in smoothness and appearance to that produced by new plywood panels as specified for wood forms.
2. Provide forms with strength to restrain forms from deflecting beyond finish tolerances specified.
3. Provide forms having sheet steel lining with steel back up framing. Do not use sheet steel lining with wood back up framing.

D. Tubular fiber Forms:

1. Provide forms with spirally constructed laminated plies of fiber.
2. Provide forms with wall thickness as recommended by the manufacturer to meet load requirements of the various uses and sizes.
3. Provide forms with wax coated outside surfaces for moisture resistance.
4. Provide forms with inside surface coated with bond-breaker compound.

E. Form Ties:

1. Provide factory fabricated tie system that will prevent form deflection beyond finished tolerances specified and will not spall concrete upon the ties removal.
2. Provide ties fitted with devices that will form cone shape holes in concrete surface not less than 3/8 inch interior diameter or more than 1-1/4 inch in exterior surface diameter and at least 1-1/2 inches deep such that the portion of the tie remaining in the concrete will be at least 1-1/2 inches back from concrete surfaces.
3. Provide ties, which pass through walls, subjected to hydrostatic pressure, including exterior foundation walls with continuously attached waterstop devices to break surface continuity around ties.

F. Form Releasing Agents:

1. Provide form releasing agents of commercial formulation that will not bond with or stain and reduce the concrete ability to meet the specified requirements.
2. Form releasing agents shall not impair subsequent treatment of concrete surfaces depending upon bond or adhesion.
3. Form releasing agents shall not impede the wetting of surfaces to be cured with water or curing compounds.
4. Volatile organic compound emissions of form releasing agents shall not exceed 2.09 pounds per gallon (250 grams per liter).

G. Chamfer Strips:

1. Provide three quarter inch triangular fillets, milled clear straight-grain pine, surfaced each side, or extruded vinyl type, with or without nail flange to form all exposed concrete edges such as columns, pilasters, beams, curbs, equipment pads, and as indicated.

PART 3 - EXECUTION

3.01 BOND BREAKER COATING

- A. Coat forms with bond breaker prior to placement of reinforcing steel or before the forms are placed in its final position. Do not allow bond breaker to come in contact with reinforcement.
- B. Do not allow excess bond breaker material to stand in puddles in the forms nor to come in contact with concrete against which fresh concrete is to be placed.
- C. Bond breaker material to be compatible with subsequent curing compound and/or surface treatment.

3.02 FORM CONSTRUCTION

- A. Erect forms in accordance with the Contractor produced working drawings, to support the vertical loads and lateral pressure in accordance with ACI-347, and anticipated concrete placement height.
- B. Erect forms butted tightly together to prevent leakage of grout and cement paste.
- C. Fit bottom of forms to the preceding lift to form a smooth complete surface, free from irregularities and offsets and to prevent leakage of grout and cement paste.
- D. Arrange joints between formwork panels vertically and horizontally to match architectural lines and construction joints.
- E. Set forms true to the indicated line and grade, to obtain specified concrete finish tolerances. Correct deviations in line before and after concrete placement, even to the extent of demolishing, removing demolished material from the island and rebuilding concrete structures, at no additional cost to the Authority.
- F. Control grade of finished surfaces and horizontal construction joints by setting chamfer strips or grading strips true to grade.
- G. Inspect forms and embedded items before placing concrete. Forms and excavation shall be free from water, dirt, debris, and foreign matter when concrete is placed.
- H. Clean all form surfaces in contact with concrete. Repair all surfaces to obtain specified concrete finish. Withdraw all projecting nails and fill holes before reusing form material.
- I. Protect materials in construction joints.
- K. Maintain steel form temperature between 50 and 95 degree F before, during and after concrete placement until the forms are removed.

3.03 REMOVAL OF FORMS

- A. Do not remove forms until concrete has aged as follows:
 - 1. Elevated beams and elevated slabs: 7 days minimum.
 - 2. Grade beams, walls and vertical surfaces: 3 days minimum.
 - 3. Bulkhead forms may be removed 48 hours after concrete placement, provided adjacent concrete is placed within 24 hours after bulkhead removal.
- B. Before form removal in accordance with Paragraph 3.03.A, elevated beams and elevated slabs shall have attained at least 70 percent of specified 28 day strength as determined by the Contractor's Independent Testing Laboratory in accordance with Section 03300 and also sufficient strength to support safely its own weight and construction live loads and lateral pressures unless otherwise indicated. The strength of concrete required for form removal shall be determined in accordance with ACI 301-96, paragraph 2.3.4.

- C. Remove all tubular fiber forms in accordance with requirements for vertical surfaces given in Paragraph 3.03.A.2.
- D. Reshore elevated elements when indicated, and when concrete weight plus construction load exceeds the design live load of the supporting framework.

3.04 TOLERANCES

- A. Comply with the requirements in ACI 117 for tolerances for formed surfaces except as specified in Table 1.

TABLE 1
TOLERANCES FOR FORMED SURFACES

1.	Vertical alignment (plumb):		
a.	In the lines and surfaces of foundation mats, base slabs, and walls	In any 10 feet of length Maximum for entire length	1/4 inch 1 inch
2.	Variation from the level or from the grades indicated on the drawings	In any 10 feet of length	1/4 inch
3.	Variation of the linear building lines from established position in plan	In any 20 feet Maximum	1 inch 1 inch
4.	Variation of distance between walls	1/4 inch per 10 feet of distance and not more than 1 inch total variation from a straight line, for entire wall length and height	
5.	Variation in the sizes and locations of sleeves, floor openings, and wall openings	Minus Plus	1/4 inch 1/2 inch
6.	Variation in cross-sectional dimensions of columns and beams and in the thickness of slabs and walls	Minus Plus	1/4 inch 1/2 inch
7.	Tolerances are not cumulative		

END OF SECTION 031000

SECTION 032000
CONCRETE REINFORCING

PART 1 -GENERAL

1.01 SUMMARY

- A. Furnish and place all reinforcement and accessories.
- B. Furnish and place all reinforcement as specified and indicated in other Sections.
- C. Furnish all CMU wall reinforcement for the masonry as indicated and as specified in Section 042000. Embed dowels into concrete at the top, middle and bottom of the CMU walls as specified or indicated.

1.02 RELATED WORK

- A. Section 031000: Concrete Forming and Accessories
- B. MTA Specification Section 520: Structural Concrete
- C. Section 042000: Unit Masonry, General

1.03 REFERENCES

- A. America Society for Testing and Materials (ASTM) Publications:
 - 1. A185: Specification for Steel Welded Wire Fabric, Plain, for Concrete Reinforcement.
 - 2. A615: Specification for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement.
- B. ACI SP-66, ACI Detailing Manual.
- C. ACI 318, Building Code Requirements for Reinforced Concrete, and Commentary.
- D. AWS D1.4, American Welding Society, Structural Welding Code, Reinforcing Steel.

1.04 DEFINITIONS: N/A

1.05 SYSTEM DESCRIPTION: N/A

1.06 SUBMITTALS

A. Submit the following:

1. Mill test reports for each shipment of reinforcement. Identify reports with specific lots in shipment and submit prior to use of reinforcement in work.
2. Chemical composition of reinforcement steel. Ladle analysis to state percentage of carbon, phosphorous, manganese and sulfur present in steel.
3. Welder's certification to the Owner's Representative, prior to use of reinforcement in work, in accordance with AWS D1.4 prior to welding, when welding is indicated or specified.
4. Shop and placement drawings to be reviewed by the Owner's Representative prior to fabrication, which show:
 - a. All construction and expansion joints.
 - b. Reinforcement detailed in conformance with ACI SP-66.
 - c. Support bars and details of bar supports including type, size and spacing.
 - d. Marking for each reinforcement item.
 - e. Locations of bar cut-offs, splices and bar development.
5. Two samples of mechanical reinforcing bar splices.

1.07 QUALITY ASSURANCE

- A. Fabrication: Do not commence fabrication before shop drawings are reviewed by the Owner's Representative. Maintain tolerances within requirements of ACI SP-66.
- B. Replace all reinforcement with bends and kinks not shown on fabrication shop drawings. Remove from job site all such reinforcement and replace with new fabricated steel at no additional cost to the Owner. Field bending of reinforcement at the work site is prohibited.
- C. Placement: Place reinforcement to tolerances given in ACI 318.
- D. Perform welding indicated and specified in conformance with requirements of AWS D1.4 for procedures, and welding.
- E. All welding performed by qualified operators, certified by test within the past 12 months, in accordance with requirements of AWS D1.4.

1.08 DELIVERY, STORAGE AND HANDLING

- A. Deliver reinforcement and accessories to work site with items of same size and shape fastened in bundles clearly marked with wired-on metal identification tags giving size and mark.
- B. Store reinforcement and accessories off ground on platform, or skid supports and protect from ground splatter.
- C. Protect reinforcement from rusting, deforming, bending, kinking and other injury.

1.09 PROJECT/SITE CONDITIONS: N/A

1.10 SEQUENCING AND SCHEDULING: N/A

PART 2 - PRODUCTS

2.01 STEEL REINFORCING BARS

- A. Provide newly rolled deformed billet-steel reinforcement bars conforming to ASTM A615, Grade 60.
- B. Provide mill bent reinforcing bars, bent cold to dimensions indicated and conforming to requirements of ACI SP-66, and ASTM A767 Class II with Supplementary Requirements S1, S2 and S3 for galvanized steel.
- C. Provide weldable reinforcement conforming to ASTM A706 as indicated or specified.

2.02 TIE WIRE

- A. Provide 16-gage minimum, mild steel or annealed iron tie wire.
- B. Provide 16-gage minimum, mild steel or annealed iron tie wire, with galvanize coating applied by hot-dip process. Provide tie wire with a chromate treatment coating after galvanizing.

2.03 REINFORCING BAR SUPPORTS

- A. Provide number 5 minimum support bars.
- B. Provide plastic protected bar supports in contact with exposed surfaces in conformance with ACI SP-66 (Class 1 – Maximum Protection).

- C. Provide 3-inch by 3-inch plain precast concrete blocks and precast concrete doweled blocks for bar supports. Provide block thickness size to produce concrete cover of reinforcement as indicated. Provide blocks of Type II cement in accordance with Section 033000.

2.04 WELDED WIRE FABRIC

- A. Provide welded wire fabric conforming to ASTM A185.
- B. Provide size indicated.
- C. Provide flat sheets of welded wire fabric conforming to ASTM 185.

2.05 FABRICATION

- A. After shop drawings are reviewed by the Owner's Representative, provide fabricated units of reinforcement conforming to the type, shape and size indicated on the fabrication shop drawings.
- B. Provide reinforcing bars cut and bent before shipment to the site. Provide bars bent cold and in a manner that will not injure the material.

PART 3 - EXECUTION

3.01 PLACEMENT

- A. Before placing in form, clean all reinforcement and accessories of mortar, oil, dirt, loose mill scale, loose or thick rust, and coatings that would destroy or reduce the bond with the concrete.
- B. Place reinforcing bars to tolerances given in ACI 318 and hold in position using tie wire with ends pointed away from forms.
- C. Set and tie all dowel reinforcement before placing concrete.
- D. Bars may be moved to avoid interference with other reinforcing steel, conduits, or embedded items. If bars are moved more than one bar diameter, resulting arrangement of bars is subject to rejection by the Authority. Place the total number of bars required as specified and indicated.
- E. Use chairs, bolsters, and spacers to hold reinforcing bars and welded wire fabric in place, of sufficient strength to resist crushing under load in accordance with ACI SP-66. Metal chairs which extend to the surface of the concrete, stones, brick chips and wood block supports shall not be used.
- F. Use precast concrete bar support blocks for foundation mats, base slabs, footings, pile caps, grade beams, and slabs on grade.

- G. Placing bars and welded wire fabric on layers of fresh concrete as the work progresses, and adjusting bars and welded wire fabric during the placement of concrete shall not be permitted.
- H. Place bar laps in contact and tie securely, or space transversely apart to permit embedment of entire surface of each bar in concrete. Length of laps for bars to conform with requirements of ACI 318, unless otherwise indicated.
- I. Do not splice reinforcement steel in mats, slabs, beams, girders and walls at points of maximum stress unless otherwise indicated.
- J. Lap splice wire-mesh reinforcement at least two full meshes; stagger splices to avoid continuous laps in either direction and wire securely together.
- K. Provide continuous reinforcement through construction joints.
- L. Do not use continuous reinforcement or other fixed metal items through expansion joints. Provide two-inch reinforcement clearance from each face of expansion joint.
- M. Do not field bend bars, including bars partially embedded in concrete, unless indicated. Do not straighten or bend in manner injurious to steel, or concrete.
- N. Do not place bars that have kinks and bends other than shown on reviewed shop drawings. Remove all such damaged bars from job site and replace at no additional cost to the Owner.
- O. Do not use heat to bend or straighten reinforcing steel.
- P. Welding of reinforcing bars shall be permitted only where indicated. Perform all welding in accordance with AWS D1.4.
- Q. All welding of reinforcing steel shall be performed only by operators certified by test in accordance with AWS D1.4.
- R. Tack welding to, or of, reinforcement is prohibited.
- S. Immediately paint all reinforcement, which is to be exposed for more than 90 days with coat of neat cement grout to prevent rust formation.
- T. Furnish and install safety caps on all exposed ends of vertical reinforcement that poses a danger to life safety.

END OF SECTION 032000

SECTION 033000
CAST-IN-PLACE CONCRETE

PART 1 - GENERAL

1.01 SUMMARY

- A. Provide all materials, labor, tools and equipment to complete all cast-in-place concrete including electrical duct banks and structures, formwork, reinforcement and all incidental Work, as indicated and specified.
- B. The Work of this Section shall also include the installation of embedded items furnished under the other Specification Sections.

1.02 RELATED WORK

- A. Section 031000: Concrete Forming and Accessories
- B. Section 032000: Concrete Reinforcing

1.03 REFERENCES

- A. ACI Standards. The following standards of the American Concrete Institute (ACI) form a part of these Specifications, and indicate the minimum standards required.
 - 1. ACI 211.1 Standard Practice for Selecting Proportions for Normal, Heavy Weight and Mass Concrete
 - 2. ACI 214R Recommended Practice for Evaluation of Strength Test Results of Concrete
 - 3. ACI 301 Specifications for Structural Concrete
 - 4. ACI 302.1R Guide for Concrete Floor and Slab Construction
 - 5. ACI 304R Guide for Measuring Mixing, Transporting and Placing Concrete, including Placing Concrete by Pumping Methods (ACI 304.2R)
 - 6. ACI 305R Hot Weather Concreting
 - 7. ACI 306R Cold Weather Concreting

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|-----|------------|--|
| 8. | ACI 308.1 | Standard Specification for Curing Concrete |
| 9. | ACI 309R | Guide for Consolidation of Concrete |
| 10. | ACI 311.4R | Guide for Concrete Inspection |
| 11. | ACI 315 | Details and Detailing of Concrete Reinforcing |
| 12. | ACI 318 | Building Code Requirements for Structural Concrete and Commentary |
| 13. | ACI 347R | Guide to Formwork for Concrete |
| 14. | ACI 350R | Code Requirements Environmental Engineering Concrete Structures and Commentary |

B. ASTM Standards. The following standards of the American Society for Testing and Materials (ASTM) form a part of these Specifications. Unless otherwise specified, materials and methods of test shall conform to ASTM Standards.

- | | | |
|----|-------|--|
| 1. | A 36 | Carbon Structural Steel |
| 2. | A 185 | Steel Welded Wire Fabric, Plain, for Concrete Reinforcement |
| 3. | A 307 | Carbon Steel Bolts and Studs, 60,000 PSI Tensile Strength |
| 4. | A 615 | Deformed and Plain Billet-Steel Bars for Concrete Reinforcement |
| 5. | C 31 | Practice for Making and Curing Concrete Test Specimens in the Field |
| 6. | C 33 | Concrete Aggregates |
| 7. | C 39 | Test Method for Compressive Strength of Cylindrical Concrete Specimens |
| 8. | C 94 | Ready-Mixed Concrete |
| 9. | C 109 | Test method for Compressive Strength of Hydraulic Cement Mortars (Using 2-inch Cube Specimens) |

10. C 127 Test Method for Specific Gravity and Absorption of Coarse Aggregate
11. C 131 Test method for Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine
12. C 138 Test Method for Unit Weight, Yield, and Air Content (Gravimetric) of Concrete
13. C 143 Test Method for Slump of Hydraulic Cement Concrete
14. C 150 Portland Cement
15. C 171 Sheet Materials for Curing Concrete
16. C 172 Practice for Sampling Freshly Mixed Concrete
17. C 173 Test Method for Air Content of Freshly Mixed Concrete by the Volumetric Method
18. C 192 Practice for Making and Curing Concrete Test Specimens in the Laboratory
19. C 231 Test Method for Air Content of Freshly Mixed Concrete by the Pressure Method
20. C 260 Air-Entraining Admixtures for Concrete
21. C 309 Liquid Membrane-Forming Compounds for Curing Concrete
22. C 494 Chemical Admixtures for Concrete
23. C 881 Epoxy-Resin-Base Bonding Systems for Concrete
24. D 41 Asphalt Primer Used in Roofing, Dampproofing, and Waterproofing
25. D 226 Asphalt-Saturated Organic Felt Used in Roofing and Waterproofing

- 26. D 312 Asphalt Used in Roofing
- 27. D 1752 Preformed Sponge Rubber and Cork Expansion Joint Fillers for Concrete Paving and Structural Construction
- 28. D 2628 Preformed Polychloroprene Elastomeric Joint Seals for Concrete Pavements

C. American National Standards Institute (ANSI)

- 1. A 116.1 Two Components Elastomeric Sealing Compounds

D. Federal Specifications

- 1. TT-S-227B Sealing Compound, Rubber Base, Two Component

1.04 DEFINITIONS: N/A

1.05 SYSTEM DESCRIPTION: N/A

1.06 SUBMITTALS

- A. Submit samples of materials and certificates of compliance for material and testing as specified in Paragraph 2.02. Samples shall be of such size as required for testing.
- B. Submit shop drawings for fabrication, bending details and placement of all reinforcing steel. Detailing shall conform with ACI 315 and 318 and shall include actual dimensions provided for concrete cover over bars.
- C. Submit qualifications, name, address, and key personnel information for the Contractor's Independent Testing Laboratory. The Contractor's Independent Testing Laboratory shall be licensed by the State of Maine.
- E. All Contractor's Independent Laboratory Test results shall be sent by the lab directly to the Owner's Representative.
- F. Submit all reports with justification and limits for use or admixtures and changes to the water and cement ratio.
- G. Submit key plans of locations of construction joints.

- H. Submit copies of concrete batch and delivery tickets on day of delivery for each concrete delivery showing concrete mix proportion.

1.07 QUALITY ASSURANCE

- A. The Structural Engineer on Record will perform a series of structural tests and inspections as specified.

1.08 DELIVERY, STORAGE AND HANDLING

- A. Provide in accordance with ACI 301.

1.09 PROJECT/SITE CONDITIONS: N/A

1.10 SEQUENCING AND SCHEDULING: N/A

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Admixtures.
 - 1. Air-entraining admixtures shall conform to ASTM Standard C 260. Provide "Darex AEA", "Vinsol NVX:", "Airecon", "Sika AER", or equal.
 - 2. Chemical admixtures may act as high range water-reducing agents, super plasticizers, retarders, or accelerators, and shall conform to ASTM Standard C 494. Calcium chloride shall not be used as an admixture.
- B. Aggregates. Aggregates for concrete shall conform to ASTM Standard C 33. Fine aggregate shall be inert natural sand. Coarse aggregate shall be well graded crushed stone or crushed gravel, size no. 67 for reinforced concrete 9 inches or less in thickness, size no. 467 for all other concrete. To be classed as crushed gravel, at least 50 percent of the fragments shall have a minimum of one face resulting from fracture. Nicked gravel will not be considered as crushed fragments. Provide a written request to the Owner for use of more than one source.
- C. Anchor Slots and Inserts. Slots and inserts for anchoring mechanical items to concrete shall be of standard manufacture and shall engage with the anchors to be provided and installed therein under other Sections.
- D. Cement. All cement shall conform to ASTM Standard C 150, Type II, except that high-early-strength cement.

- E. Epoxy Bonding Compound. Epoxy bonding compound shall be a two-component epoxy-resin system conforming to ASTM C 881, Type II, Grade 2 for application to horizontal surfaces and Grade 3 for vertical surfaces, Class to match concrete substrate.
- F. Epoxy grout shall be epoxy bonding compound mixed with aggregate recommended by the epoxy manufacturer.
- G. Floor Hardener.
 - 1. Dry shake floor hardener shall consist of specially processed, size-graded non-metallic aggregate, Portland Cement and inorganic pigment, and shall be "Colorcron" manufactured by Master Builders, "Harcot Redi Mixed" manufactured by Sonneborn, "Lithochrome Color Hardener" manufactured by Schofield Construction Specialties, or equal. Color shall be as selected by the Owner.
 - 2. Chemical floor hardener shall be a colorless aqueous solution containing not less than two pounds of zinc or magnesium fluosilicate per gallon, or a sodium silicate solution having specific gravity of 16.7 Baume, or a pre-manufactured hardener manufactured by "Lapidolith", "Saniseal", "Hornolith", or equal. Pre-manufactured hardeners shall be delivered ready for use in the manufacturer's original containers.
- H. Formwork. Provide in accordance with Section 031000.
- I. Joint Sealer.
 - 1. Joint sealer shall be a two-component cold-applied sealing compound conforming to Federal Specification TT-S-227B, or ANSI Standard A116.1. Type and class shall be compatible with continuous exposure to sewage. Joint details indicated shall be modified to suit the requirements of the sealant used.
- J. Reinforcement. Provide in accordance with Section 032000.
- K. Wire Fabric. Provide in accordance with Section 032000.
- L. Water. Mixing water for concrete shall be clean, fresh, and potable.
- M. Non-shrinking Grout. Non-shrinking grout shall be "Embeco 636" or "Embeco 153" manufactured by Master Builders, "Ferrolith G" manufactured by Sonneborn Conteck, "Firmix" manufactured by the Euclid Chemical Co., or equal.

- N. Dust Proof Sealer (DPS). Provide Sonothane by Sonneborn Building Products Division of Contech, Inc.; Polytok Coating MC by Toch Brothers Division of Carboline Company; Tufthane by Tremco Manufacturing Company; or equal.

2.02 TESTING

- A. General. Testing of aggregates, proposed mix designs, and concrete, for compliance with the Specifications will be performed by the Contractor's Independent Testing Laboratory. Additional tests required because of changes in materials or proportions, requested by the Contractor, will be performed at no additional cost to the Owner.
- B. Cement and Other Mill Tests. Certified mill test reports covering all cement shall be submitted by the Contractor for review prior to the use of these materials. The tests shall cover requirements specified herein. Samples shall be furnished by the Contractor for independent tests to be performed at no additional cost to the Owner.
- C. Tests of Aggregates and Concrete.
 - 1. Advance data. Before any concrete is placed, the Contractor shall submit the following information:
 - a. Name of proposed concrete supplier (ready-mixed).
 - b. Proposed type and brand of cement. (Use of more than one brand is not permissible for exposed concrete surfaces.)
 - c. Proposed source of fine and coarse aggregate. (Use of more than one source is not permissible without advance approval.)
 - d. Proposed admixtures.
 - e. Proposed mix proportions for each class of concrete as indicated.
 - f. Previous test data for proposed fine and coarse aggregate and for concrete made from the same materials, if available.
 - g. Submit the results of ASTM C 1260 alkali silica testing of fine and coarse aggregate every 3 months.
 - 2. Alternate sources. Concurrent tests of alternate sources of aggregates will be made at no additional cost to the Owner. If the first source submitted is rejected, subsequent tests shall be performed at no additional cost to the Owner.

- D. Testing During Construction. The following tests shall be performed by the Contractor's Independent Testing Laboratory during construction:
1. Weekly aggregate tests at the mixing plant, scale tests, inspection of batch measurements and mixing procedures. (The concrete supplier shall delivery inspection slips from plant inspector to inspector at point of placement.)
 2. Slump and entrained air tests at point of discharge for every 100 cubic yards of concrete.
 3. Strength tests for concrete consisting of three or more compression (or flexure) specimens molded near the point of sampling, stored for one day at point of molding with temperature and moisture conditions in accordance with ASTM C 39, laboratory-cured, and tested at 7 and 28 days. Not less than one set of specimens will be made for each 100 cubic yards of concrete or fraction thereof placed in any one day, and for each separate mix design.
 4. Provide all labor for sampling and testing. Furnish in accordance with ASTM C 39 molds and plastic bag covers for making compression specimens, facilities for storage and curing of specimens in accordance with ASTM C 39 and deliver day-old specimens to the Contractor's Independent Testing Laboratory. At the mixing plant, facilities for sampling and testing gradation and moisture shall be provided. The Contractor shall at all times keep the Owner's Representative informed as to his concrete placement schedule two days in advance.

PART 3 - EXECUTION

3.01 CONSTRUCTION METHODS

- A. Proportioning. Proportioning of all concrete mixtures shall be subject to the review of the Owner's Representative and no concrete shall be placed without such review. (See Paragraph 2.02.C.) Proportioning shall conform to the recommendations of ACI 211.1 and ACI 301. Proportions shall be selected to meet all the requirements of specified standards and to produce a mixture which will work readily into the forms and around reinforcement by the methods of placing employed, but without permitting segregation of materials or collection of excessive free water at the surface.

Proportioning shall provide concrete with following properties:

Compressive strength	4000 psi minimum
Maximum water/cement ratio	0.44
Slump	1 to 4 inches
Air entrainment	4 to 6 %

1. Strength. Concrete shall develop a minimum compressive strength as indicated at 28 days cure unless otherwise noted. Strength requirements are based on 28-day compressive strengths except for high-early strengths, which are based on 7-day compressive strengths.
2. Air content. All exterior concrete shall be air entrained. Air-entrained concrete may be used elsewhere, at the option of the Contractor. Air-entrained concrete shall be produced by adding the air-entraining admixture to each batch at the mixer. The air content of freshly mixed air-entrained concrete shall be within the limits indicated as percent of the volume of the concrete.
3. Slump. The slump of concrete (ASTM C 143) shall be within the normal limits indicated and mixtures shall be proportioned to provide for that range without exceeding the maximum water-cement ratio. If higher slump is needed, submit justification for Owner's review prior to implementation. High Range Water Reducers – superplasticizers shall be used in accordance with the manufacturer's recommendations. During the course of concrete placement, it will be necessary to reduce slump as the depth of fresh concrete increases, subject to review by the Owner. Concrete delivered with slump outside the normal limits will be rejected by the Owner.
4. Admixtures.
 - a. Admixture for water reduction may be used in all concrete, in the proportions recommended by the manufacturer, when requested in writing and reviewed by the Owner.
 - b. Admixtures for retarding or accelerating the set may be used, at the option of the Contractor, in the proportions recommended by the manufacturer, when requested in writing and reviewed by the Owner.
5. The maximum water to cement ratio for the concrete shall be as indicated.
6. Adjustments during construction: Based on strength test results obtained as the Work progresses, adjust the maximum water-cement ratio and

corresponding mix proportions to maintain specified strengths or to decrease consistently excessive strengths.

- B. Formwork. Provide formwork in accordance with Section 031000.
- C. Reinforcement. Provide in accordance with Section 032000.
- D. Embedded Items. Embedded items shall conform with ACI 301 and all special requirements as indicated. Coordinate and verify the installation of all embedded items, including those furnished and/or installed by filed sub-bidders.
- E. Insulation. Insulation shall be installed as indicated.
- F. Concrete Mixing.
 - 1. Ready-mixed concrete shall conform to ASTM Standard C 94. The mixing and transporting equipment and the method of placement shall be subject to the review of the Owner.
 - 2. Mixing of all other concrete shall conform with ACI 301.
- G. Placing. Placing of concrete shall conform with ACI 301. In all cases, the Contractor shall give the Owner a minimum of 48 hours notice of intended concrete placement and no placement shall begin until the Owner has approved the condition of foundations, forms, reinforcement, and embedded items.
 - 1. Thoroughly wet down the subgrade in advance of the placing of the concrete. There shall be no puddles or pockets of mud when the concrete is placed.
 - 2. Clean the earth foundation upon which concrete is to be placed such that it is free from debris, frost, ice and standing or running water. Prior to placing concrete, level and compact the earth foundation.
 - 3. Before depositing new concrete on concrete that has set, roughen and clean the surfaces of the set concrete to be free of laitance, foreign matter and loose particles. Saturate the set concrete with water and, after free or glistening water disappears, slush the surface of the set concrete with a coat of grout. The grout coat shall be well scrubbed in by means of stiff brushes wherever possible. No concrete shall be placed before the grout coat has attained initial set. Grout shall consist of one part cement and one part sand with only a just amount of water to provide workability.
 - a. When the surface of old concrete is inaccessible, place the grout to spread it over the entire surface as the concrete is deposited.

- b. Where "Epoxy Grout" is indicated use epoxy resin grout in strict accordance with the directions of the manufacturer.
- H. Non-shrinking Grout. Grout for setting equipment bases, and wherever non-shrinking grout is indicated, shall be used in strict accordance with the manufacturer's directions.
- I. Repair of Surface Defects. Proceed with the repair of defects in formed surfaces and filling of the holes immediately after the removal of forms (See Paragraph 3.01.B). Conform with ACI 301 requirements, except that, when approved by the Owner, honeycombed surfaces may be repaired by filling the voids without prior removal of concrete. All fins and projects shall be removed and irregular areas smoothed with carborundum stones.
 - 1. Voids left by entrapped air or water bubbles at formed surfaces (sometimes covered by a thin film of mortar) shall be exposed by a wire brush and filled. For surfaces below finish grade, only repair honeycomb and fill tie holes.
- J. Finishing of Formed Surfaces. Proceed with finishing of formed surfaces concurrently with, or immediately after, the repair of surface defects in conformance with ACI 301. Finish related unformed surfaces, such as tops of walls, by initially placing an excess of fresh concrete at the top of the form, striking off the excess with wooden tools, and forcing coarse aggregate below the surface before final floating. Crown such surfaces (if horizontal) slightly to provide drainage. No addition of mortar topping or retempering of concrete to facilitate finishing will be permitted. Provide grout cleaned finish conforming to ACI 301 on all interior exposed concrete, except slabs, and on all exterior vertical surfaces to 6 inches below grade.
- K. Flatwork: Flatwork includes slabs on grade, framed slabs, and other flat concrete surfaces. Flatwork shall conform with ACI 301 and ACI 302.1R.
 - 1. Floor hardener. Apply floor hardener to areas indicated. Apply the floor hardeners as follows:
 - a. Apply chemical floor hardener after the floors are thoroughly cured and perfectly dry with all other work above them completed.
 - 1) Apply zinc or magnesium fluosilicate evenly, using three coats and allowing 24 hours between coats. The first coat shall be 1/3 strength, the second coat 1/2 strength, and the third coat 2/3 strength. Each coat shall remain on the concrete surface for 15 minutes.

- 2) Apply sodium silicate evenly, using three coats, allowing 24 hours between coats. Apply the sodium silicate full strength at the rate of 1/3 gallon per 100 square feet.
 - 3) After inspection by the Owner's representative apply concrete hardener in conformance with the Manufacturer's instructions.
- b. Apply dust proof sealer after concrete is fully cured in accordance with manufacturer's printed instruction.
- L. Curing and Protection. Curing and protection of concrete shall conform with ACI 308. Cure concrete to retain moisture and maintain a temperature of at least 50 degrees Fahrenheit at the concrete surface for a minimum of 7 days after placement.

3.02 EVALUATION OF CONCRETE STRENGTH

- A. Concrete strength shall conform with ACI 301 and ACI 214. When the strength of laboratory-cured test specimens meet the requirements no other tests of hardened concrete will be required. If the strength of test specimens are unsatisfactory, the areas of concrete represented shall be subject to additional tests, at no additional cost to the Owner.

3.03 ACCEPTANCE OF STRUCTURES

- A. The acceptance of completed concrete Work will be governed by the Provisions of ACI 301.

3.04 CONTRACT CLOSEOUT

- A. Provide in accordance with Contract requirements.

END OF SECTION 033000

SECTION 042000
UNIT MASONRY, GENERAL

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings, Contract Conditions all other Technical Specifications Sections apply to work of this Section insofar as applicable.
- B. Coordinate work with that of all other trades affecting, or affected by work of this Section. Cooperate with such trades to assure the steady progress of all Project work.

1.02 DESCRIPTION

- A. The location of each type of unit masonry work is shown on the Drawings. In general, the work includes the following:
 - 1. CMU walls and applied weatherproofing.
 - 2. Brick facing and precast concrete sills.
 - 3. All ties, reinforcement and anchors required for securing all masonry work together and to adjacent work, except as otherwise specified.
 - 4. All through-wall metal and fabric flashing.
 - 5. Rigid cavity wall insulation and loose fill CMU insulation.
 - 6. Setting and/or building in all flashing, frames, windows, blocking, loose steel lintels, plates, anchors, bolts, ties, sleeves, door and frame, access doors, and all other items requiring building into work of this section.
 - 7. Cutting and patching of work in this section as required for the work of other sections.
 - 8. Cleaning and pointing.
 - 9. Submission of samples and shop drawings as specified or otherwise requested by the Engineer.
 - 10. Construction of one sample masonry panel for each type of masonry to be used, for Engineer's approval. Each panel will measure approximately 4'-0" x 4'-0".
- B. Masonry Mortar and Grout are specified in Section 042000.12.
- C. Masonry Accessories and Precast Concrete Sills are specified in Section 042000.13.
- D. Brick Masonry is specified in Section 042113.
- E. Concrete Masonry Units are specified in Section 042200.

1.03 QUALITY ASSURANCE

- A. Comply with provisions of following codes, specifications and standards, except as otherwise indicated.
1. "BIA Technical Notes on Brick Construction", except as herein modified.
 2. "Building Code Requirements for Engineered Brick Masonry" from the "BIA Technical Notes".
 3. ACI 531 "Building Code Requirements for Concrete Masonry Structures".
 4. ACI 531.1 "Specification for Concrete Masonry Construction".
 5. ANSI/NBS H74 (A41.2) "Building Code Requirements for Reinforced Masonry".
 6. ANSI/NBS 211 (A41.1) "Building Code Requirements for Masonry".

Where provisions of above codes and standards conflict with building regulations in effect for this Project, the building regulations will govern, but only to establish minimum requirements.

B. Coordination:

Review installation procedures and coordinate with other work that must be integrated with masonry.

C. Test for Masonry Materials:

Test prisms of materials in accordance with ASTM Standard E 447. The fully grouted prism strength shall be greater than 2700 psi.

Not less than three specimens shall be made for each initial preliminary test.

Not less than three shall be made for each field test to confirm that the materials are as assumed in the design. The standard age of test specimens shall be 28 days, but seven-day tests may be used provided the relationship between the seven-day and 28-day strengths of the masonry is established by adequate data for the materials used.

Make at least three field tests during construction. Test specimen for grout shall be field formed in accordance with UBC Standard No. 24-22 (NCMA TEK 23A). The compressive strength of grout shall be determined by testing field formed specimen in a damp condition in accordance with applicable provisions of ASTM C 39.

D. Construction Tolerances:

1. Variation from Plumb: For vertical lines and surfaces of columns, walls and arises do not exceed 1/4 inch in 10 feet or one story.
2. Variation from Level: For lines of exposed lintels, sills, parapets, horizontal grooves and other conspicuous lines, do not exceed 1/4 inch in any bay or 20 feet maximum, nor 3/4 inch in 40 feet or more.
3. Variation of Linear Building Line: For position shown in plan and related portion of columns, walls and partitions, do not exceed 1/2 inch in any bay or 20 feet maximum, nor 3/4 inch in 40 feet or more.
4. Variation in Cross-Sectional Dimensions: For columns and thickness of walls do not exceed minus 1/4 inch nor plus 1/2 inch from dimensions shown.

E. Job Mock-Up:

Prior to installation of masonry work, erect a sample wall panel mock-up using materials, bond and joint tooling required for final work. Provide special features as directed for sealant and contiguous work. Build mock-up at the site, where directed, parallel to finished wall of the building, of full thickness and approximately 4 feet long by 4 feet high, indicating the proposed range of color, texture and workmanship to be expected in the completed work, as well as sealants, flashing, insulation, ties, reinforcing, etc. Obtain the Engineer's acceptance of visual qualities of the mock-up before start of masonry work. Retain mock-up during construction as a standard for judging completed masonry work. Do not alter, move or destroy mock-up until work is completed.

1.04 JOB CONDITIONS

A. Materials Protection:

Protect masonry materials during storage and construction from wetting by rain, snow or groundwater and from soiling or inter-mixture with earth and other materials.

Do not use metal reinforcing or ties having loose rust or other coatings, including ice, which will reduce or destroy bond.

Protect grout and mortar materials from deterioration by moisture and temperature. Store in a dry location or in waterproof containers. Keep containers tightly closed and away from open flames. Protect liquid components from freezing. Comply with manufacturer's recommendations for minimum and maximum temperature requirements for storage.

B. Protection of Work:

During erection, cover top of wall with heavy waterproof sheeting at end of each day's work. Cover partially completed structures when work is not in progress. Extend cover a minimum of 24 inches down both sides and hold cover securely in place. Protect base of walls from rain-splashed mud and mortar splatter by means of coverings spread on ground and over wall surface.

Do not apply uniform floor or roof loading for at least 12 hours after building masonry walls or columns. Do not apply concentrated loads for at least 3 days after building masonry walls or columns.

Prevent grout or mortar from staining the face of masonry to be left exposed or painted. Immediately remove grout and mortar in contact with such masonry. Protect sills, ledges and projections from droppings of mortar and other materials.

Take special care to keep the cavity between unit masonry wythe and backup material free of buildup which will act as a bridge for water penetration through the wall construction. Constant monitoring of this area shall be required to ensure that the bottom of the cavity does not fill with mortar droppings and that there is no mortar or other buildup between face wythe and backup construction. Method for preventing mortar droppings within the cavity shall be demonstrated for, and approved by, the Engineer.

C. Cold Weather Protection:

Remove all ice or snow formed on masonry bed by carefully applying heat until the top surface is dry to the touch. Remove all masonry determined to be frozen or damaged by freezing conditions.

D. Procedures Required During Construction:

Perform the following construction procedures while the work is progressing. When the outside temperature falls below 40°F during construction the temperature of the mortar shall be within a range of 70°F and a maximum of 120°F after all ingredients have been combined. The following construction requirements shall be followed to obtain the required mortar temperature.

When the outside air temperature is:

From 40°F to 32°F: Heat mixing water or sand to a minimum of 70°F and a maximum of 160°F.

From 32°F to 25°F: Heat sand and water to a minimum of 70°F and a maximum of 160°F, maintain temperature of mortar on boards above freezing.

25°F and below: Heat sand and mixing water to a minimum of 70°F and maximum of 160°F; provide enclosures and auxiliary heat to maintain air temperature above 32°F; do not lay units which have a temperature of less than 20°F. Units shall be heated to about 40°F to prevent sudden cooling of the heated mortar.

E. Procedures Required for Completed Masonry:

Perform the following for protection of completed masonry and masonry not being worked on.

When mean daily air temperature is:

From 40°F to 32°F: Protect masonry from rain or snow for at least 48 hours by covering with weather-resistive membrane.

From 32°F to 25°F: Completely cover masonry with weather-resistive membrane for at least 48 hours.

25°F and below: Maintain masonry temperature above 32°F for 48 hours using enclosures and supplementary heat, electric heating blankets, infrared lamps, or other acceptable methods.

PART 2 - MATERIALS

2.01 GENERAL

Refer to other sections of Division 4 for required masonry mortar, grout, masonry accessories, masonry units, face brick, and installation methods.

PART 3 - EXECUTION

3.01 INSPECTION:

Contractor must examine the areas and conditions under which unit masonry work is to be installed and notify the Authority's representative in writing of conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected in an acceptable manner.

3.02 PREPARATION

Except for absorbent units specified to be wetted by the manufacturer and approved by the Engineer, lay masonry units surface dry and adjust mortar mix to conform to the degree of water absorption for the individual masonry unit. Do not wet concrete masonry units. Use wetting methods which ensure that each masonry unit (except concrete masonry units) is nearly saturated but surface dry when laid.

3.03 INSTALLATION, GENERAL

Build cavity walls, composite walls, and other masonry construction to the full thicknesses shown. Build single-wythe walls to the actual thickness of the masonry units, using units of nominal thickness indicated.

Build chases and recesses as shown or required for the work of other trades. Unless otherwise shown, provide not less than 8 inches of masonry between chase or recess and jamb of openings, and between adjacent chases and recesses.

Leave openings for equipment to be installed before completion of masonry work. After installation of equipment, complete masonry work to match work immediately adjacent to the opening.

Cut masonry units using appropriate motor-driven masonry saws to provide clean, sharp, un-chipped edges. Cut units as required to provide pattern shown and to fit adjoining work neatly. Use full-size units without cutting wherever possible.

3.04 LAYING MASONRY WALLS

A. Mortar Types:

Unless otherwise indicated, use mortar as specified in Section 042000.12, "Masonry Mortar and Grout".

B. Batch Control:

Measure and batch materials by weight such that the required proportions for mortar can be accurately controlled and maintained. It is recommended that all batch materials be prepackaged to ensure consistency of proportions in the mortar mix. Measurement of sand by shovel will not be permitted.

Mix mortars with the minimum amount of water consistent with workability to provide maximum bond strength of the mortar.

Do not use mortar which has begun to set or if more than 2 hours has elapsed since initial mixing. Re-temper mortar during the 2 hour period only as required to restore workability.

Layout walls in advance for accurate spacing of surface bond patterns with uniform joint widths and to properly locate openings, movement-type joints, returns and offsets. Avoid the use of less-than-half-size units at corners, jambs and wherever possible at other locations.

Lay-up walls plumb and true to comply with specified tolerances, with courses level, accurately spaced and coordinated with other work.

C. Pattern Bond:

Lay exposed masonry in the bond patterns indicated. Lay concealed masonry with all units in a wythe in running bond. Bond and interlock each course of each wythe at corners. Do not use units with less than 4 inch horizontal face dimensions at corners or jambs.

D. Mortar Bedding and Jointing:

To ensure that the cavities of walls are kept clean from mortar droppings, all bed joints adjacent to the cavity shall be beveled.

Lay solid brick size masonry units with completely filled bed and head joints; butter ends with sufficient mortar to fill head joints and shove into place. Do not slush head joints.

Lay solid concrete masonry units greater than 4" in thickness with divided bed joints unless full bedding indicated. Keep drainage channels (if any) free of mortar. Form head joints with sufficient mortar so that excess will be squeezed out as units are shoved into position. Butter both sides of units to be placed, or butter one side of unit-in-place and one side of unit-to-be-placed.

Lay hollow concrete masonry units with full mortar coverage on horizontal and vertical faces of shells. Bed webs in mortar in starting course on footings and in all courses of piers, columns and pilasters, and where adjacent to cells or cavities to be reinforced or filled with concrete or grout.

Maintain joint widths shown, except for minor variations required to maintain bond alignment. If not shown, lay walls with 3/8 inch joints. Rake out mortar in preparation for application of sealants where shown and directed.

Cut joints flush for masonry walls which are to be concealed or to be covered by other materials, unless otherwise indicated.

Tool exposed joints slightly concave unless otherwise indicated.

Remove masonry units disturbed after laying; clean and reset in fresh mortar. Do not pound corners to fit stretcher units which have been set in position. If adjustments are required, remove units, clean off mortar and reset in fresh mortar.

E. Collar Joints:

Where shown, fill the vertical longitudinal joint between wythes solidly with mortar by parging the in-place wythe and shoving units into the parging.

F. Stopping and Resuming Work:

Rack back 1/2-unit length in each course; do not tooth. Clean exposed surfaces of set masonry, wet units lightly (if required) and remove loose masonry units and mortar prior to laying fresh masonry.

G. Built-in Work:

As the work progresses, "build-in" items specified under this and other sections of these specifications. Fill in solidly with masonry around built-in items.

Fill space between hollow metal frames and masonry solid with mortar.

Where built-in items are to be embedded in cores of hollow masonry units, place a layer of metal screen lath in the joint two courses below the affected cell or cells, and rod grout into cores for four courses.

H. Horizontal Joint Reinforcing:

Refer to Section 042000.13 "Masonry Accessories" for type of materials required.

Provide continuous horizontal joint reinforcing as shown and specified. Fully embed longitudinal side rods in mortar for their entire length with a minimum cover of 5/8 inch on exterior side of walls and 1/2 inch on interior side of walls. Lap reinforcement a minimum of 6 inches at ends of units. Do not bridge control and expansion joints with reinforcing.

In single-wythe and multi-wythe walls (solid or cavity) where continuous horizontal reinforcing also acts as structural bond or tie between wythes, space reinforcing as required by code but not more than 16 inches on center vertically.

Reinforce masonry openings greater than 1'-0" wide, with horizontal joint reinforcing placed in 2 horizontal joints approximately 8 inches apart, immediately above the lintel and immediately below the sill. Extend reinforcing a minimum at 2'-0" beyond jambs of the opening, bridging control joints only where indicated.

I. Corners:

Provide interlocking masonry unit bond in each course at corners, unless otherwise shown.

For horizontally reinforced masonry, provide continuity at corners with prefabricated "L" units, in addition to masonry bonding.

J. Intersecting and Abutting Walls:

Unless vertical expansion or control joints are shown at juncture, provide same type of bonding specified for structural bonding between wythes and provide continuity with horizontal joint reinforcing using prefabricated "T" units.

K. Intersecting Load-bearing Walls:

If carried up separately, provide rigid steel anchors at not more than 2'-0" on center vertically. Form anchors of galvanized steel not less than 1- 1/2" x 1/4" x 2'-0" long with ends turned up not less than 2 inches or with cross-pins. If used with hollow masonry units, embed ends in mortar-filled cells.

L. Cavity Walls:

Keep cavity clean of mortar droppings and other materials during construction. Strike joints facing cavity flush.

Tie exterior wythe to back-up with truss type ties embedded in mortar joints. Refer to Section 042000.13 "Masonry Accessories" for type of ties required.

M. Anchoring Masonry Work:

Provide anchoring devices of the type shown and as specified under Section 042000.13 "Masonry Accessories". If not shown or specified, assume that anchoring devices are required and request a clarification from the Engineer before commencing masonry work.

Anchor masonry to structural members where masonry abuts or faces such members to comply with the following:

Provide an open space not less than 1 inch in width between masonry and structural member, unless otherwise shown. Keep open space free of mortar and other rigid materials.

Anchor masonry to structural members with metal ties embedded in masonry joints and attached to structure. Provide anchors with flexible tie sections, unless otherwise shown.

N. Expansion Joints for Exterior Brick Masonry:

Provide vertical expansion and isolation joints in brick masonry where shown. Build-in related items as the masonry work progresses. Refer to Section 079200, Joint Sealers.

O. Control Joints for Concrete Masonry Units:

Consult the Engineer for the location of control joints.

P. Lintels:

Provide steel lintels where shown, in accordance with Section 055000, Metal Fabrications.

Provide concrete masonry unit reinforced bond beams where shown in accordance with Section 042200 – Concrete Masonry Units.

Provide minimum bearing at each jamb of 4 inches for openings less than 6'-0" wide; 8 inches for wider openings.

Q. Flashing of Masonry Work:

Provide concealed flashings in masonry work at obstructions to the downward flow of water in the wall so as to divert such water to the exterior. Concealed flashings shall be provided at, but not be limited to, the following locations:

- Wall base, continuous and above finish grade.
- Window sills.
- Above steel lintels, relief angles and shelf angles.
- Projections, recesses and caps.
- Top of walls.

Prepare masonry surfaces to be smooth and free from projections which could puncture flashing. Seal penetrations in flashing with approved mastic. Extend flashings the full length of lintels and shelf angles and minimum of 4 inches into masonry at each end. Extend flashing from 4 inches beyond exterior face of masonry, through the outer wythe, turned up a minimum of 4 inches, and through the inner wythe to within 1/2 inch of the interior face of the wall in exposed work. Where interior surface of inner wythe is concealed by furring, carry flashing completely through the inner wythe and turn up approximately 2 inches and adhere to face of interior wythe.

Where inter-backup is other than masonry, install flashing to conform to profile of shelf angle and extend a minimum of 8 inches up (and adhere to) the backup material.

Lap ends of flashings by overlapping a minimum of 6 inches and seal lap with mastic recommended by manufacturer.

Provide 8 inch high end dams at the termination of all non-continuous flashings. Also provide continuous vertical flashings at all wall openings.

Install elastic flashings in accordance with manufacturer's instructions.

Provide prefabricated PVC honeycomb weep joint inserts in the head joints of the first course of masonry immediately above all concealed flashings. Space 24 inches on center, unless otherwise indicated. Provide 1/4 inch diameter cotton rope weeps, returned 12 inches up back-up wall. Take care not to cover weeps with sealant or mortar.

Install nailers for flashing and other related work where shown to be built into masonry work.

3.05 REPAIR, POINTING AND CLEANING

A. Remove and replace masonry units which are loose, chipped, broken, stained or otherwise damaged, or if units do not match adjoining units as intended. Provide new units to match adjoining units and install in fresh mortar or grout, 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 all joints including corners, openings and adjacent work to provide a neat, uniform appearance, and where required, properly prepared for application of sealant.

C. Cleaning Exposed, Unglazed Masonry Surfaces:

Wipe off excess mortar as the work progresses. Dry brush at the end of each day's work.

D. Final Cleaning:

After mortar is thoroughly set and cured, clean 1/2 of sample wall panel as follows. Obtain Engineer's acceptance of sample cleaning before proceeding to clean masonry work.

Dry clean to remove large particles of mortar using wood paddles and scrapers. Use chisel or wire brush if required and approved.

Presoak wall by saturating with water and flush off loose mortar and dirt. Scrub down wall with stiff bristle brushes and water mixed with the appropriate amount of one of the following masonry cleaners:

1. Vana-trol by Prosoco Inc.
2. Light duty Concrete Cleaner by Prosoco Inc.
3. EacoChem MND80 by EaCo Chem, Inc.

Rinse walls using clean, pressurized water, to neutralize cleaning solution and remove loose material. Acid cleaning of masonry will not be permitted.

Protect non-masonry surfaces from damage as necessary during cleaning operations. Restore all items so damaged to a like-new condition acceptable to the Engineer at no additional cost.

E. Protection:

Protect the masonry work from deterioration, discoloration and other damage during subsequent construction operations.

END OF SECTION 042000

SECTION 042000.12
MASONRY MORTAR AND GROUT

PART 1 – GENERAL

1.01 RELATED DOCUMENTS

- A. Examine Drawings, Contract Conditions all other Sections of the Specifications for requirements which affect work of this Section whether or not such work is specifically mentioned in this Section.
- B. Coordinate work with that of all other trades affecting, or affected by work of this Section. Cooperate with such trades to assure the steady progress of all Project work.

1.02 DESCRIPTION

Masonry mortar for brick and concrete masonry unit are specified in this section.

1.03 QUALITY ASSURANCE

Do not change source or brands of masonry mortar materials during the course of the work.

1.04 SUBMITTALS

A. Manufacturer's Data:

Submit eight (8) copies of manufacturers' specifications and instructions for each manufactured product.

B. Samples:

Submit samples of each type of colored masonry mortar, showing the range of color which can be expected in the finished work. Label samples to indicate type and amount of colorant used. Engineer's review will be for color only. Compliance with all other requirements is exclusively the responsibility of the Contractor.

PART 2 - MATERIALS

2.01 MATERIALS

- A. Portland Cement: ASTM C 150, Type I, non-staining, without air entrainment and of natural color or white as required to produce the required color of mortar or grout.
- B. Hydrated Lime: ASTM C 207, Type S.
- C. Aggregates for Mortar: ASTM C 144, except for joints less than 1/4 inch use aggregate graded with 100% passing the No. 16 sieve.

- D. Aggregate for Grout: ASTM C 404.
- E. Water: Clean, potable, free of deleterious materials which would impair strength or bond.
- F. Colored Mortar Pigments: Natural and synthetic iron oxides and chromium oxides, compounded for use in mortar mixes. Use only pigments with record of satisfactory performance in masonry mortars. Do not exceed pigment-to-cement ratio, by weight, of 1-to-7. Subject to compliance with requirements, colored mortar pigments which may be incorporated in the work include, but are not limited to, the following:
 - 1. Solomon Grind-Chem Services, Inc.; "SGS Mortar Colors".
 - 2. Davis Colors, A Subsidiary of Rockwood Industries, Inc.; "True Tone Mortar Colors".
 - 3. Similar colors manufactured by Bonsol Construction Products or Riverton Lime and Stone Co. are acceptable.

2.02 MORTAR MIXES

- A. Do not lower the freezing point of mortar by use of admixtures or antifreeze agents.
- B. Do not use masonry cement.
- C. Do not use calcium chloride or other antifreeze compounds in mortar or grout.
- D. Mortar for Unit Masonry (Proportion by Volume Method):

Non-staining, cement-lime mortar complying with ASTM C 270, "Table 1, Proportion Specification Requirements", but limiting acceptable types to those listed below for cement-lime mixes.

 - 1. Type M: 1/4 part lime per part of Portland Cement.
 - 2. Type S: Over 1/4 up to 1/2 part lime per part of Portland Cement.
- E. Use the following mortar mix for the applications indicated.
 - 1. Use Type M mortar for masonry below grade and in contact with earth.
 - 2. Use Type S mortar for other applications.
- F. Colored Pigmented Cement Mortar:

Proportion pigments with other ingredients to match sample approved by the Engineer.

2.03 GROUT MIX

Portland cement, sand, gravel and water, proportioned as required to provide a 28-day minimum compressive strength of 2500 psi.

PART 3 - EXECUTION

3.01 Refer to Section 042000, "Unit Masonry, General" for required installation procedures of mortar and grout specified in this section.

END OF SECTION 042000.13

SECTION 042000.13
MASONRY ACCESSORIES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings, Contract Conditions other Technical Specifications Sections apply to work of this Section insofar as applicable.
- B. Coordinate work with that of all other trades affecting, or affected by work of this Section. Cooperate with such trades to assure the steady progress of all Project work.

1.02 DESCRIPTION

- A. Section 042000, "Unit Masonry, General" specifies the installation of masonry work including the accessories specified under this section.
- B. The location of the masonry work is shown on the Drawings. The types of masonry accessories required include the following:

Continuous horizontal wire reinforcing.

Vertical bar type reinforcing.

Anchoring devices for masonry.

Concealed flashings built into masonry work.

Control joint strips.

Masonry weep joints.

Full height cavity wall drainage mat.

Filler strips at tops of masonry partitions.

Drip Plates

Precast concrete sills.

1.03 SUBMITTALS

- A. Manufacturer's Data:

Submit eight (8) copies of manufacturer's specifications and installation instructions for each masonry accessory required. Include data substantiating that materials comply with specified requirements.

B. Test and Engineering Data:

Submit eight (8) copies of certifications of load tests or engineering data substantiating capability of the anchors to withstand the imposed compression/tension loads.

PART 2 - MATERIALS

2.01 CONTINUOUS WIRE REINFORCING

A. Horizontal Wall Reinforcing: Extra heavy-duty (galvanized in accordance with ASTM A-153 at exterior walls and interior walls in humid and wet areas) continuous truss type in accordance with ASTM A-82. Provide preformed corner and intersection units. Vertical spacing of reinforcement courses shall be 16 inches on center unless closer spacing is shown on the Drawings. However, in all cases, place reinforcement in the first two course joints immediately over and under openings, extending not less than 48 inches on each side, and in bottom of three course beds, and the top course bed. Unit width shall be such that the side rods center on the walls of hollow masonry units. Reinforcing shall be Hohmann & Barnard, Inc. units listed below or approved equal products manufactured by Dur-O-Wall Products, Inc. or AA Wire Products Co.

1. Single Wythe: Hohmann & Barnard, Inc., "Truss Mesh" #120, 3/16 inch side rods, #9 cross rods, hot dip galvanized in accordance with ASTM A 123, Class B2.
2. Double Wythe and Cavity: Hohmann & Barnard, Inc., "#165-S.I.S." consisting of #165 Truss Box Mesh (3/16 inch side rods, #9 cross rods, 3/16 inch boxes); "Seismiclip"; 3/16 inch "Byna-tie"; 3/16 inch Continuous Wire; all hot dip galvanized in accordance with ASTM A 123, Class B2 except continuous wire to be mill galvanized in accordance with ASTM A 116/641, Class 3.

Note: Continuous wire reinforcement is required for all 4 inches thick (nominal) and wider units.

B. Masonry Anchors:

1. Masonry to Steel Stud: Hohmann & Barnard #DW-10 with 3/16 "Byna-Tie" and "Seismiclip", or approved equal by AA Wire Products Co. or Dur-O-Wall, Inc.
2. Masonry to Cast-in-Place Concrete: Hohmann & Barnard #305 Dovetail Slot, #315-BT Flexible Dovetail and "Seismiclip", or approved equal by AA Wire Products Co. or Dur-O-Wall, Inc.

Notes:

All materials shall be hot-dip galvanized in accordance with ASTM A 123, Class B2.

Continuous horizontal reinforcement (e.g., truss type and single wire type) shall be secured to each masonry anchor with "Seismiclips".

- C. Masonry Partition Top Anchors: Refer to the Structural Drawings.
- D. Rigid Steel Anchors: Hot dip galvanized 1 1/2" x 1/4" x 2'-0" long with ends turned up 2 inches in opposite directions or with acceptable cross pins.

2.02 FLASHING FOR MASONRY

Copper Fabric Laminated: Copper sheet weighing 5 ounces per square foot bonded with asphalt between 2 layers of glass fiber cloth. Flashing shall be manufactured by one of the following:

Copper Fabric; Afco Products, Inc.
Copper Fabric Flashing; Sandell Mfg., Co. Inc.
Copper Fabric Flashing; York Mfg., Inc.

Adhesive for flashing shall be as provided by the flashing manufacturer.

2.03 MISCELLANEOUS MASONRY ACCESSORIES

- A. Reinforcing Bars: Deformed steel, ASTM A 615, Grade 60, of the sizes shown.
- B. Preformed Control Joint Gaskets: Material as indicated below, designed to fit standard sash block and maintain lateral stability in masonry wall; size and configuration as indicated or required.
 - 1. Styrene-Butadiene Rubber Compound: ASTM D 2000, Designation M2AA-805
- C. Weep Joints: Provide the following:
 - 1. PVC Honeycomb: Provide 3/8" wide by height of bed joint prefabricated honeycomb units.
- D. Full Height Cavity Drainage Mat: Provide 3/4" thick by full height and width of all cavity wall spaces. Product shall be similar to CavClear Masonry Mat or Mortairvent CW.
- E. Compressible Filler: Premolded filler strips complying with ASTM D1056, Type 2, Class A, Grade 1; compressible up to 35 percent; of width and thickness indicated; formulated from the following material.
 - 1. Neoprene.
- F. Drip Plate: Provide the following:
 - 1. Manufacturer: Hohmann & Barnard, Inc. Drip Plate DP-FTSA

2. Width: 3"
3. Foam-Tite Seal Width: 2.5"
4. Material: Type 304 Stainless Steel (26 guage)

2.04 PRECAST CONCRETE

- A. Architectural precast concrete: Provide custom fabricated, integrally colored sills, complying with the following:
1. Compressive strength: 5,000 psi minimum at 28 days.
 2. Entrained air: 5% - 6%.
 3. Finish: Light sandblast finish approved by the Authority.
 4. Formwork: Comply with applicable requirements of ACI 347, and with PCA forms of Architectural Concrete. Forms shall bear APA grade-trademark and shall have specially formulated aluminum edge sealer. Provide forms true, straight and square. Where joints occur in forms, the interior surface shall be flush. Forms shall be braced rigidly. Prior to each pour, coat forms with approved non-staining form release agent that will not interfere with adhesion of sealants, insulation adhesives or applied finishes.
 5. Reinforcement: Provide reinforcement as shown on shop drawings and as specified herein. Provide additional reinforcement required for handling, transportation and erection stresses. Reinforcement shall be cold rolled steel complying with ASTM A 615, Grade 60, deformed and welded wire fabric conforming to ASTM A 185. Reinforcing steel shall be hot-dip galvanized after fabrication.
 6. Detailing and fabrication of reinforcement shall conform to ACI 315 and ACI 315R.

PART 3 - EXECUTION

3.01 INSTALLATION

Refer to Section 042000, "Unit Masonry, General" for installation of masonry accessories specified under this section.

END OF SECTION 042000.13

SECTION 042113
BRICK MASONRY

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings, Contract Conditions and other Technical Sections apply to work of this Section insofar as applicable.
- B. Coordinate work with that of all other trades affecting, or affected by work of this Section. Cooperate with such trades to assure the steady progress of all Project work.

1.02 DESCRIPTION

- A. Brickwork is indicated on the Drawings. Installation of the face brick and common brick are specified in Section 042000, "Unit Masonry, General".
- B. Masonry mortar and grout is specified in Section 042000.12, "Masonry Mortar and Grout".
- C. Masonry accessories, including reinforcing, are specified in Section 042000.13, "Masonry Accessories".

1.03 QUALITY ASSURANCE

- A. Obtain face brick from one manufacturer, of uniform texture and color (or uniform blend in the variation thereof).
- B. Standards:
 - Facing Brick: ASTM C 216-75, Grade SW.
 - Building (Common) Brick: ASTM C 62.

1.04 SUBMITTALS

- A. Manufacturer's Data: Submit brick manufacturer's specifications and other data for each type of product required, including certification that each product complies with the specified requirements. Include instructions for handling, storage, installation and protection of each type of brick.
- B. Samples:
 - 1. Submit 5 samples of exposed brick. Include the full range of exposed color and texture to be expected in the completed work. Engineer's review will be for color and texture only. Compliance with all other requirements is exclusively the responsibility of the Contractor.

2. All brick when submitted for approval shall be accompanied by the manufacturer's statement of the following:

Compressive strength of the brick which will indicate the degree of hardness.

Certification that the brick submitted is Type SW (Severe Weather) brick.

Special instructions for laying the brick, if any.

Any modifications to the mortar mix which might be required for proper bond strength.

PART 2 - MATERIALS

2.01 MATERIALS FOR BRICK MADE FROM CLAY OR SHALE

- A. At Contractor's option, provide solid brick, cored or uncored, for vertical brickwork. Do not use cored brick with net cross-sectional area less than 75% of gross area in the same plane or with core holes less than 3/4 inch from any edge.

2.02 BRICK TYPES

- A. Face Brick: Comply with the requirements of ASTM C 216, Grade SW, Type FBS standard modular size brick shall be one of the following:

Belden Brick: 503-505A

Glen Gery: Carlton

Endicott: Rose Smooth

- B. Building (Common) Brick: Conform to ASTM C 62, Grade SW.

PART 3 - EXECUTION

3.01 INSTALLATION

Refer to Section 042000 "Unit Masonry, General" for installation of brick.

END OF SECTION 042113

SECTION 042200
CONCRETE MASONRY UNITS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings, Contract Conditions and Technical Sections apply to work of this Section insofar as applicable.
- B. Coordinate work with that of all other trades affecting, or affected by work of this Section. Cooperate with such trades to assure the steady progress of all Project work.

1.02 DESCRIPTION

- A. Concrete masonry units (CMU) are indicated on the drawings. The types of concrete masonry units required include the following:
 - 1. Hollow load bearing block, normal weight.
 - 2. Solid load bearing block, normal weight.
- B. Installation of CMU is specified in Section 042000, "Unit Masonry, General".
- C. Mortar is specified in Section 042000.12, "Masonry Mortar and Grout".
- D. Accessories, including reinforcing, are specified in Section 042000.13, "Masonry Accessories".
- E. Installation of field applied weatherproofing at exterior face of CMU within cavity.

1.03 QUALITY ASSURANCE

- A. Fire Performance Characteristics: Where indicated, provide materials and construction which are identical to those of assemblies whose fire endurance has been determined by testing in compliance with ASTM E 119 by a recognized testing and inspecting organization or by another means, as acceptable to authority having jurisdiction.
- B. Obtain units from one manufacturer, cured by one process, and of uniform texture and color for each type required, for each continuous area and visually related areas.
- C. Standards: Concrete masonry units shall be manufactured to meet the following minimum standards:

Hollow load bearing block; ASTM C 90.

Solid load bearing block; ASTM C 145.

1.04 SUBMITTALS

- A. Product Data: Submit manufacturer's data for each type of concrete masonry unit required, including certified copies of laboratory test reports and other data as may be required to show compliance with specified requirements.
- B. Samples: Submit 5 samples of each type of concrete masonry unit required to be painted. Select units to show range of texture which can be expected in the finished work.

PART 2 - MATERIAL

2.01 CONCRETE MASONRY UNIT MATERIALS

A. General

Comply with referenced standards and other requirements indicated below applicable to each form of concrete masonry unit required.

Size: Manufacturer's standard units with nominal face dimensions of 16 inches long x 8 inches high (15-5/8" x 7-5/8" actual) of the various widths shown, unless otherwise indicated.

Exposed Faces: Provide manufacturer's standard color and texture, unless otherwise indicated. Wherever concrete units are indicated to be painted, provide fine-textured units.

Special Shapes: Provide for lintels, corners, jambs, sash, control joints, headers, bonding and other special conditions.

B. Concrete Block

Where concrete blocks are shown, comply with the following classifications, weights, grades, curing, and other requirements as indicated.

1. Grade: Grade N.
2. Type: Provide Type I, moisture-controlled.

Cure units by autoclave treatment at a minimum temperature of 350°F (176°C) and a minimum pressure of 125 psi.

Limit moisture absorption of 25% of saturation during delivery and until time of installation.

3. Hollow Load bearing Block: ASTM C 90, normal weight.

4. Solid Load bearing Block: ASTM C 145, normal weight using concrete aggregates complying with ASTM C 33, producing a dry net weight of not more than 125 pounds per cubic foot.

C. Field Applied Water Resistive Barrier: Similar to Carlisle Barritech NP

PART 3 - EXECUTION

3.01 INSTALLATION

Refer to Section 042000, "Unit Masonry, General" for installation of the concrete masonry units specified in this section.

Install water resistive barrier at exterior face of CMU wall in accordance with the manufacturer's installation instructions.

END OF SECTION 042200

SECTION 051200
STRUCTURAL STEEL FRAMING

PART 1 - GENERAL

1.01 SUMMARY

- A. Extent of structural steel work is shown on drawings, including schedules, notes and details to show size and location of members, typical connections, and type of steel required.
- B. Structural steel is that work defined in American Institute of Steel Construction (AISC) "Code of Standard Practice" and as otherwise shown on drawings. All structural steel shall be hot dip galvanized after shop fabrication to greatest extent possible.
- C. Miscellaneous metal fabrications are specified elsewhere in Section 055000 Metal Fabrications. Steel Joists are specified in Section 052100 and Steel Deck in Section 053100. Refer to Section 033000 Concrete for anchor bolt installation in new concrete; chemical adhesive anchors used in existing concrete and stone are specified in this section.
- D. Source Quality Control: Materials and fabrication procedures are subject to inspection and tests in mill, shop, and field, conducted by a qualified inspection agency. Such inspections and tests will not relieve Contractor of responsibility for providing materials and fabrication procedures in compliance with specified requirements.

Promptly remove and replace materials or fabricated components, which do not comply.

1.02 RELATED WORK:

- A. MTA Specification Section 520: Structural Concrete
- B. Section 053100: Steel Deck
- C. Section 055000: Metal Fabrications
- D. Section 099123: Painting

1.03 REFERENCES:

- A. American Institute of Steel Construction (AISC)
 - 1. AISC "Code of Standard Practice for Steel Buildings and Bridges".
 - 2. AISC "Specifications for the Design, Fabrication, and Erection of Structural Steel for Buildings", including "Commentary" and Supplements thereto as issued June 1, 1989.
 - 3. AISC "Specifications for Structural Joints using ASTM A 325 or A 490 Bolts" approved by the Research Council on Riveted and Bolted Structural Joints of the

Engineering Foundation.

4. American Welding Society (AWS) D1.1 "Structural Welding Code - Steel".

B. American Society of Testing and Materials (ASTM)

1. ASTM A 6 General Requirements for Delivery of Rolled Steel Plates, Shapes, Sheet Piling and Bars for Structural Use.
2. ASTM A 123 Zinc (Hot Galvanized) Coatings on Products Fabricated from Rolled, Pressed, and Forged Steel Shapes, Plates and Hardware.
3. ASTM A 153 Zinc Coating (Hot Dip) on Iron and Steel Hardware.
4. ASTM A 307 Carbon Steel Externally Threaded Standard Fasteners.
5. ASTM A 325 High Strength Bolts for Structural Steel Joints.
6. ASTM A 449 Quenched and Tempered Steel Bolts and Studs.
7. ASTM A 500 Cold Formed Welded and Seamless Carbon Steel Structural Tubing in Round and Shapes.
8. ASTM A 501 Hot Formed Welded and Seamless Carbon Steel Structural Tubing.
9. ASTM A 384 Standard Practice for Safeguarding against Warpage and Distortion during Hot-Dip Galvanizing of Steel Assemblies.
10. ASTM A 305 Contractor's Qualification Statement.
11. ASTM A 36 Specification for Carbon Structural Steel.
12. ASTM F 593 Stainless Steel Bolts, Hex Cap Screws, and Studs.
13. ASTM F 594 Specification for Stainless Steel Nuts.
14. ASTM A 666 Specification for Annealed or Cold-Worked Austenite Stainless Steel Sheet, Strip, Plate, and Flat Bar.
15. ASTM A 143 Standard Practice for Safeguarding Against Embrittlement of Hot-Dip Galvanized Structural

Steel Products and Procedure for Detecting Embrittlement.

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| 16. | ASTM A 780 | Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings. |
| 17. | ASTM A 992 | Structural Shapes for use in Building Framings. |
| 18. | ASTM F 1554 | Anchor Rods |

1.04 DEFINITIONS: N/A

1.05 SYSTEM DESCRIPTION: N/A

1.06 SUBMITTALS:

- A. Product Data: Submit producer's or manufacturer's specifications and installation instructions for following products. Include laboratory test reports, notarized certificates and other data to show compliance with specifications (including specified standards).
 - 1. Structural steel (each type), including certified copies of mill reports covering chemical and physical properties.
 - 2. High-strength bolts (each type) and stainless steel bolts, including nuts and washers.
 - 3. Chemical adhesive anchors, including threaded rod, nuts, washers and adhesive capsule. Include certification of compatibility drinking (potable) water.
 - 4. Structural steel primer paint.
 - 5. Non-shrink, non-metallic grout.
 - 6. Hot dip galvanizing process.
 - 7. Calibration report for chemical anchor testing equipment
- B. Shop Drawings: Submit shop drawings prepared under supervision of a registered professional engineer, including complete details and schedules for fabrication and assembly of structural steel members, procedures and diagrams.
- C. Include details of cuts, connections, camber, holes and other pertinent data. Indicate welds by standard AWS A2.1 and A2.4 symbols, and show size, length and type of each weld.

1.07 QUALITY ASSURANCE:

- A. Codes and Standards: Comply with provisions of codes and standards listed in Paragraph 1.03, unless otherwise indicated.

- B. Qualifications for Welding Work: Quality welding processes and welding operators in accordance with AWS "Standard Qualification Procedure."

Provide certification that welders to be employed in work are satisfactorily passed AWS qualification tests.

If recertification of welders is required, retesting will be at no additional cost to the Owner's Representative.

- C. Chemical Adhesive Anchor Field Testing; On-site testing of chemical adhesive anchors shall be performed by the manufacturer's representative at all sites. Two random tests shall be performed for each type of wall material (brick or stone masonry) at each site in general conformance to the testing procedure below. The costs for these tests shall be borne by the contractor. If test results fail to meet the required allowable design values shown on the Drawings by more than 50 percent (1.5 x allowable bond strength), the Consultant may request additional testing at no additional cost to the Owner's Representative. If these additional tests fail to meet the required design values, the contractor shall submit to the Consultant proposed methods of correcting the deficient anchors for his review. Material descriptions and required installation procedures are described elsewhere in this section.

Test Assembly: The test assembly for the chemical adhesive anchors shall consist of a 30-ton hollow core hydraulic ram and pump assembly with both 5,000 psi and 10,000-psi gages (submit calibration report) and a steel tripod 17 inches apart at the base. The Tripod is placed directly over the anchor bearing on the base material surface (not all anchors will be testable).

The hollow core of the ram is placed on the seat of the tripod (which has a hole) and the pull is passed through both ram and seat, and is coupled to the anchor. The nut and washer attach the pull rod to the ram at its outermost end.

Test Procedure: Through hand pumping, gradually apply load to anchor. Based on the conversion system required to attain loading valves in kips (1,000 lbs.), apply load until it has reached a value 50 percent greater than the required allowable bond strength shown for the particular size anchor on the drawings, Two random tests (locations to be chosen by the Consultant) will be performed for each type of wall material at each site.

1.08 DELIVERY, STORAGE AND HANDLING:

- A. Deliver materials to site at such intervals to insure uninterrupted progress of work.
- B. Deliver anchor bolts and anchorage devices, which are to be embedded in cast-in-place concrete or masonry, and chemical adhesive anchors in ample time so not to delay work.
- C. Store materials to permit easy access for inspection and identification. Keep steel members off ground, using pallets, platforms or other supports. Protect steel members and packaged materials from erosion and deterioration.
- D. Do not store materials on structure in a manner that might cause distortion or damage to members or supporting structures. Repair or replaced damaged materials or structures as directed.

1.09 PROJECT/SITE CONDITION: N/A

1.10 SEQUENCING AND SCHEDULING: N/A

PART 2 - PRODUCTS

2.01 MATERIALS

- A. Metal Surfaces, General: For fabrication of work which will be exposed to view, use only materials which are smooth and free of surface blemishes including pitting, rust and scale seam marks, roller marks, rolled trade names and roughness. Remove such blemishes by grinding, or by welding and grinding, prior to cleaning, treating and application of surface finishes.
- B. Structural Steel Shapes: ASTM A 992 and Plates and Bars: ASTM A 36, shall be chemically compatible with galvanizing, ASTM A 384 and A 305.
- C. Cold Formed Steel Tubing: ASTM A500, Grade B.
- D. Anchor Bolts: F 1554 GR 55, threaded stock unless otherwise indicated (see Paragraph 2.01 J for chemical adhesive anchors).
- E. High-Strength and Stainless Steel Threaded Fasteners: Heavy hexagon structural bolts, heavy hexagon nuts and hardened washers as follows:

Quenched and tempered medium-carbon steel bolts, nuts and washers, complying with ASTM A325. Stainless steel bolts, nuts and washers shall be AISI type 316.
- F. Electrodes for Welding: E70XX or E316L - 16 (stainless) electrodes complying with AWS Code.
- G. Non-shrink, Non-Metallic Grout: See Section 033000.
- H. Hot Dip Galvanizing: Shall conform to ASTM B-6, with 0.5 percent nickel added to zinc.
- I. Chemical Adhesive Anchors: Shall consist of an all threaded anchor rod, nut washer, and adhesive capsule. The composition of these components shall be as follows:

Anchor rods shall be manufactured from AISI Type 316 stainless steel meeting the requirements of ASTM 539-80. A chisel point of 90 degrees shall be formed or cut on the end of the rod to be embedded.

Nuts shall be manufactured from AISI Type 316 stainless meeting the requirements of ASTM F594 Group II.

Washers shall be manufactured from AISI Type 316 stainless steel and shall be the requirements of ASTM A666 Type 316 "1/4 Hard."

The Adhesive capsule shall consist of a sealed glass container, which contains all components of the adhesive mortar. These components shall consist of a vinylester (epoxy acrylate) resin, quartz aggregate, and a hardening agent. Within the capsule these components shall be pre-measured and pre-proportioned in the exact volume and composition necessary for proper curing. These components shall be isolated from each other within the capsule such that curing shall not be initiated until such time that anchor installation occurs.

In 4,000 psi concrete (required values for masonry on drawings) at one capsule embedment, the adhesive shall provide the following ultimate and allowable bond strengths:

<u>Diameter of Threaded Anchor Rod (inches)</u>	<u>Embedment (inches)</u>	<u>Hole Diameter (inches)</u>	<u>Ultimate Bond Strength (lbs.)</u>	<u>Allowable Bond Strength (lbs.)</u>
3/8	3 1/2	15/32	9,070	2,420
1/2	4 1/4	9/19	12,460	3,330
5/8	5	11/16	19,010	5,070
3/4	6 5/8	7/8	27,230	7,260
7/8	6 5/8	1	32,070	8,550
1	8 1/4	1/8	45,070	12,290
1 1/4	12	1 1/2	97,260	25,940

It should be noted that the required allowable bond capacities shown on the Drawings are for embedment in masonry wall material and that their required bond strengths (tensile) are lower than the values shown above. Values for embedment in 4,000 psi concrete are listed for ease of comparison and availability of product data. Epoxy injection may be used in lieu of adhesive capsules.

2.02 FABRICATION

- A. Shop Fabrication and Assembly: Fabricate and assemble structural assemblies in shop to greatest extent possible. Fabricate items of structural steel in accordance with AISC Specifications and as indicated on the Contract Drawings. Provide camber in structural members where indicated.

Properly mark and match-mark materials for field assembly. Fabricate for delivery sequence, which will expedite erection and minimize field handling of materials.

Where finishing is required, complete assembly, including welding of units, before start of finishing operations. Provide finish surfaces of members exposed in final structure free of markings, burrs, and other defects.

- B. Connections: Weld or bolt shop connections, as indicated. Bolt field connections, except where welded connections or other connections are indicated.

Provide high-strength or stainless steel threaded fasteners for all bolted connections.

- C. High-Strength and Stainless Steel Bolted Construction: Install high-strength threaded fasteners in accordance with AISC "Specifications for Structural Joints using ASTM A325 or A490 Bolts," where indicated on the Drawing. Install stainless steel bolts where indicated on the Drawings.
- D. Bolt Holes: Drill or punch holes perpendicular to metal surfaces. Do not flame cut holes or enlarge holes by burning. Drill holes in bearing plates.
- E. Welded Construction: Comply with AWS Code for procedures, appearance and quality of welds, and methods used in correcting welding work.

2.03 PAINTING

- A. General: Shop paint or field apply all structural steel coating systems, except those members to be hot dip galvanized in accordance with the coating manufacturer's written specifications and Section 099123 PAINTING.

Do not paint surfaces, which are to be field welded, or high-strength bolted with friction-type connections.

Apply 2 coats of paint to surfaces, which are inaccessible after assembly or erection. Change color of second coat to distinguish it from first.

Field paint existing structural steel work indicated on the Drawings.

2.04 GALVANIZING

- A. Steel members, shop fabrications and assemblies shall be hot dip galvanized after fabrication in accordance with ASTM A123. Safeguard against embrittlement in conformance with ASTM A143.
- B. Do not treat galvanized surfaces with oils, grease or chemicals.
- C. Do not apply paint primer to steel members, which are to be hot dip galvanized.
- D. For repairs and touch-ups, apply over wire brushed surfaces, zinc rich paint (95 percent by weight) using a brush in accordance with ASTM A780. Dry film thickness of applied repair paint to be not less than coating thickness of required by ASTM A123.

PART 3 - EXECUTION

3.01 ERECTION

- A. Temporary Shoring and Bracing: Provide temporary shoring and bracing members with connections of sufficient strength to bear imposed loads. Remove temporary members and connections when permanent members are in place and final connections are made. Provide temporary guy lines to achieve proper alignment of structures as erection proceeds.

- B. Setting Bases and Bearing Plates: Clean concrete and masonry bearing surfaces of bond-reducing materials and roughen to improve bond to surfaces. Clean bottom surface of base and bearing plates.

Set loose and attached base plates and bearing plates for structural members or wedges or other adjusting devices. Use leveling nuts when setting column bases.

- C. Tighten anchor bolts after supported members have been positioned and plumbed. Do not remove wedges or shims, but if protruding, cut off flush with edge of base or bearing plate prior to packing with grout.

- D. Pack grout solidly between bearing surfaces and bases or plates to ensure that no voids remain. Finish exposed surfaces, protect installed materials, and allow to cure.

- E. Field Assembly: Set structural frames accurately to lines and elevations indicated. Align and adjust various members forming part of complete frame or structure before permanently fastening. Clean bearing surfaces and other surfaces, which will be in permanent contact before assembly. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.

Level and plumb individual members of structure within specified AISC tolerances.

Establish required leveling and plumbing measurements on mean operating temperature of structure. Make allowances for difference between temperature at time of erection and mean temperature at which structure will be when completed and in service. Splice members only where indicated on contract drawings.

- F. Erection Bolts: On exposed welded construction, remove erection bolts, fill holes with plug welds and grind smooth at exposed surfaces.

- G. Comply with AISC Specifications for bearing, adequacy of temporary connections, alignment, and removal of paint of surfaces adjacent to field welds.

Do not enlarge undersized holes in members by burning or by use of drift pins. Ream holes that must be enlarged to admit bolts.

- H. Gas Cutting: Do not use gas cutting torches in field for correction fabrication errors in primary structural framing. Cutting will be permitted only on secondary members, which are not under stress, as appearance when permitted.

- I. Touch-up Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint. Apply paint to exposed areas using same material as used for shop painting.

Apply by brush or spray to provide minimum dry film thickness of 1.5 mils.

- J. Chemical Adhesive Anchor Installation:

The installation procedure shall be strictly as per manufacturer's instructions. Additionally, the following steps shall be taken:

All holes shall be fully cleaned using a nylon brush and compressed air. The holes shall be covered in such a fashion that they remain free of all debris until such time that anchor installation occurs.

The hole depth shall be equal to the length of the adhesive capsule unless otherwise indicated on the Drawings. In all cases, the volume to the mixed adhesive shall be at least equal to the volume between the threaded rod and the hole wall. In no case shall the hole depth be less than the adhesive capsule length.

The hole diameter shall be exactly as recommended by the manufacturer.

The adhesive capsules shall be placed in the cleaned holes and the anchor rods shall be driven into them using a rotary hammer drill set to "rotary and hammer" mode. Full embedment shall be assured. The manufacturer's recommended cure time shall be allowed to elapse prior to any loading of the anchor bolt.

3.02 QUALITY CONTROL:

- A. Owner's Representative's Consultant will engage an independent testing and inspection agency to inspect high-strength bolted connections and welded connections and to perform tests and prepare test reports.

Testing agency shall conduct and interpret tests and state in each report whether specimens comply with requirements, and specifically state any deviations therefrom.

Provide access for testing agency places where structural steel work is being fabricated or produced so that required inspection and testing can be accomplished.

Testing agency may inspect structural steel at plant before shipment; however, Owner's Representative's Consultant reserves right, at any time before final acceptance, to reject material not complying with specified requirements.

- B. Correct deficiencies in structural steel work, which inspections and laboratory test reports have indicated to be not in compliance with requirements at no additional cost to the Owner. Perform additional tests, at no additional cost to the Owner, as may be necessary to reconfirm any non-compliance of original work, and as may be necessary to show compliance of corrected work.

END OF SECTION 051200

SECTION 052100
STEEL JOIST FRAMING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. K-series steel joists.
2. Joist accessories.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of joist, accessory, and product.

B. Shop Drawings:

1. Include layout, designation, number, type, location, and spacing of joists.
2. Include joining and anchorage details, bracing, bridging, and joist accessories; splice and connection locations and details; and attachments to other construction.

1.3 INFORMATIONAL SUBMITTALS

A. Welding certificates.

B. Manufacturer certificates.

C. Mill Certificates: For each type of bolt.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: A manufacturer certified by SJI to manufacture joists complying with applicable standard specifications and load tables in SJI's "Specifications."

1. Manufacturer's responsibilities include providing professional engineering services for designing special joists to comply with performance requirements.

B. Welding Qualifications: Qualify field-welding procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, and handle joists as recommended in SJI's "Specifications."

PART 2 - PRODUCTS

2.1 K-SERIES STEEL JOISTS

- A. Manufacture steel joists of type indicated according to "Standard Specifications for Open Web Steel Joists, K-Series" in SJI's "Specifications," with steel-angle top- and bottom-chord members, underslung ends, and parallel top chord.

2.2 PRIMERS

- A. Low-Emitting Materials: Paints and coatings shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."
- B. Primer: SSPC-Paint 15, or manufacturer's standard shop primer complying with performance requirements in SSPC-Paint 15.
- C. Primer: Provide shop primer that complies with Section 099123 "Painting".

2.3 JOIST ACCESSORIES

- A. Bridging: Provide bridging anchors and number of rows of horizontal or diagonal bridging of material, size, and type required by SJI's "Specifications" for type of joist, chord size, spacing, and span. Furnish additional erection bridging if required for stability.
- B. Bridging: Schematically indicated. Detail and fabricate according to SJI's "Specifications." Furnish additional erection bridging if required for stability.
- C. Furnish ceiling extensions, either extended bottom-chord elements or a separate extension unit of enough strength to support ceiling construction. Extend ends to within 1/2 inch (13 mm) of finished wall surface unless otherwise indicated.
- D. Carbon-Steel Bolts and Threaded Fasteners: ASTM A 307, Grade A (ASTM F 568M, Property Class 4.6), carbon-steel, hex-head bolts and threaded fasteners; carbon-steel nuts; and flat, unhardened steel washers.
 - 1. Finish: Hot-dip zinc coating, ASTM A 153/A 153M.
- E. High-Strength Bolts, Nuts, and Washers: ASTM A 325 (ASTM A 325M), Type 1, heavy hex steel structural bolts; ASTM A 563 (ASTM A 563M) heavy hex carbon-steel nuts; and ASTM F 436 (ASTM F 436M) hardened carbon-steel washers.
 - 1. Finish: Hot-dip zinc coating, ASTM A 153/A 153M, Class C.
- F. Furnish miscellaneous accessories including splice plates and bolts required by joist manufacturer to complete joist assembly.

2.4 CLEANING AND SHOP PAINTING

- A. Clean and remove loose scale, heavy rust, and other foreign materials from fabricated joists and accessories.
- B. Apply one coat of shop primer.
- C. Shop priming of joists and joist accessories is specified in Section 099123 "Painting".

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Do not install joists until supporting construction is in place and secured.
- B. Install joists and accessories plumb, square, and true to line; securely fasten to supporting construction according to SJI's "Specifications," joist manufacturer's written recommendations, and requirements in this Section.
 - 1. Before installation, splice joists delivered to Project site in more than one piece.
 - 2. Space, adjust, and align joists accurately in location before permanently fastening.
 - 3. Install temporary bracing and erection bridging, connections, and anchors to ensure that joists are stabilized during construction.
- C. Field weld joists to supporting steel bearing plates and framework. Coordinate welding sequence and procedure with placement of joists. Comply with AWS requirements and procedures for welding, appearance and quality of welds, and methods used in correcting welding work.
- D. Bolt joists to supporting steel framework using carbon-steel bolts.
- E. Bolt joists to supporting steel framework using high-strength structural bolts. Comply with Research Council on Structural Connection's "Specification for Structural Joints Using ASTM A 325 or ASTM A 490 Bolts" for high-strength structural bolt installation and tightening requirements.
- F. Install and connect bridging concurrently with joist erection, before construction loads are applied. Anchor ends of bridging lines at top and bottom chords if terminating at walls or beams.

3.2 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to inspect field welds and bolted connections and to perform field tests and inspections and prepare test and inspection reports.

END OF SECTION 052100

SECTION 053100
STEEL DECKING

PART 1 - GENERAL

1.01 SUMMARY

- A. Provide all labor, materials and equipment to construct roof deck, composite floor deck and noncomposite form deck as indicated and specified.

1.02 RELATED WORK

- A. MTA Specification Section 520: Structural Concrete
- B. Section 051200: Structural Steel Framing
- C. Section 052100: Steel Joist Framing
- D. Section 055000: Metal Fabrications
- E. Section 099123: Painting

1.03 REFERENCES: N/A

1.04 DEFINITIONS: N/A

1.05 SYSTEM DESCRIPTION: N/A

1.06 SUBMITTALS

- A. Product Data: For each type of deck, accessory, and product indicated.
- B. Shop Drawings: Include layout and types of deck panels, anchorage details, reinforcing channels, pans, deck openings, special jointing, accessories, and attachments to other construction.
- C. Product certificates.
- D. Welding certificates.

1.07 QUALITY ASSURANCE

- A. Provide specified herein.
- B. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code Steel," and AWS D1.3, "Structural Welding Code Sheet Steel."

- C. Fire Test Response Characteristics: Where indicated, provide steel deck units identical to those steel deck units tested for fire resistance per (ASTM) E119 by a testing and inspection agency acceptable to authorities having jurisdiction.
 - 1. Fire Resistance Ratings: Indicated by design designations from UL's "Fire Resistance Directory" or from the listings of another testing and inspecting agency.
 - 2. Steel deck units shall be identified with appropriate markings of applicable testing and inspecting agency.
- D. AISI Specifications: Calculate structural characteristics of steel deck according to AISI's "Specification for the Design of Cold-Formed Steel Structural Members."
- E. The Structural Engineer of Record will conduct a series of structural tests and inspections.

1.08 DELIVERY, STORAGE AND HANDLING

- A. Provide as specified herein.

1.09 PROJECT/SITE CONDITIONS: N/A

1.10 SEQUENCING AND SCHEDULING: N/A

PART 2 - PRODUCTS

2.01 ROOF DECK

- A. Steel Floor Deck: Fabricate panels, without top flange stiffening grooves, to comply with "SDI Specifications and Commentary for Steel Roof Deck," in SDI Publication No. 29.
 - 1. Galvanized and Shop Primed Steel Sheet: ASTM A 653/A 653M, Structural Steel (SS), Grade 33 (230), G60 (Z180) zinc coating; cleaned, pretreated, and primed with manufacturer's baked on, lead and chromate free rust inhibitive primer.
 - 2. Deck Profile: Type 3DR, deep rib.
 - 3. Profile Depth: 3 inches (76 mm).
 - 4. Design Uncoated Steel Thickness: 0.0598 inch (1.52 mm) as indicated.

2.02 ACCESSORIES

- A. Accessories: Steel deck manufacturer's standard accessory materials, including mechanical fasteners, closure strips, pour stops, and closures for deck.

- B. Galvanizing Repair Paint: ASTM A 780 with dry film containing a minimum of 94 percent zinc dust by weight.
- C. Repair Paint: Lead and chromate free rust inhibitive primer.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install deck panels and accessories according to applicable specifications and commentary in SDI Publication No. 29, manufacturer's written instructions, and requirements in this Section.
- B. Place deck panels on supporting frame and adjust to final position with ends accurately aligned and bearing on supporting frame before being permanently fastened. Do not stretch or contract side lap interlocks.
- C. Place deck panels flat and square and fasten to supporting frame without warp or deflection.
- D. Cut and neatly fit deck panels and accessories around openings and other work projecting through or adjacent to decking.
- E. Provide additional reinforcement and closure pieces at openings as required for strength, continuity of decking, and support of other work.
- F. Comply with AWS requirements and procedures for manual shielded metal arc welding, appearance and quality of welds, and methods used for correcting welding work.
 - 1. Mechanical fasteners may be used in lieu of welding to fasten deck. Locate mechanical fasteners and install according to deck manufacturer's written instructions.
- G. Pour Stops and Girder Fillers: Weld steel sheet pour stops and girder fillers to supporting structure according to SDI recommendations, unless otherwise indicated.
- H. Floor Deck Closures: Weld steel sheet column closures, cell closures, and Z closures to deck, according to SDI recommendations, to provide tight fitting closures at open ends of ribs and sides of decking. Weld cover plates at changes in direction of floor deck panels, unless otherwise indicated.

I. Repairs and Protection:

1. Galvanizing Repairs: Prepare and repair damaged galvanized coatings on both surfaces of deck with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.
2. Repair Painting: Wire brush and clean rust spots, welds, and abraded areas on both surfaces of prime painted deck immediately after installation, and apply repair paint.

3.02 FIELD QUALITY CONTROL

- A. Testing: The Owner's Representative will engage a qualified independent testing agency to perform field quality control testing.
- B. Field welds will be subject to inspection.
- C. Remove and replace work that does not comply with specified requirements.
- D. Additional testing and inspecting, at no additional cost to the owner, will be performed to determine compliance of corrected work with specified requirements.

3.03 CONTRACT CLOSEOUT

- A. Provide in accordance with Contract requirements.

END OF SECTION 053100

SECTION 055000
METAL FABRICATIONS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings, Contract Conditions and other Technical Sections apply to work of this Section insofar as applicable.
- B. Coordinate work with that of all other trades affecting, or affected by work of this Section. Cooperate with such trades to assure the steady progress of all Project work.

1.02 DESCRIPTION

- A. The work includes furnishing all materials, equipment, labor, supervision, design and drafting services, and fabricating, painting and performing all operations necessary to complete the metal fabrication work as shown on the Drawings, as specified herein, and as is additionally required to properly complete the work. Metal fabrication includes items made from iron, steel and aluminum shapes, plates, bars, strips, tubes, pipes and castings which are not specified elsewhere.
- B. Without in any way limiting the scope of work, the following major items are mentioned:
 - 1. Aluminum bar grating frame.
 - 2. Welded support fabrications.
 - 3. Various anchors for installing/setting in concrete and masonry.
 - 4. Lintels
 - 5. Shop painting of all ferrous items unless otherwise specified.

1.03 QUALITY ASSURANCE

- A. Codes and Standards: Comply with provisions of the following (latest edition including all amendments), except as otherwise indicated:

The State of Maine Building Code.

AISC "Code of Standard Practice for Steel Buildings and Bridges".

AWS D1.1 "Structural Welding Code".

ASCE-7 "Minimum Design Loads for Buildings and Other Structures".

NAAMM "Standard Specifications for Metal Bar Grating and Metal Bar Grating reads" and "Metal Bar Grating Manual".

- B. Qualifications for Welding Work: Qualify welding processes and welding operators in accordance with AWS "Standard Qualification Procedure". Provide certification that welders to be employed in work have satisfactorily passed AWS qualification tests.
- C. Field Measurements: Where possible, take field measurements prior to preparation of shop drawings and fabrication. Do not delay job progress; allow for field trimming and fitting where taking field measurements before fabrication might delay work.
- D. Shop Prefabrication/Assembly: Prefabricate/preassemble items in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.
- E. The work specified under this Section shall be performed by firms that have been engaged in the satisfactory manufacture and fabrication of work of the same type and magnitude as specified herein for a period of at least five years.

1.04 SUBMITTALS

- A. Product Data: Submit eight (8) copies of manufacturers' specifications, anchorage/installation details and installation instructions for products to be used in miscellaneous metal fabrications, including paint and grout products.
- B. Shop Drawings: Submit shop drawings for fabrication and erection of miscellaneous metal fabrications. Include plans, elevations, and details of sections and connections. Show anchorage and accessory items. Provide templates for anchor bolts, etc., to be installed by others.

Where materials or fabrications are indicated to comply with certain requirements for design loadings, include structural computations, material properties, and other information needed for structural analysis.

Any discrepancies in the Engineer's Drawings shall be brought to the attention of the Engineer for adjustment. The Contractor shall verify field dimensions with those dimensions given on the Engineer's Drawings, and obtain by measurement at the site all necessary dimensions and levels dependent on construction in-place.

Prior to submission of the shop drawings to the Engineer, they shall be pre-checked by the Contractor for conformity of detail with the Contract Documents and site conditions, and shall be coordinated with other work on the Project as necessary. The signature of a representative of the Contractor indicating that the shop drawings have been pre-checked will be required. The Contractor shall be wholly responsible for the conformity of dimensions and details of the shop drawings with the Contract Documents and site conditions.

After receipt of the shop drawings by the Engineer, they will be reviewed and necessary revisions will be marked on the sepias which will be returned to the Contractor. Revisions shall then be made and the shop drawings resubmitted. This procedure will be continued until the shop drawings are released for construction. The Contractor shall then deliver to the Engineer one transparency and three prints for his record and the use of his personnel.

At least one copy of each released shop drawing shall be kept available in the Contractor's field office; shop drawings not bearing evidence of release for construction by the Engineer shall not be kept on the job.

- C. Samples: Submit 2 sets of representative samples of materials and finished products. Also include a sample weld connection.
- D. Design Calculations: The Contractor shall provide written verification that a registered engineer in the State of Maine has designed connections to supporting structures, and all other structurally related items.

1.05 DELIVERY AND STORAGE

- A. Upon delivery to the jobsite or storage site, the miscellaneous metal fabrications shall be carefully unloaded and stacked at least 1 foot above the ground in such a manner as to provide ready surface drainage and adequate air circulation. All members exhibiting defective coatings, scars, abrasions, poor surface preparation, etc., shall be remedied by the Contractor to the satisfaction of the Engineer prior to placing items in storage or, if in the Engineer's opinion, such damaged items cannot be satisfactorily repaired, said items shall be promptly removed from the site and replaced with new items meeting the Engineer's satisfaction.
- B. Deliver items to the site in a sequence that will allow the work to proceed without delay but will avoid long term storage of items at the site.

PART 2 - MATERIALS

2.01 MATERIALS

- A. Metal Surfaces: For fabrication of miscellaneous metal work which will be exposed to view, use only materials which are smooth and free of surface blemishes, including pitting, seam marks, roller marks, rolled trade names and roughness.
- B. Steel Plates, Shapes and Bars: ASTM A 36.
- C. Aluminum: All structural extrusions shall be 6063-T6; all other extrusions shall be 6063-T5.
- D. Expansion Bolts: Stainless steel "Kwik Bolts" as manufactured by Hilti Fastening Systems or approved equal.

- E. Non-Shrink, Non-Metallic Grout: Pre-mixed, factory-packaged, non-staining, non-corrosive, non-gaseous grout complying with CRD-C621. Provide grout specifically recommended by manufacturer for interior and exterior applications required.
- F. Welding Rods: Conform to AWS Specification AWS D1.1.
- G. Fasteners:

Provide stainless steel fasteners for exterior use and where built into exterior walls. Only non-magnetic stainless steel fasteners and washers shall be used where the fastener or washer will be in contact with aluminum.
- H. Paint:

Metal Primer Paint: Except as otherwise noted, apply the following Tnemec primer, or approved equal by PPG, Devoe or DuPont to all non-galvanized ferrous surfaces.

Tnemec Series 10-99 Modified Alkyd Rust Inhibitive Primer, 3 dry mils, spray applied.
- I. Galvanizing Repair Paint: High zinc dust content paint for regalvanizing welds and abrasions in galvanized steel, complying with Military Specifications MIL-P-21035 (Ships).

2.02 FABRICATION

A. Workmanship:

Use materials of size and thickness indicated or, if not indicated, as required to produce strength and durability in finished products for the use intended, using proven and acceptable details of fabrication and support.

Form exposed work true to line and level with accurate angles and surfaces and straight sharp edges. Ease exposed edges to a radius of approximately 1/32 inch unless otherwise shown. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

Weld corners and seams continuously, complying with AWS recommendations. At exposed connections, grind exposed welds smooth and flush to match and blend with adjoining surfaces.

Provide for anchorage of type shown, coordinated with supporting structure. Fabricate and space anchoring devices to provide adequate support for intended use.

All holes indicated on the Drawings necessary for the installation of anchors shall be made as part of the work of this Section. No holes other than as indicated on the Drawings shall be drilled, punched or cut without the approval of the Engineer. Holes shall not be made by burning.

Material and workmanship shall at all times be subject to the approval of the Engineer.

Thickness of metal and details of assembly and anchors shall provide ample strength and stiffness with anchors concealed where possible. Provide waterproof joints where metal is exposed to the weather. Provide holes and connections for the work of other trades.

B. Codes and Regulations:

All fabrications intended for personnel walking, climbing, guarding and working surfaces, and the installation thereof, shall meet the requirements of the Department of Labor Occupational Safety and Health Standards and all State and local codes. In the event of conflicting requirements, the more stringent or conservative shall apply. All such work shall be stamped by a Professional Engineer registered in the State of Maine.

C. Galvanizing:

Provide a zinc coating for those items shown or specified to be galvanized, as follows:

ASTM A 153 for hot-dip galvanized iron and steel hardware.

ASTM A 123 for hot-dip galvanized iron and steel products.

D. Shop Painting:

Shop paint miscellaneous metal work, except surfaces and edges to be field welded, and galvanized surfaces, unless otherwise indicated. Shop paint the portions of embedded steel to be exposed, and for an additional 2 inches below the exposed portion. Surface preparation and painting shall be performed in accordance with all applicable requirements of Section 099123.

"Commercial Blast Clean" welded support fabrications in accordance with Steel Structures Painting Council (SSPC) SP-6. For ferrous items, clean off heavy rust, loose mill scale, other deleterious materials in accordance SSPC SP-3 "Power Tool Cleaning".

Remove oil, grease and similar contaminants in accordance with SSPC SP-1 "Solvent Cleaning" prior to performing any other surface preparation procedures.

Immediately after surface preparation, apply primer in accordance with manufacturer's instructions at a rate to provide a uniform dry film thickness of 3.0 dry mils. Use painting techniques which will result in full coverage of joints, corners, edges and all other surfaces.

Unless otherwise specifically indicated, apply one shop coat to all non-galvanized carbon steel fabricated items, except apply 2 coats of paint to surfaces inaccessible after assembly or erection. Change color of second coat to distinguish it from the first.

2.03 MISCELLANEOUS METAL FABRICATIONS

A. Rough Hardware:

Furnish conventional as well as bent or otherwise custom fabricated bolts, plates, anchors, hangers, dowels and other miscellaneous steel and iron shapes as required for framing, supporting, anchoring or securing items to concrete, masonry and other materials.

Fabricate items to sizes, shapes and dimensions required. Furnish steel washers for heads and nuts.

B. Miscellaneous Framing and Supports:

Provide miscellaneous steel framing and supports which are not specified elsewhere, as required to properly complete the work.

Fabricate miscellaneous units to sizes, shapes and profiles shown or, if not shown, of required dimensions to receive other work to be retained by framing. Fabricate from structural steel shapes, plates and bars of welded construction using mitered joints for field connections. Cut, drill and tap units as required. No burning of holes shall be allowed.

Hot dip galvanize all miscellaneous carbon steel frames, attachments, supports, etc., to be used in exterior applications and in exterior walls.

C. Aluminum Bar Grating:

Grating shall be pressure-locked type, 1 1/2 inch thick, with rectangular bearing bars. Fabricate grating to be flat, without warp, sized to fit in the utility pit recessed galvanized steel frame. Undercut grating 3/16 inch in both directions to facilitate periodic removal and reinstallation.

D. Brackets, Flanges, Fittings and Anchors:

Provide all types of brackets, closures, flanges, miscellaneous fittings and anchors which are not provided under other specification sections as necessary for the proper completion of the work.

Hot dip galvanize carbon steel members, fittings, brackets, fasteners, and other components for exterior applications and when used in and on exterior walls.

E. Loose Bearing Plates:

Provide loose bearing plates for steel items bearing on masonry or concrete construction, made flat, free from warps and twists, and of required thickness and

bearing area. Drill plates to receive anchors and for grouting as required. Galvanize after fabrication.

PART 3 - EXECUTION

3.01 PREPARATION

Coordinate and furnish anchorages, setting drawings, diagrams, templates, instructions, and directions for installation of anchorages, such as concrete inserts, sleeves, anchor bolts and miscellaneous items having integral anchors which are to be embedded in concrete or masonry construction. Coordinate delivery of such items to work performed at the site.

3.02 INSTALLATION

A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing miscellaneous metal fabrications to in-place construction; including expansion anchors, anchor bolts, toggle bolts, through-bolts, lag bolts, wood screws and other connectors, as required. Only expansion anchors are to be used for attaching items to masonry. All fasteners for exterior construction shall be Type 304 or 316 stainless steel.

B. Cutting, Fitting and Placement: The Contractor shall perform all measuring, detailing, cutting, drilling and fitting required to install miscellaneous metal fabrications. Set work accurately in location, alignment and elevation, plumb, level, true and free of rack, measured from verified established lines and levels. Provide temporary bracing or anchors in formwork for items which are to be built into concrete, masonry or similar construction.

Fit exposed connections accurately together to form tight hairline joints. Field weld connections which cannot be shop welded because of shipping size limitations. Grind exposed joints smooth and touch-up shop paint coat and galvanizing. Do not weld, cut or abrade the surfaces of exterior units which have been hot-dip galvanized after fabrication and are intended for bolted or screwed field connections.

C. Field Welding: Comply with AWS Code for procedures of manual shielded metal-arc welding, appearance and quality of welds made, and methods used in correcting welding work.

D. Setting Loose Bearing Plates:

Clean concrete and masonry bearing surfaces and roughen to improve bond to surfaces. Clean bottom surface of bearing plates.

Set loose bearing plates on wedges. Position bearing members and tighten the anchor bolts. Do not remove wedges but cut-off flush with the edge. Use non-metallic, non-shrink grout, unless otherwise indicated.

Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

3.03 ADJUST AND CLEAN

- A. Restore finishes damaged during installation so that no evidence remains of corrective work.
- B. Touch-Up Painting: Immediately after erection, power tool clean in accordance with SSPC SP-3, field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with same material as used for shop painting. Apply by brush or spray to provide a minimum thickness of 2.0 dry mils of modified alkyd primer.
- C. For Galvanized Surfaces: Thoroughly clean field welds, bolted connections and abraded areas and apply 2 coats of approved galvanizing repair compound.
- D. Restore aluminum finishes as directed by the fabricator and approved by the Resident.

END OF SECTION 055000

SECTION 055113
METAL PAN STAIRS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings, Contract Conditions and other Technical Sections apply to work of this Section insofar as applicable.
- B. Coordinate work with that of all other trades affecting, or affected by work of this Section. Cooperate with such trades to assure the steady progress of all Project work.

1.2 SUMMARY

- A. Section Includes:
 - 1. Preassembled steel stairs with concrete-filled treads.
 - 2. Steel tube railings attached to metal stairs.
 - 3. Steel tube handrails attached to walls adjacent to metal stairs.
- B. Related Requirements:
 - 1. Section 033000 "Cast-in-Place Concrete" for concrete fill for stair treads and platforms.
 - 2. Section 055213 "Pipe and Tube Railings" for pipe and tube railings.

1.3 COORDINATION

- A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.
- B. Coordinate installation of anchorages for metal stairs. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.
- C. Coordinate locations of hanger rods and struts with other work so that they do not encroach on required stair width and are within the fire-resistance-rated stair enclosure.

1.4 ACTION SUBMITTALS

- A. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1.5 INFORMATIONAL SUBMITTALS

- A. Welding certificates.
- B. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers certifying that shop primers are compatible with topcoats.

1.6 QUALITY ASSURANCE

- A. Installer Qualifications: Fabricator of products.
- B. Welding Qualifications: Qualify procedures and personnel according to the following:
 - 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
 - 2. AWS D1.3/D1.3M, "Structural Welding Code - Sheet Steel."

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Structural Performance of Stairs: Metal stairs shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
 - 1. Uniform Load: 100 lbf/sq. ft.
 - 2. Concentrated Load: 300 lb applied on an area of 4 sq. in.
 - 3. Uniform and concentrated loads need not be assumed to act concurrently.
 - 4. Stair Framing: Capable of withstanding stresses resulting from railing loads in addition to loads specified above.
 - 5. Limit deflection of treads, platforms, and framing members to $L/360$ or 1/4 inch, whichever is less.
- B. Structural Performance of Railings: Railings shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
 - 1. Handrails and Top Rails of Guards:
 - a. Uniform load of 50 lb/ft applied in any direction.
 - b. Concentrated load of 200 lb applied in any direction.
 - c. Uniform and concentrated loads need not be assumed to act concurrently.

C. Seismic Performance of Stairs: Metal stairs shall withstand the effects of earthquake motions determined according to ASCE/SEI 7

1. Component Importance Factor: 1.5.

2.2 METALS

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

B. Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

C. Steel Tubing: ASTM A 500 (cold formed) or ASTM A 513.

D. Uncoated Hot-Rolled Steel Sheet: ASTM A 1011/A 1011M, either commercial steel, Type B, or structural steel, Grade 30 (Grade 205), unless another grade is required by design loads.

2.3 FASTENERS

A. General: Provide zinc-plated fasteners with coating complying with ASTM B 633 or ASTM F 1941 Class Fe/Zn 12 for exterior use, and Class Fe/Zn 5 where built into exterior walls. Select fasteners for type, grade, and class required.

B. Bolts and Nuts: Regular hexagon-head bolts, ASTM A 307, Grade A with hex nuts, ASTM A 563 and, where indicated, flat washers.

C. Anchor Bolts: ASTM F 1554, Grade 36, of dimensions indicated; with nuts, ASTM A 563 and, where indicated, flat washers.

1. Provide mechanically deposited or hot-dip, zinc-coated anchor bolts for exterior stairs

D. Post-Installed Anchors: Torque-controlled expansion anchors or chemical anchors capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488/E 488M, conducted by a qualified independent testing agency.

1. Material for Interior Locations: Carbon-steel components zinc plated to comply with ASTM B 633 or ASTM F 1941 Class Fe/Zn 5, unless otherwise indicated.

2. Material for Exterior Locations and Where Stainless Steel Is Indicated: Alloy Group 1 or Group 2 stainless-steel bolts, ASTM F 593, and nuts, ASTM F 594.

2.4 MISCELLANEOUS MATERIALS

- A. Shop Primers: Provide primers that comply with Section 099123 "Painting".
- B. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.
 - 1. Use primer containing pigments that make it easily distinguishable from zinc-rich primer.
- C. Shop Primer for Galvanized Steel: Primer formulated for exterior use over zinc-coated metal and compatible with finish paint systems indicated.
- D. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.
- E. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187/D 1187M.
- F. Concrete Materials and Properties: Comply with requirements in Section 033000 "Cast-in-Place Concrete" for normal-weight, air-entrained, ready-mix concrete with a minimum 28-day compressive strength of 3000 psi unless otherwise indicated.
- G. Welded Wire Reinforcement: ASTM A 185/A 185M, 6 by 6 inches W1.4 by W1.4, unless otherwise indicated.

2.5 FABRICATION, GENERAL

- A. Provide complete stair assemblies, including metal framing, hangers, struts, clips, brackets, bearing plates, and other components necessary to support and anchor stairs and platforms on supporting structure.
 - 1. Join components by welding unless otherwise indicated.
 - 2. Use connections that maintain structural value of joined pieces.
- B. Preassembled Stairs: Assemble stairs in shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation.
- C. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
- D. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.
- E. Form exposed work with accurate angles and surfaces and straight edges.

- F. Weld connections to comply with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. Weld exposed corners and seams continuously unless otherwise indicated.
- G. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) screws or bolts unless otherwise indicated. Locate joints where least conspicuous.

2.6 STEEL-FRAMED STAIRS

- A. NAAMM Stair Standard: Comply with "Recommended Voluntary Minimum Standards for Fixed Metal Stairs" in NAAMM AMP 510, "Metal Stairs Manual," Commercial Class, unless more stringent requirements are indicated.
- B. Stair Framing:
 - 1. Fabricate stringers of steel plates or channels.
 - a. Provide closures for exposed ends of channel stringers.
 - 2. Construct platforms of steel plate or channel headers and miscellaneous framing members as needed to comply with performance requirements.
 - 3. Weld or bolt stringers to headers; weld or bolt framing members to stringers and headers. If using bolts, fabricate and join so bolts are not exposed on finished surfaces.
 - 4. Where stairs are enclosed by gypsum board or shaft-wall assemblies, provide hanger rods or struts to support landings from floor construction above or below. Locate hanger rods and struts where they do not encroach on required stair width and are within the fire-resistance-rated stair enclosure.
- C. Metal Pan Stairs: Form risers, subtread pans, and subplatforms to configurations shown from steel sheet of thickness needed to comply with performance requirements, but not less than 0.067 inch.
 - 1. Steel Sheet: Uncoated hot-rolled steel sheet unless otherwise indicated.
 - 2. Directly weld metal pans to stringers; locate welds on top of subtreads where they are concealed by concrete fill. Do not weld risers to stringers.
 - 3. Attach risers and subtreads to stringers with brackets made of steel angles or bars. Weld brackets to stringers and attach metal pans to brackets by welding, riveting, or bolting.
 - 4. Shape metal pans to include nosing integral with riser.
 - 5. Attach abrasive nosings to risers.

6. At Contractor's option, provide stair assemblies with metal pan subtreads filled with reinforced concrete during fabrication.
7. Provide subplatforms of configuration indicated or, if not indicated, the same as subtreads. Weld subplatforms to platform framing.

2.7 STAIR RAILINGS

- A. Comply with applicable requirements in Section 055213 "Pipe and Tube Railings."
 1. Fabricate newels of square steel tubing and provide newel caps of pressed steel as shown.
 2. Rails may be bent at corners, rail returns, and wall returns, instead of using prefabricated fittings.
 3. Connect posts to stair framing by direct welding unless otherwise indicated.
- B. Steel Tube Railings: Fabricate railings to comply with requirements indicated for design, dimensions, details, finish, and member sizes, including wall thickness of tube, post spacings, and anchorage, but not less than that needed to withstand indicated loads.
 1. Rails and Posts: 1-5/8-inch diameter or 1-1/2-inch square top and bottom rails and 1-1/2 inch square posts.
 2. Picket Infill: 1/2-inch round or square pickets spaced less than 4 inches (100 mm) clear.
 3. Intermediate Rails Infill: 1-5/8-inch diameter or 1-1/2-inch square intermediate rails.
- C. Welded Connections: Fabricate railings with welded connections. Cope components at connections to provide close fit, or use fittings designed for this purpose. Weld all around at connections, including at fittings.
- D. Form changes in direction of railings as follows:
 1. As detailed.
- E. For changes in direction made by bending, use jigs to produce uniform curvature for each repetitive configuration required. Maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of components.
- F. Close exposed ends of railing members with prefabricated end fittings.
- G. Provide wall returns at ends of wall-mounted handrails unless otherwise indicated. Close ends of returns unless clearance between end of rail and wall is 1/4 inch or less.
- H. Connect posts to stair framing by direct welding unless otherwise indicated.

- I. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, end closures, flanges, miscellaneous fittings, and anchors for interconnecting components and for attaching to other work. Furnish inserts and other anchorage devices for connecting to concrete or masonry work.
 - 1. For galvanized railings, provide galvanized fittings, brackets, fasteners, sleeves, and other ferrous-metal components.
 - 2. For nongalvanized railings, provide nongalvanized ferrous-metal fittings, brackets, fasteners, and sleeves, except galvanize anchors embedded in exterior masonry and concrete construction.
 - 3. Provide type of bracket that provides 1-1/2-inch clearance from inside face of handrail to finished wall surface.
- J. Fillers: Provide fillers made from steel plate, or other suitably crush-resistant material, where needed to transfer wall bracket loads through wall finishes to structural supports. Size fillers to suit wall finish thicknesses and to produce adequate bearing area to prevent bracket rotation and overstressing of substrate.

2.8 FINISHES

- A. Finish metal stairs after assembly.
- B. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A 153/A 153M for steel and iron hardware and with ASTM A 123/A 123M for other steel and iron products.
 - 1. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.
 - 2. Fill vent and drain holes that are exposed in the finished Work, unless indicated to remain as weep holes, by plugging with zinc solder and filing off smooth.
- C. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with SSPC-SP 3, "Power Tool Cleaning."
- D. Apply shop primer to uncoated surfaces of metal stair components, except those with galvanized finishes and those to be embedded in concrete or masonry unless otherwise indicated. Comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

PART 3 - EXECUTION

3.1 INSTALLING METAL PAN STAIRS

- A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing metal stairs to in-place construction. Include threaded

fasteners for concrete and masonry inserts, through-bolts, lag bolts, and other connectors.

- B. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal stairs. Set units accurately in location, alignment, and elevation, measured from established lines and levels and free of rack.
- C. Install metal stairs by welding stair framing to steel structure or to weld plates cast into concrete unless otherwise indicated.
- D. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.
- E. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.
- F. Field Welding: Comply with requirements for welding in "Fabrication, General" Article.
- G. Place and finish concrete fill for treads and platforms to comply with Section 033000 "Cast-in-Place Concrete."
- 1. Install abrasive nosings with anchors fully embedded in concrete. Center nosings on tread width.
- H. Install precast concrete treads with adhesive supplied by manufacturer.

3.2 INSTALLING RAILINGS

- A. Adjust railing systems before anchoring to ensure matching alignment at abutting joints. Space posts at spacing indicated or, if not indicated, as required by design loads. Plumb posts in each direction. Secure posts and rail ends to building construction as follows:
 - 1. Anchor posts to steel by welding or bolting to steel supporting members.
 - 2. Anchor handrail ends to concrete and masonry with steel round flanges welded to rail ends and anchored with postinstalled anchors and bolts.
- B. Attach handrails to wall with wall brackets. Locate brackets as indicated or, if not indicated, at spacing required to support structural loads. Secure wall brackets to building construction as follows:
 - 1. For concrete and solid masonry anchorage, use drilled-in expansion shields and hanger or lag bolts.
 - 2. For hollow masonry anchorage, use toggle bolts.

3. For wood stud partitions, use hanger or lag bolts set into studs or wood backing between studs. Coordinate with carpentry work to locate backing members.
4. For steel-framed partitions, use hanger or lag bolts set into wood backing between studs. Coordinate with stud installation to locate backing members.
5. For steel-framed partitions, use self-tapping screws fastened to steel framing or to concealed steel reinforcements.
6. For steel-framed partitions, use toggle bolts installed through flanges of steel framing or through concealed steel reinforcements.

3.3 ADJUSTING AND CLEANING

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

END OF SECTION 055113

SECTION 055213
PIPE AND TUBE RAILINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings, Contract Conditions and other Technical Sections apply to work of this Section insofar as applicable.
- B. Coordinate work with that of all other trades affecting, or affected by work of this Section. Cooperate with such trades to assure the steady progress of all Project work.

1.2 SUMMARY

- A. Section Includes:
 - 1. Steel pipe and tube railings.
- B. Related Requirements:
 - 1. Section 055113 "Metal Pan Stairs" for steel tube railings associated with metal pan stairs.

1.3 COORDINATION

- A. Coordinate selection of shop primers with topcoats to be applied over them. Comply with paint and coating manufacturers' written recommendations to ensure that shop primers and topcoats are compatible with one another.
- B. Coordinate installation of anchorages for railings. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.
- C. Schedule installation so wall attachments are made only to completed walls. Do not support railings temporarily by any means that do not satisfy structural performance requirements.

1.4 ACTION SUBMITTALS

- A. Product Data: For the following:
 - 1. Manufacturer's product lines of mechanically connected railings.
 - 2. Railing brackets.
 - 3. Grout, anchoring cement, and paint products.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

- C. Delegated-Design Submittal: For railings, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For testing agency.
- B. Welding certificates.
- C. Paint Compatibility Certificates: From manufacturers of topcoats applied over shop primers certifying that shop primers are compatible with topcoats.
- D. Product Test Reports: For pipe and tube railings, for tests performed by a qualified testing agency, according to ASTM E 894 and ASTM E 935.
- E. Evaluation Reports: For post-installed anchors, from ICC-ES.

1.6 QUALITY ASSURANCE

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

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

1.8 FIELD CONDITIONS

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

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Source Limitations: Obtain each type of railing from single source from single manufacturer.

2.2 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Railings, including attachment to building construction, shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

1. Handrails and Top Rails of Guards:
 - a. Uniform load of 50 lbf/ ft. applied in any direction.
 - b. Concentrated load of 200 lbf applied in any direction.
 - c. Uniform and concentrated loads need not be assumed to act concurrently.
2. Infill of Guards:
 - a. Concentrated load of 50 lbf applied horizontally on an area of 1 sq. ft.
 - b. Infill load and other loads need not be assumed to act concurrently.

B. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.

1. Temperature Change: 120 deg F, ambient; 180 deg F.

2.3 METALS, GENERAL

A. Metal Surfaces, General: Provide materials with smooth surfaces, without seam marks, roller marks, rolled trade names, stains, discolorations, or blemishes.

2.4 STEEL AND IRON

A. Pipe: ASTM A 53/A 53M, Type F or Type S, Grade A, Standard Weight (Schedule 40), unless another grade and weight are required by structural loads.

1. Provide galvanized finish for exterior installations and where indicated.

B. Plates, Shapes, and Bars: ASTM A 36/A 36M.

2.5 FASTENERS

A. General: Provide the following:

1. Hot-Dip Galvanized Railings: Type 304 stainless-steel or hot-dip zinc-coated steel fasteners complying with ASTM A 153/A 153M or ASTM F 2329 for zinc coating.
2. Provide exposed fasteners with finish matching appearance, including color and texture, of railings.

B. Fasteners for Anchoring Railings to Other Construction: Select fasteners of type, grade, and class required to produce connections suitable for anchoring railings to other types of construction indicated and capable of withstanding design loads.

C. Fasteners for Interconnecting Railing Components:

1. Provide concealed fasteners for interconnecting railing components and for attaching them to other work, unless exposed fasteners are unavoidable or are the standard fastening method for railings indicated.

- D. Post-Installed Anchors: chemical anchors capable of sustaining, without failure, a load equal to 4 times the load imposed when installed in concrete, as determined by testing according to ASTM E 488/E 488M, conducted by a qualified independent testing agency.
 - 1. Material for Exterior Locations: Alloy Group 1 stainless-steel bolts, ASTM F 593, and nuts, ASTM F 594.

2.6 MISCELLANEOUS MATERIALS

- A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.
- B. Low-Emitting Materials: Paints and coatings shall comply with the testing and product requirements of the California Department of Public Health's (formerly, the California Department of Health Services') "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- C. Etching Cleaner for Galvanized Metal: Complying with MPI#25.
- D. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.
- E. Shop Primer for Galvanized Steel: Primer formulated for exterior use over zinc-coated metal and compatible with finish paint systems indicated.
- F. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107/C 1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.
- G. Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with water at Project site to create pourable anchoring, patching, and grouting compound.
 - 1. Water-Resistant Product: At exterior locations provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating and that is recommended by manufacturer for exterior use.

2.7 FABRICATION

- A. General: Fabricate railings to comply with requirements indicated for design, dimensions, member sizes and spacing, details, finish, and anchorage, but not less than that required to support structural loads.
- B. Shop assemble railings to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation. Use connections that maintain structural value of joined pieces.

- C. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
- D. Form work true to line and level with accurate angles and surfaces.
- E. Fabricate connections that are exposed to weather in a manner that excludes water. Provide weep holes where water may accumulate.
- F. Cut, reinforce, drill, and tap as indicated to receive finish hardware, screws, and similar items.
- G. Connections: Fabricate railings with either welded or nonwelded connections unless otherwise indicated.
- H. Welded Connections: Cope components at connections to provide close fit, or use fittings designed for this purpose. Weld all around at connections, including at fittings.
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove flux immediately.
 - 4. At exposed connections, finish exposed surfaces smooth and blended so no roughness shows after finishing and welded surface matches contours of adjoining surfaces.
- I. Welded Connections for Aluminum Pipe: Fabricate railings to interconnect members with concealed internal welds that eliminate surface grinding, using manufacturer's standard system of sleeve and socket fittings.
- J. Nonwelded Connections: Connect members with concealed mechanical fasteners and fittings. Fabricate members and fittings to produce flush, smooth, rigid, hairline joints.
 - 1. Fabricate splice joints for field connection using an epoxy structural adhesive if this is manufacturer's standard splicing method.
- K. Form Changes in Direction as Follows:
 - 1. As detailed.
- L. For changes in direction made by bending, use jigs to produce uniform curvature for each repetitive configuration required. Maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of components.
- M. Close exposed ends of railing members with prefabricated end fittings.
- N. Brackets, Flanges, Fittings, and Anchors: Provide flanges, miscellaneous fittings, and anchors to interconnect railing members to other work unless otherwise indicated.
- O. Provide anchorage devices for connecting railings to concrete work. Fabricate anchorage devices capable of withstanding loads imposed by railings. Coordinate anchorage devices with supporting structure.

2.8 STEEL AND IRON FINISHES

A. Galvanized Railings:

1. Hot-dip galvanize exterior steel railings, including hardware, after fabrication.
2. Comply with ASTM A 123/A 123M for hot-dip galvanized railings.
3. Comply with ASTM A 153/A 153M for hot-dip galvanized hardware.
4. Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.
5. Fill vent and drain holes that are exposed in the finished Work, unless indicated to remain as weep holes, by plugging with zinc solder and filing off smooth.

B. For galvanized railings, provide hot-dip galvanized fittings, brackets, fasteners, sleeves, and other ferrous components.

C. Preparing Galvanized Railings for Shop Priming: After galvanizing, thoroughly clean railings of grease, dirt, oil, flux, and other foreign matter, and treat with etching cleaner.

PART 3 - EXECUTION

3.1 EXAMINATION

- #### A. Examine plaster and gypsum board assemblies, where reinforced to receive anchors, to verify that locations of concealed reinforcements are clearly marked for Installer. Locate reinforcements and mark locations if not already done.

3.2 INSTALLATION, GENERAL

- #### A. Fit exposed connections together to form tight, hairline joints.

- #### B. Perform cutting, drilling, and fitting required for installing railings. Set railings accurately in location, alignment, and elevation; measured from established lines and levels and free of rack.

1. Do not weld, cut, or abrade surfaces of railing components that are coated or finished after fabrication and that are intended for field connection by mechanical or other means without further cutting or fitting.
2. Set posts plumb within a tolerance of 1/16 inch in 3 feet.

- #### C. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

1. Coat, with a heavy coat of bituminous paint, concealed surfaces of aluminum that are in contact with grout, concrete, masonry, wood, or dissimilar metals.

- #### D. Adjust railings before anchoring to ensure matching alignment at abutting joints.

- #### E. Fastening to In-Place Construction: Use anchorage devices and fasteners where necessary for securing railings and for properly transferring loads to in-place construction.

3.3 RAILING CONNECTIONS

- A. Nonwelded Connections: Use mechanical or adhesive joints for permanently connecting railing components. Seal recessed holes of exposed locking screws using plastic cement filler colored to match finish of railings.
- B. Welded Connections: Use fully welded joints for permanently connecting railing components. Comply with requirements for welded connections in "Fabrication" Article whether welding is performed in the shop or in the field.

3.4 ANCHORING POSTS

- A. Anchor posts to concrete roof decks with base plates pre-welded to the rail posts. Use chemical anchors for attachment of bearing plates to concrete.

3.5 ADJUSTING AND CLEANING

- A. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas, and repair galvanizing to comply with ASTM A 780/A 780M.

3.6 PROTECTION

- A. Protect finishes of railings from damage during construction period with temporary protective coverings approved by railing manufacturer. Remove protective coverings at time of Substantial Completion.

END OF SECTION 055213

SECTION 061000
ROUGH CARPENTRY

PART 1 - DESCRIPTION

1.01 RELATED DOCUMENTS

- A. Drawings, Contract Conditions and other Technical Specifications Sections apply to work of this Section insofar as applicable.
- B. Coordinate work with that of all other trades affecting, or affected by work of this Section. Cooperate with such trades to assure the steady progress of all Project work.

1.02 DESCRIPTION

- A. The work in this section consists of furnishing all materials, equipment, supplies, transportation, labor and supervision, and performing all operations required to perform all rough carpentry work as shown on the Drawings, as specified herein, and as is additionally necessary to properly complete the work. Work includes, but is not limited to, the following:
 - 1. Structural and rough wood framing.
 - 2. Roof trusses and roof framing, including all blocking, outriggers, etc.
 - 3. Soffit, fascia and rake framing.
 - 4. Rough hardware.
 - 5. Gable and overhang framing and sheathing.
 - 6. Roof sheathing.
 - 7. Insulation stops.
 - 8. Wood for other trades (i.e., blocking, nailers, grounds, etc.).
 - 9. Wood blocking required at back of fire extinguishers, electric panels, telephone panels, motor operators, wall stops, windows, toilet accessories, etc.
 - 10. Temporary protection as required.

1.03 SPECIFIED ELSEWHERE

- A. The installation of door hardware is specified in Section 087100.
- B. Finish carpentry items such as soffits, cabinets, shelving, standing and running trim, exterior trim, window stools, etc., are specified in Section 062013.

1.04 SHOP DRAWINGS

- A. Submit copies of shop drawings and manufacturer's product data for approval.
- B. Submit shop drawings of trusses showing all necessary design details and calculations, stamped by a professional structural engineer licensed in the State of Maine. Also include jobsite storage instructions and details for a continuous insulation stop at all eaves. The Contractor shall furnish and install insulation stops even though they are not shown on the Resident's Drawings.
- C. Submit 18 inch long samples of wood to be used for each element (i.e., trusses, fasciae, rakes, etc.) for approval. Also submit 24 inch square samples of panel products and each rough hardware item (sheathing clips; metal hangers, straps and gussets; etc.) for approval.

1.05 GENERAL

- A. All lumber shall be new, dressed on all sides (S4S), and shall conform to U.S. Department of Commerce Simplified Practice Recommendation R16. Lumber for the various uses shall have characteristics appropriate for the intended use.
- B. All lumber and plywood in contact with the ground, concrete, or exposed to the weather shall be preservative treated as specified herein and as indicated on the drawings.
- C. Obtain measurements and verify dimensions shown on shop drawing details before proceeding with carpentry work, wherever possible.
- D. Correlate the location of furring, nailers, blocking, grounds and similar supports so that attached work will comply with design requirements.
- E. Fit carpentry work to other work. Scribe and cope as required for accurate fit.
- F. Time delivery and installation of carpentry work to avoid delaying other work which is dependent on or affected by the carpentry work and to comply with protection and storage requirements.
- G. Keep carpentry materials dry during transport and storage. Store lumber and plywood in stacks with provision for air circulation within stacks. Protect exposed materials against weather. Do not store dressed or treated lumber or plywood outdoors. Store trusses in accordance with the manufacturer's approved instructions and recommendations.

PART 2 - MATERIALS

2.01 STRUCTURAL FRAMING

- A. Structural framing, including plates, rafters, outlookers, bracing, blocking, etc., shall be kiln-dried Hem-Fir, No. 1 or better, free of loose knots and other defects that would impair its strength.

2.02 ROOF TRUSSES AND FRAMING

- A. The wood trusses and roof framing shall be designed and manufactured by Wood Structures, Inc., of Biddeford, Maine, or approved equal. The top and bottom cords of the trusses shall be a minimum of 2" x 6", as shown. (Coordinate with duct work which may impact the design of trusses and framing.) Provide gussets and extensions as indicated and required.
- B. The trusses shall be factory fabricated with adequate plant and under supervision of properly qualified personnel.
- C. The trusses shall be assembled with built-in camber and ready for site erection. All members shall be precision cut and assembled in a jig to ensure uniformity with all gusset plates accurately positioned.
- D. Metal gusset plates shall be 20 gauge hot-dip galvanized plates perforated with punched teeth. Plate design values shall be as approved by FHA.
- E. The fabricator of the trusses shall furnish steel connections and hardware for joining timber members to each other and to their supports exclusive of anchorages embedded in masonry. Such hardware shall conform to the details shown on the Drawings or the approved shop drawings. Hardware items shall have one coat of shop applied premium grade primer containing a rust inhibitor. All exposed connections to be hot-dip galvanized.

2.03 ROUGH HARDWARE

- A. Anchors, bolts, nuts, and miscellaneous metal items shall conform to requirements of Federal Specifications FF-B-575. Fastenings for exterior construction shall be hot-dip galvanized.
- B. Framing connectors, joist hangers, straps, metal bridging, etc., shall be as manufactured by TECO Timber Engineering Co., Heckman Building Products Inc., or Simpson Strong Tie Connectors, hot dip galvanized in accordance with ASTM A 123 or A 153, as applicable.

2.04 SHEATHING, DECKING AND MISCELLANEOUS PLYWOOD

- A. Sheathing shall be "Exterior" APA Performance - Rated Panels (C-D Exterior PS-1), 5/8 inch thick unless otherwise noted. Provide sheathing clips between panels for all joint areas not over framing.
- B. Miscellaneous plywood for interior applications, such as electric panel backing boards, shall be Interior DFPA C-D with exterior glue.

2.05 SOFFITS, FASCIAE AND RAKES

- A. Fasciae, fasciae moldings, rakes, and rake moldings shall be preservative treated custom grade solid Hem-Fir selected for its clear appearance, free of loose knots, large knots, pitch streaks, cupping, etc., subject to approval by the Engineer, fabricated to the shapes shown on the Drawings.
- B. Soffits shall be sheathed with ½" thick preservative treated plywood prior to installation of PVC finish panels.

2.06 FURRING

- A. Furring shall be No. 1 Common Eastern Spruce of the sizes noted on the Drawings.

2.07 WOOD PRESERVATIVE

- A. Preservative Treatment: Lumber and plywood shall be treated with preservatives in compliance with applicable requirements of AWPB Standards C2 (Lumber) and C9 (Plywood) and of AWPB standards listed below. Mark each treated item with the AWPB Quality Mark.
 - 1. Pressure-treat above-ground items with water-borne preservatives complying with AWPB LP-2. After treatment, kiln-dry to a maximum moisture content of 15 percent. Treat indicated items and the following:
 - a. Wood cants, nailers, curbs, blocking, stripping, and similar members in connection with roofing, flashing, vapor retarders and waterproofing.
 - b. Wood sleepers, blocking, furring, stripping and similar concealed members in contact with masonry or concrete.
 - c. Wood framing members less than 18 inches above grade.
 - 2. Pressure-treat wood members in contact with ground with water-borne preservatives complying with AWPB LP-22:
 - 3. Complete fabrication of items to be treated prior to treatment, where possible. If members are cut, drilled or otherwise altered after treatment, coat the affected surfaces with two heavy brush coats of same chemical used for treatment. Inspect

each piece of lumber or plywood after drying and discard damaged and defective pieces.

2.08 NAILS

- A. All nails for framing, sheathing, fasciae, gables and all other exterior applications shall be "double" hot dipped galvanized equal to those provided by Maze Nails, Peru, IL.

PART 3 - CONSTRUCTION METHODS

3.01 INSTALLATION

- A. Do all carpentry work required, lay out all lines, provide necessary measurements, and furnish all needed assistance in cooperation with the various trades to insure that the work is thoroughly and satisfactorily completed.
- B. Anchor framing members to timber, concrete, and masonry as indicated. All rough carpentry shall be laid out as called for on the Drawings. Cut framing square on bearings, closely fitted, accurately set to required lines and levels, plumb, and secured rigidly in place at bearings and connections.
- C. All carpentry shall be performed by workmen skilled in the trade. Lines shall be run true and accurate for support of finish carpentry and other applied finishes.
- D. Provide all temporary bracing as required. Maintain OSHA approved ladders at all times for convenient and safe access to all portions of the building.
- E. Set trusses plumb, straight and on accurate spacing as shown on the approved Shop Drawings. Use great care in erection to avoid flexing of trusses in the weak direction. Brace trusses temporarily with substantial bracing to prevent falling and distortion from wind and other causes.
- F. Frame members for passage of pipes and ducts to avoid cutting structural members. Do not cut, notch or bore members for passage of pipes or wiring without permission of the Resident. Reinforce framing members as directed where damaged or weakened by approved cutting.
- G. Nail or spike members in accordance with National Lumber Manufacturer's Association Manual for House Framing.
- H. Apply roof sheathing sheets with face grain perpendicular to the rafters and trusses. All end joints shall be on rafters/trusses and shall be staggered. Use a minimum of two (2) sheathing clips to join edges between trusses. Secure sheathing with 8d galvanized nails at 6 inch centers along panel edges, at 12 inch centers at intermediate trusses. Install floor decking in accordance with APA recommendations but with not less than one fastener 6 inches on center at edges and one fastener 12 inches on center over supports.

- I. Exterior woodwork shall be provided in the longest practicable lengths to minimize joints. Joints shall be hairline; mitered, scarfed or dadoed, as proposed by the Contractor and approved by the Resident. Joints in running material shall occur only over supports. Exposed mill ends are not acceptable. Drilled holes, cut-outs, cut edges and ends, and other alterations made after preservative treatment shall be sealed before installation.
- K. Provide temporary wood protection for concrete, at trucking points, at entrances, over floor openings, at metal door bucks, and at finished woodwork and millwork, until completion and acceptance of the work.
- L. Provide temporary supports and wood centering as required.

END OF SECTION 061000

SECTION 061753
SHOP-FABRICATED WOOD TRUSSES

PART 1 GENERAL

1.01 SUMMARY

A. Work Included:

1. Designing, fabricating, supplying, and erecting wood trusses including steel connectors, gussets, and fasteners, galvanized.
2. Furnishing and installing lateral support of trusses as required.

1.02 RELATED WORK

- A. Section 042000 – Unit Masonry, General
- B. Section 061000 – Rought Carpentry

1.03 REFERENCES

- A. ASTM Standards. The following standards of the American Society for Testing and Materials form a part of these Specifications. Unless otherwise specified, materials and methods of test shall conform to ASTM Standards.

1. A 90 Weight of Coating on Zinc-Coated (Galvanized) Iron or Steel Articles
2. A25 General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by the Hot-Dip Process
3. E 84 Standard Test Method for Surface Burning Characteristics of Building Materials

- B. Miscellaneous Standards. The following standards form a part of these Specifications.

1. NFPA (National Forest Products Association) - National Design Specification for Stress Grade Lumber and Its Fastenings
2. PS (Product Standard) 20 - American Softwood Lumber Standard
3. AWWA (American Wood Products Association) C2 Standard - Pressure Treated Wood
4. TPI - Truss Plate Institute

1.04 DEFINITIONS

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

- B. Lumber grading agencies, and the abbreviations used to reference them, include the following:

1. NELMA - Northeastern Lumber Manufacturers Association.
2. NLGA - National Lumber Grades Authority.
3. SPIB - Southern Pine Inspection Bureau.
4. WCLIB - West Coast Lumber Inspection Bureau.
5. WWPA - Western Wood Products Association.

1.05 SUBMITTALS

- A. Submit Shop Drawings prior to fabrication in accordance with Contract requirements.
 - 1. Indicate truss framing plans; species and grades of lumber used; design loading and allowable stress; force analysis of each member; pitch, span and spacing of trusses; gauge thickness, nominal sizes and locations of connectors at joints; bearing and anchorage details; framed openings; permanent bracing and bridging, fasteners, details of wind bracing, and all truss interconnections.
 - 2. Shop Drawings and calculations shall bear seal of Professional Engineer registered in the State of Maine.
- B. Submit manufacturer's instructions on lateral bracing.

1.06 QUALITY ASSURANCE

- A. Metal Connector-Plate Manufacturer Qualifications: A manufacturer that is a member of TPI and that complies with TPI quality-control procedures for manufacture of connector plates published in TPI 1.
- B. Manufacturer's responsibilities include providing professional engineering services needed to assume engineering responsibility.
- C. Engineering Responsibility: Preparation of Shop Drawings and comprehensive engineering analysis by a qualified professional engineer.
- D. Source Limitations for Connector Plates: Obtain metal connector plates through one source from a single manufacturer.
- E. Comply with applicable requirements and recommendations of the following publications:
 - 1. TPI 1, "National Design Standard for Metal Plate Connected Wood Truss Construction."
 - 2. TPI DSB, "Recommended Design Specification for Temporary Bracing of Metal Plate Connected Wood Trusses."
 - 3. TPI HIB, "Commentary and Recommendations for Handling, Installing & Bracing Metal Plate Connected Wood Trusses."
- F. Wood Structural Design Standard: Comply with applicable requirements in AFPA's "National Design Specifications for Wood Construction" and its "Supplement."
- G. Lumber used in the manufacture of trusses: Grade stamp clearly visible, including conformance with NFPA.

1.07 DELIVERY, STORAGE AND HANDLING

- A. Comply with TPI recommendations to avoid damage and lateral bending. Provide for air circulation around stacks and under coverings.
- B. Inspect trusses showing discoloration, corrosion, or other evidence of deterioration. Discard and replace trusses that are damaged or defective.

- C. The Contractor and Fabricator shall coordinate all shipping options, access to site, and erection procedures.

1.08 SEQUENCING AND SCHEDULING

- A. Time delivery and erection of trusses to avoid extended on-site storage and to avoid delaying progress of other trades whose work must follow erection of trusses.

PART 2 PRODUCTS

2.01 GENERAL

- A. Metal-Plate-Connected Wood Trusses shall be fabricated in an enclosed structure under controlled conditions by an experienced fabricator. The Truss fabricator shall verify all dimensions in the field prior to commencing fabrication. Trusses shall not be fabricated until all shop drawings have been approved.
- B. The Truss fabricator shall design the Trusses based on the design loads and the configuration given on plans. Truss configurations shown are diagrammatic only. Final configurations and connections to be determined by truss manufacturer.
- C. The Truss fabricator shall select the gusset plate to be used at each joint as well as plates required to field-splice Truss. All plates must have a working capacity of at least 125% of the design loads.
- D. The Truss manufacturer shall account for the combined effects of bending and axial stresses in chord members due to uniformly applied loads.

2.02 MATERIALS

- A. Wood Chords and Webs: PS 20, graded to NFPA rules, No. 1 structural grade, spruce-pine-fir, maximum moisture content of 16%.
- B. Plates: Hot-Dip Galvanized Steel Sheet: ASTM A 653/A 653M, G60 (Z180) coating designation; Designation SS, Grade 33, and not less than 0.036 inch (0.9 mm) thick.
- C. Nails: FS FF-N-105, Type 304 stainless steel.
- D. Metal Framing Anchors: Provide framing anchors made from metal indicated and as follows:
 1. Galvanized Steel Sheet: Hot-dip, zinc-coated steel sheet complying with ASTM A 653/A 653M, G60 (Z180) coating designation.
 2. Truss Tie-Downs (Hurricane or Seismic Ties): Bent strap tie for fastening roof trusses to wall plate below.
 3. Roof Truss Clips: Angle clips for bracing bottom chord of roof trusses at non-load-bearing walls, 1-1/4 inches (32 mm) wide by 0.050 inch (1.3 mm) thick. Clip is fastened to truss through slotted holes to allow for truss deflection.
- E. Lateral Support: As recommended by truss manufacturer and applicable codes.

F. Miscellaneous Materials:

1. Protective Coatings: SSPC-Paint 16, coal-tar epoxy-polyamide paint.

2.03 FABRICATION

- A. Ensure members are accurately cut to length, angle and true to line to ensure tight joints.
- B. Design and fabricate trusses in multiple pieces where required for transportation limitations, to be field-spliced.

2.04 ACCESSORIES

- A. Hurricane Ties.
- B. Fasteners.
- C. Blocking and Bracing.
- D. Hangers.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install wood trusses only after supporting construction is in place and is braced and secured.
- B. Before installing, splice trusses delivered to Project site in more than one piece.

3.02 ERECTION

- A. The wood and fabrication criteria of all prefabricated wood trusses shall meet with National Design Specification for Stress-Grade Lumber and its Fastenings by National Forest Products Association (latest revision); Timber Construction Standards, by American Institute of Timber Construction (latest revision); and Design Specification for Light Metal Plate Connected Wood Trusses, by Truss Plate Institute (latest revision).
- B. Wood trusses shall be handled, installed and braced in accordance with “Handling, Installing and Bracing Metal Plate Connected Wood Trusses HIB-91” of the Truss Plate Institute. The Truss fabricator shall furnish a copy of this manual and ship it in a watertight container with the trusses.
- C. Where field connections of truss sub-assemblies are necessary, the connections shall be in accordance with the details shown on the approved truss design shop drawings.
- D. All trusses and other roof structural components shall be fabricated in properly equipped manufacturing facilities of a permanent nature. They shall be manufactured by experienced workmen. All trusses shall be fabricated under the strict rules of the Truss Plate Institute.
- E. Fabricated trusses and sub-assemblies shall be handled with care so that they are not damaged.

- F. Proper erection bracing shall be installed to hold the trusses true and plumb and in safe condition until permanent truss bracing and bridging can be solidly nailed in place to form a structurally sound framing system. All erection and permanent bracing shall be installed and components permanently and securely fastened before application of any loads to the trusses. Permanent bracing shall meet all requirements of HIB-91 and the working drawings and specifications, whichever are the more stringent.
 - G. All prefabricated wood trusses are to be installed in accordance with Bracing Wood Trusses Commentary (BWT-76), as published by the Truss Plate Institute.
 - H. Field erection of the trusses, including items such as proper handling, safety precautions, temporary bracing to prevent toppling or dominoing of the trusses during erection, and any other safe guards or procedures consistent with good workmanship and good building erection practices, shall be the responsibility of the General Contractor and/or the framing subcontractor.
 - I. All framing shall be performed in accordance with the Contract Drawings.
 - J. All framing shall be set accurately to required lines and levels, rigidly secured in place with all necessary bolts, nails, spikes and bracing.
 - K. All connections, anchors, tie-downs (hurricane/seismic ties), clips shall be approved connectors as required to meet the design loads. Shop drawings shall be submitted for Engineer's review before fabrication.
 - L. All trusses must be securely braced both during erection and after permanent installation. Bracing shall be furnished by truss fabricator.
 - M. Framing members shall not be cut, notched or bored without prior approval of Engineer.
 - N. Double trusses shall be used at all openings.
 - O. Plates shall be double and lapped at all corners.
 - P. Set and secure wood trusses level, plumb, and in correct locations.
 - Q. Ensure truss ends have sufficient bearing area.
 - R. Cutting and altering of members is not permitted.
- 3.03 REPAIRS AND PROTECTION
- A. Repair damaged galvanized coatings on exposed surfaces with galvanized repair paint according to ASTM A 780 and manufacturer's written instructions.
 - B. Protective Coating: Clean and prepare exposed surfaces of metal connector plates and anchors. Brush-apply one coat of protective coating.
 - 1. Apply materials to provide minimum dry film thickness recommended by coating system manufacturer.

END OF SECTION 061753

SECTION 062013
FINISH CARPENTRY

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings, Contract Conditions and other Technical Specifications Sections apply to work of this Section insofar as applicable.
- B. Coordinate work with that of all other trades affecting, or affected by work of this Section. Cooperate with such trades to assure the steady progress of all Project work.

1.02 DESCRIPTION

- A. Finish carpentry work is shown on Drawings.
- B. Finish carpentry work includes, but is not limited to the following:
 - 1. Composite PVC standing and running trim and sills at windows
 - 2. Composite PVC panel soffits with soffit vents.
 - 3. Composite PVC exterior standing and running trim.

1.03 SUBMITTALS

- A. Product Data: Submit eight (8) copies of manufacturer's specifications and installation instructions for each product required.
- B. Shop Drawings: Submit eight (8) copies of shop drawings showing location of each item, dimensioned plans and elevations, large scale details, installation procedures and requirements, attachment devices and other components.
- C. Samples: Submit the following samples for each species and cut or pattern of architectural woodwork:
 - 1. Composite PVC trim for opaque finish; 6" x 3/4" x 18".
 - 2. Plywood for painted finish (including edge banding), 1 finished sample of each type, 12 inches' square.
 - 3. Composite PVC soffit panels for opaque finish; 6" x 1/2" x 12". Include PVC trim accessories for joining panels.

1.06 PRODUCT DELIVERY, STORAGE AND HANDLING

Protect finish carpentry products during transit, delivery, storage and handling to prevent damage, soiling and deterioration.

1.07 WORK NOT INCLUDED

A. Finishing of standing and running trim is specified in Section 099123.

PART 2 - MATERIALS

2.01 BASIC MATERIALS AND FABRICATION METHODS

A. Except as otherwise indicated, comply with following requirements for architectural woodwork not specifically indicated as prefabricated or prefinished standard products.

B. Wood Moisture Content: Provide kiln-dried (KD) lumber with an average moisture content range of 9% to 12% for interior work; 15% for exterior. Maintain temperature and relative humidity during fabrication, storage and finishing operations.

C. Interior Wood and PVC:

1. Concealed Solid Wood: Ponderosa Pine, Sugar Pine or Idaho Pine; No. 2 or better.
2. Interior Plywood - Painted Finish: Interior grade A-B DFPA Douglas fir with matching edge bands where edges are exposed.
3. Interior Composite PVC Trim – Painted Finish: Azek Trim, or similar as approved by Architect.
4. Interior Composite PVC Panel – Painted Finish: Azek Sheet, or similar as approved by the Architect.

F. Exterior PVC

1. Composite PVC Soffits - Painted Finish: Azek Sheet, or similar as approved by the Architect.
2. Composite PVC Trim - Painted Finish: Azek Trim, or similar as approved by the Architect.
3. PVC Accessories – “H” profile trim units for butting end joints of panels.

G. Soffit Vents: Soffit vents shall be aluminum "Vent-a-Strip", Model 70 as manufactured by H.C. Products, Co., or approved equal.

- H. Design and Construction Features: Comply with details shown for profile and construction of finish carpentry; and, where not otherwise shown, comply with applicable Quality Standards, with alternate details at the fabricator's option.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Condition finish carpentry to average prevailing humidity conditions in installation areas prior to installing.
- B. Meet at the site prior to delivery of finish carpentry and review coordination and environmental controls required for proper installation and ambient conditioning in areas to receive work. Include in meeting the Contractor, Resident and other Authority representatives; installers, painting, mechanical work and electrical work, and firms or persons responsible for continued operation (whether temporary or permanent) of HVAC system as required to maintain temperature and humidity conditions. Proceed with installation only when everyone concerned agrees that required ambient conditions can be properly maintained.
- C. Deliver inserts and similar anchoring devices to be built into substrates well in advance of time substrates are to be built.
- D. Prior to installation of, examine shop fabricated work for completion, and complete work as required, including back priming and removal of packing.

3.02 INSTALLATION OF WOODWORK

- A. Install the work plumb, level, true and straight with no distortions. Shim as required using concealed shims. Install to a tolerance of 1/8 inch in 8'-0" for plumb and level (including countertops); 1/16-inch maximum offset in flush adjoining surfaces; and 1/8 inch maximum offsets in revealed adjoining surfaces.
- B. Scribe and cut work to fit adjoining work and refinish cut surfaces or repair damaged finish at cuts.
- C. Anchor finish carpentry to anchors or blocking built-in or directly attached to substrates. Secure to grounds, stripping and blocking with countersunk, concealed fasteners and blind nailing as required for a complete installation. Except where prefinished matching fastener heads are required, use fine finishing nails for exposed nailing's, countersunk and filled flush with woodwork, and matching final finish where transparent finish is indicated.
- D. Standing and Running Trim: Install with minimum number of joints possible, using full-length pieces (from maximum length of lumber available) to the greatest extent possible. Stagger joints in adjacent and related members. Cope at returns, miter at corners, and comply with Quality Standards for joinery.

3.03 INSTALLATION OF EXTERIOR SOFFITS & TRIM

All exterior soffits and trim shall be mitered to tight, hair-line joints and shall be back and edge sealed with clear sealer after all cuts are made (including those for soffit vents) and before installation. Joints in running material shall occur only at supports. Prior to installing, surfaces that will be inaccessible after installation shall be thoroughly back-primed. Fasteners shall be set below the finish surface and the holes filled and sanded smooth. Butted soffit panels shall have PVC "H" channels at seams with concealed fasteners.

3.04 ADJUSTMENT, CLEANING, FINISHING AND PROTECTION

- A. Repair damaged and defective work to eliminate functional and visual defects. Where it is not possible to repair items to the Resident's satisfaction, replace the work at no additional cost. Adjust joinery for uniform appearance.
- B. Lubricate, make final adjustments for proper operation, and clean hardware.
- C. Clean composite PVC exposed and semi-exposed surfaces. Touch-up finishes to restore damaged or soiled areas to the Engineer's satisfaction.
- D. Refer to Section 099123 for final finishing of installed finish carpentry work and architectural woodwork.
- E. Protection:
 - 1. Protect finish carpentry during the remainder of the construction period to ensure that work will be without damage or deterioration at time of acceptance.
 - 2. Cover completed work with protective covering as necessary to protect from damage, applied in a manner which will allow easy removal without damaging finish carpentry, or adjoining work. Remove coverings immediately before Final Acceptance.

END OF SECTION 062013

SECTION 072100
THERMAL INSULATION

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings, Contract Conditions and other Technical Specifications Sections apply to work of this Section insofar as applicable.
- B. Coordinate work with that of all other trades affecting, or affected by work of this Section. Cooperate with such trades to assure the steady progress of all Project work.

1.02 DESCRIPTION

- A. The work includes furnishing of all labor and materials necessary to provide an installation which is complete in every respect and of the composition and quality as specified herein.
- B. Applications of insulation specified in this section include, but are not limited to, the following:
 - 1. Board type for perimeter slab and foundation walls.
 - 2. Board type for masonry cavity walls.
 - 3. Spray foam type for sealing around mechanical and electrical penetrations.
 - 4. Batt type insulation at the bottom chords of roof trusses.
 - 5. Loose masonry insulation for CMU voids.
- C. The work also includes furnishing and installing polyethylene vapor retarders.

1.03 QUALITY ASSURANCE

- A. Thermal Resistance: Where a minimum "R" value is given, provide thickness required to achieve indicated value.
- B. Thermal Transmittance-Heat Transfer: Where a maximum "U" value is given for a wall assembly, provide thickness required to achieve indicated value.
- C. Fire and Insurance Ratings: Comply with fire-resistance, flammability and insurance ratings indicated, and comply with regulations as interpreted by applicable codes and local authorities.

1.04 SUBMITTALS

- A. Product Data: Submit eight (8) copies of the manufacturers' specifications and installation instructions for each type of insulation and vapor barrier material required.
- B. Certified Tests: Submit eight (8) copies of certified test report showing compliance with specified performance values if submitted product is other than those specified.

1.05 PRODUCT HANDLING

Protect insulation from sunlight, from physical damage and from becoming wet, soiled, or covered with ice and snow. Comply with manufacturers' recommendations for handling, storage and protection during installation.

PART 2 - MATERIALS

2.01 MANUFACTURERS

Available Manufacturers: Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work include, but are not limited to those listed below.

2.02 MATERIALS

- A. Extruded Polystyrene Board Insulation: Rigid, closed-cell, extruded, polystyrene insulation board with integral high-density skin; comply with ASTM C 578, Type IV, achieve minimum compressive strength of 25 psi at 10% deformation per ASTM D 1621; achieve maximum moisture absorption of 0.3% by volume per ASTM C 272; 5-year aged R-value of 5 per inch at 75°F.

"SM", "TG" or "RM", Dow Chemical Co.
Formula 400, UC Industries/U.S. Gypsum

Expanded polystyrene insulation board is not acceptable.

- B. Unfaced Glass Fiber Batt Insulation: Thermal insulation produced by combining glass fibers with thermosetting resins to comply with ASTM C 665 for Type I and ASTM E 136.
- C. Concrete Masonry Unit Insulation: Shall be loose fill vermiculite insulation treated for water repellency, conforming to ASTM C 516, Type II, equal to "Zonolite Masonry Insulation" by W.R. Grace & Co.
- D. Spray Foam Insulation: Shall be "Great Stuff" by Dow Chemical Company, or similar as approved by the Architect.

- E. Adhesive for Bonding Insulation: Type recommended by insulation manufacturer and complying with fire-resistance requirements.
- F. Mechanical Anchors: Type and size, as recommended by insulation manufacturer for conditions of application and substrates.
- G. Mastic Sealer: Type recommended by insulation manufacturer for bonding edge joints between units and filling voids in work.
- H. Vapor Retarder: 6 mil polyethylene film with laboratory tested vapor transmission rating of 0.2 perms, natural color. Provide manufacturer recommended, Engineer approved tape for sealing laps.

PART 3 - EXECUTION

3.01 INSPECTION AND PREPARATION

Examine substrate and conditions under which insulation work is to be performed and notify the Engineer in writing of unsatisfactory conditions. Do not proceed with insulation work until unsatisfactory conditions have been corrected in an acceptable manner.

Clean substrates of substances harmful to insulations (or vapor barriers, including removal of projections which might puncture vapor barriers).

3.02 INSTALLATION OF INSULATION

- A. Comply with manufacturers' instructions for installation or consult manufacturer's technical representative for specific recommendations before proceeding with work.
- B. Apply insulation (full thickness) over entire area to be insulated. Cut and fit tightly around obstructions, and fill voids with insulation, taking care not to overly compress the insulation. Remove projections which interfere with placement.

C. Under-slab Insulation

Set units in accordance with the manufacturer's instructions and recommendations and protect from damage.

D. Cavity-Wall and Foundation Insulation:

Install polystyrene insulation board with globs of adhesive as recommended by manufacturer. Fit closely around reinforcing and obstructions, with all edges butted tightly.

Seal joints between insulation units by applying mastic to edges of each unit to form a tight seal as units are shoved into place. Fill voids in completed installation and around penetrations with mastic or approved sealant.

- E. Loose CMU and Spray Foam Insulation: Install in strict accordance with the manufacturers' instructions.

3.03 INSTALLATION OF VAPOR RETARDER

- A. Extend vapor retarder to extremities of areas to be protected from vapor transmission. Secure in place with adhesives or other anchorage system as approved by the Engineer. Extend vapor retarder to cover miscellaneous voids in insulation substrates.
- B. Seal vertical joints in vapor retarders over framing by lapping not less than 2 wall studs. Fasten vapor retarders to framing at top, end and bottom edges, at perimeter of wall openings and at lap joints in a manner acceptable to the Resident; space fasteners 16 inches on center. After retarder has been fastened, cover fasteners and lap joint with approved tape.

3.04 PROTECTION

Protect installed insulation and vapor retarders from harmful weather exposures and from physical abuse. Installer shall advise Contractor of exposure hazards, including possible sources of deterioration and fire hazards.

END OF SECTION 072100

SECTION 074113.16
STANDING SEAM METAL ROOFING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Examine all other Sections of the Specifications for requirements which affect work of this Section whether or not such work is specifically mentioned in this Section.
- B. Coordinate work with that of all other trades affecting, or affected by work of this Section. Cooperate with such trades to assure the steady progress of all Project work.

1.02 DESCRIPTION

- A. The Contractor shall design, engineer and furnish all materials, equipment, supplies, tools, labor and supervision, and shall perform all work required for the complete installation of weathertight structural standing seam aluminum-zinc alloy coated steel roofing systems for the Building, complete with matching accessories and appurtenances as shown on the Contract Drawings, as specified herein, as required and recommended by the roofing system manufacturer and approved by the Engineer, and as is additionally required for the proper completion of the work, including but not limited: providing a continuous panel anchorage system, waterproofing membrane, expansion joint, crickets, edge treatments, trim closures, penetration flashing, base and cap flashings, transition flashings, miscellaneous flashings, fasteners, sealants, snow guards, etc.

Note: The Contract Drawings depict the design concept and the basic relationship of the various roofs to each other and to other surrounding construction. The metal roofing system shown on the Contract Drawings is a high profile, wide spaced batten system. However, the roof to be provided under this Contract shall be a structural standing seam metal roof as described hereinafter. Edge conditions, flashings, etc., shall remain as shown except where different details are proposed by the roofing system manufacturer to accommodate their particular roofing system and such changes are accepted by the Engineer.

It shall be understood that it is solely the Contractor's responsibility to fully inspect and investigate all conditions affecting the proper installation of the standing seam metal roofing system required, and to insure that all conditions are suitably provided for in the manufacture, fabrication and installation of the roofing system regardless of what may be shown/specified or not shown/specified on the Contract Drawings or in the specifications. The aesthetic requirements shown on the Contract Drawings, other than batten spacing, the requirements of these specifications, and the preferred recommendations of the roofing system manufacturer, as approved by the Resident, shall be complied with in all instances, at no additional cost to the Authority. In case of conflict between requirements, the more stringent and costly requirement, as determined solely by the Resident, shall apply. Therefore, it is incumbent on the Contractor to

review the Contract Work in detail with the proposed roofing system manufacturer(s) prior to submitting a bid for the Contract work.

Single panels with proper lap at intersections shall be use for each slope to cover the perimeter of the roof. Submit Shop Drawings for approval.

- B. Flashing and sheet metal required for the work of this Section, such as for edge conditions and penetration flashings, shall match the roofing and shall be provided in accordance with the requirements of the roofing system manufacturer's approved Shop Drawings and installation instructions.
- C. Joint sealer work that is required to make the roofing installation watertight and weathertight with abutting construction shall be performed as part of the work of this Section in accordance with the, roofing system manufacturer's approved Shop Drawings and installation instructions.

1.03 SUBMITTALS

- A. Shop Drawings: As noted above, the Contract Drawings depict the design concept and the basic relationship of the various roofs to each other and to surrounding construction based on a high profile, wide spaced batten system. It is solely the responsibility of the Contractor to have the proposed roofing system manufacture develop detailed Shop Drawings to properly adapt the proposed roof system to all Project conditions. Shop Drawings shall include but not be limited to: layouts of vapor retarder, waterproofing membrane, and roofing panels, and full scale plans, elevations and details of edge conditions, joints, expansion joints, standing seam profiles, anchorages, blocking, flashings, closures, tie-ins to adjacent construction, and all other details required to fully illustrate all conditions of work. Distinguish between factory and field assembly work.
 - 1. Shop Drawings shall bear the seal and signature of a Professional Engineer, licensed in the State of Maine.
 - 2. Layout drawings and sections shall show adjacent construction, and be keyed into benchmarks and grid lines established on the Contract Drawings.
 - 3. Details shall show dimensions, thicknesses, materials, finishes, continuous anchors, edge trim, sealant locations, fasteners and spacing, etc. Details shall also show and identify joint conditions, anticipated fabrication and erection tolerances, anticipated thermal movement, etc.
 - 4. Provide isometric drawings for each juncture between flashing assemblies, at interfacing and adjacent work, at penetrations, and at typical roof transitions and end conditions.
 - 5. Roofing panel, waterproofing membrane, vapor retarder, edge trim, etc., joints shall be laid out on the Shop Drawings. It shall be understood that the Engineer

will be at liberty to revise joint layouts as deemed necessary, at no additional cost and with no time extension.

6. Submit erection drawings showing proposed sequence of installation.
 7. Submit manufacturer's written instructions and comments, fastener descriptions and spacings, and all other pertinent information.
 8. Submit manufacturer's written instructions and details for the snow guard system.
- B. Product Data: Submit specifications for material and fabrication of metal roofing system materials, and detailed instructions and recommendations for handling, storing, installation and maintenance. Include manufacturers' product data for roof panels, fasteners, sealants, backer rod, insulation, vapor retarder, waterproofing membrane, and all other manufactured products. Include certified test reports showing compliance with requirements where a test method is indicated.
- C. Samples
1. Submit samples of roofing system components. Provide assembled sample panels 18 inches long by two panels wide using the same materials to be used in the finished work. Include continuous anchors, fasteners, waterproofing membrane, insulation and other accessories. Provide a horizontal (end) joint on each side of standing seam in the middle of the sample panel.
 2. Submit a 24 inch long radius roof edge fabrication (e.g., edge cover and brake metal closures), each with typical finished mating joints.
- D. Quality Control/Assurance Submittals
1. Submit for review copies of ASCE-7 Load Analysis prepared and/or reviewed and sealed by a Professional Engineer licensed in the State of Maine.
 2. Submit design calculations bearing the seal and signature of a Professional Engineer licensed in the State of Maine, indicating compliance with specified performance criteria and fastener pull-out calculations. The submittal shall indicate fastener types, spacings and numbers required for each installation condition.
 3. Submit test reports for independent testing laboratories bearing the seal of a registered Professional Engineer to certify compliance with the specified performance criteria.
 4. Submit complete and current data for the roof system as follows:
 - a. Thermal cycle testing of the metal roof panel and continuous panel anchors as specified.

- b. Uniform ultimate wind uplift load capacity for the roofing system specified.
 - c. Ultimate pullout capacity for all anchors.
 - d. U.L. 90 classification data specific to the roofing system to be provided. Include letter by U.L. attesting that the roofing system is currently classified and listed.
 - e. Model load test per ASTM E 330, modified.
 - f. Static air infiltration test data.
 - g. Water penetration test data.
5. Submit manufacturer's complete log of field reports (initial, progress and final).
6. Upon completion of the work, submit letter from the manufacturer certifying that the roof installations are in accordance with the approved Shop Drawings and installation instructions and requirements, and that the manufacturer will issue the specified watertightness warranty.

E. Welding

Submit welder certifications.

F. Warranties

Submit samples of the roofing manufacturer's twenty-year warranty agreeing to repair/replace defective materials and workmanship in an aesthetically acceptable manner, to the Authority's complete satisfaction, as required to maintain the roofing installations, including flashings, trim, etc., in a watertight condition under peak weather conditions. Warranty shall not exclude any conditions, such as flashings, trim, penetrations, etc.

Submit sample of the roofing manufacturer's standard twenty-year sheet steel warranty and material finish warranty.

Warranties shall be in addition to and not a limitation of other rights the Authority may have against the Contractor under the Contract Documents.

1.04 QUALITY ASSURANCE

- A. Contractor shall have a minimum of 5 years continuous successful experience in fabricating and installing roofing systems of similar type (e.g., long field-formed panels) and complexity to that required for this Project and shall be an authorized installer for the roofing system manufacturer. Submit a list of installations. The manufacturer of the roofing system shall have a minimum of 10-years experience in the manufacturer of roofing systems of the type required for this Project.

- B. Use adequate numbers of skilled workmen who are thoroughly trained and experienced in the necessary crafts, and who are completely familiar with the specified requirements and the methods needed for proper performance of the work of this Section.
- C. Manufacturer's representative is to inspect and approve surfaces to which the roofing system material will be applied prior to start of work and shall instruct and assist installer as deemed necessary. Manufacturer's representative shall also provide intermittent project supervision and final inspection at end of work and before issuance of warranty. Also refer to paragraph 3.03.
- D. In addition to complying with requirements of governmental agencies having jurisdiction, the roofing system shall comply with U.L. Class 90 wind uplift requirements based on wind loads at the site, U.L. Class A fire rating requirements and pertinent recommendations contained in the SMACNA "Architectural Sheet Metal Manual".
- E. Roof System Requirements
 - 1. Structural Tests: Installed roof system shall carry positive uniform design loads with maximum system deflection of $L/180$ as measured at the rib of the panel.
 - 2. Water Penetration: Installed roof system shall exhibit no uncontrolled water penetration when exposed to dynamic rain at 6.25 psf differential air pressure for not less than five minutes, when testing in accordance with ASTM E 331.
 - 3. The metal roof system shall be designed to:
 - a. Drain leakage and condensation to the exterior.
 - b. Provide independent movement of all roof components consistent with a thermal range of -20 to +180 degrees F, and consistent with anticipated movement of the building structures.
 - c. Provide panel weathertightness without reliance on sealants or elastomeric membranes.
 - d. Provide flashing, gutters, downspouts and edge assemblies related to the roof that are watertight.
 - e. Provide required wind uplift resistance as determined by ASCE-7 analysis with a safety factor of 1.5.
- F. Panel Anchor Requirements

Connection of continuous panel anchors to substrate shall be designed to resist loads developed by the specified pressures with due regard to prying forces and/or bending

due to eccentric loading. Performances shall be evaluated at positions of extreme thermal movement. Factor of safety for connections shall be 2.5.

- G. Uniform load capacity of 2 times design load shall be determined by testing in accordance with the principles of ASTM E 330, adapted to testing of formed sheet panels by additions to specific sections as follows:
 - 1. Roof test specimens shall represent the conditions evaluated, free of undue influence of perimeter conditions. Panels shall be continuous over one or more interior supports and contain at least four panel widths.
 - 2. No roof attachments are permitted at the sides other than the standard edge condition. For uplift tests, at least one end seal shall be flexible and in no way restrain the crosswise distortion of the panels.
 - 3. Roofing panels and accessories are to be production material of the same type and thickness required for use on the Project.
 - 4. Longitudinal seals or plastic film shall not span any crevice or crack that may tend to separate under differential pressure.
- H. Any necessary welding shall be performed only by skilled workmen with current AWS certification for the type of welding work required for this Contract. Welding shall be performed in accordance with applicable AWS requirements.

PART 2 - PRODUCTS

2.01 GENERAL

- A. Fabricate for waterproof and weather-resistant performance, with expansion provisions for running work, sufficient to permanently prevent leakage, damage, and deterioration of the work. Form work to fit substrates. Comply with roofing system manufacturer's instructions and recommendations for forming material.
- B. Materials shall be selected for their surface flatness and freedom from blemishes. Materials exhibiting waves, roller marks, gouges, dents, creases, pitting, scrapes, scars and similar defects will be rejected.
- C. All metal work shall be formed to produce installed units free from waves, buckling, severe oil-canning and similar defects under all conditions of service. Units shall be formed true to line, with smooth "sharp" bend lines, and with exposed edges folded back to form hems.

2.02 ROOF SYSTEM MANUFACTURERS

- A. The "Zee-Lock Roof System" produced by Berridge Manufacturing Company (as indicated in current literature) is cited as capable of meeting the appearance, quality, construction type, performance and durability requirements of this Contract. Systems by other manufacturers that are equivalent in all respects (i.e., appearance, type of construction, performance and durability), may be used in the work. However, it shall be understood that the Resident will be the sole judge of a system's acceptability, and that the rejection of a proposed system shall not give rise to any claims for additional compensation or extension to the Time(s) of Completion.

2.03 METAL ROOF PANELS

- A. Minimum 24 gage aluminum-zinc alloy (Galvalume) coated sheet steel conforming to ASTM A 792 in continuous field formed panels of the required lengths. The gage of the coated steel shall be increased from 24 gage, at no additional cost, if necessary to meet Contract requirements.
- B. Panels shall have a minimum 2 inch vertical rib height, spaced 16 inches on center.
- C. Panels shall be true standing seam shape, requiring no foam closures or fillers at terminations.
- D. Standing seams shall incorporate mechanically interlocked continuous anchors of a configuration that will prevent entrance or passage of water.
- E. Continuous concealed anchors shall resist positive and negative loading yet permit thermal expansion and contraction of panels.
- F. Seams that are not mechanically locked are not acceptable.
- G. Standing seams shall contain a factory applied extruded vinyl weather seal to prevent siphoning of moisture through the side joint seam.
- H. Horizontal seams shall not be permitted.

2.04 CONTINUOUS ANCHORS

- A. Standing seam roof panels shall be fastened to continuous zee-shaped anchors that are secured to the substrate.
- B. Manufacturer shall design the continuous anchors, fasteners and fastener spacing to maintain the required wind uplift resistance and other performance criteria.

2.05 MISCELLANEOUS METAL

- A. Provide all necessary terminations, flashings, gutters, edge conditions, special shapes, transitions, expansion joints, etc., required for complete and weathertight installations. All such items shall be the same material as the roof panels, except that edge condition materials and brake metal closures shall be minimum 22 gage.

B. Fasteners

Exposed fasteners shall be Series 300 stainless steel fasteners with neoprene-backed watertight stainless steel washers. All exposed portions of fasteners and washers shall receive a two-coat high quality urethane finish to match the roof panels.

Exposed rivets, where approved by the Engineer, shall be self-plugging type, minimum 3/16 inch diameter, fabricated from Series 300 stainless steel with the same material for stems, and with neoprene seal washers.

Concealed fasteners shall be corrosion resistant type equal to self-drilling "Dril-lex" fasteners with "Stalgard" coating by Elco Industries, Inc., Rockford, IL.

Fasteners and plates for installation of insulation shall be equal to "Sarnafasteners and Plates" by Sarnafil, Inc., Canton, MA.

C. Plywood Sheathing

As specified in Rough Carpentry Section.

D. Roofing Underlayment

Shall be ice/waterproofing membrane specified below.

E. Ice/Waterproofing Membrane

Self-adhering 60 mil reinforced rubberized asphalt waterproofing membrane equal to "Winter Guard Waterproofing Shingle Underlayment" by CertainTeed Corporation, Valley Forge, PA.

F. Vapor Retarder

Shall be the ice/waterproofing membrane specified above.

G. Sealant

One-part silicone sealant equal to "Spectrem 1" by Tremco Sealants and Coatings, Beachwood, OH.

- H. Fall Protection Roof Anchors: Provide fall protection roof anchors in locations indicated in the drawings. Provide Guardian CB-12 Roof Anchor or similar as approved by the Engineer.

2.06 FABRICATION

- A. Fabricate panels onsite in continuous lengths as required. Examine panels as they are being formed to insure that they are within the manufacturer's acceptable tolerances.
- B. Provide linear sheet metal items in minimum 10'-0" lengths except as otherwise approved on the Shop Drawings. Form flashing using single pieces for the full width. Provide shop fabricated, mitered and joint corners.
- C. Comply with the dimensions, profiles, and details shown, or if not shown, in accordance with details provided by the Engineer.

2.07 SNOW GUARDS

- A. Snow guards shall be prefabricated ladder type, aluminum two-pipe snow guards designed for use with standing seam metal roofing and complete with brackets and fasteners for anchoring as manufactured by Alpine Snow guards. Acceptable alternate bracket manufacturer shall be S-5! Metal Roof Innovations, Ltd. All snow guard components, including brackets and fasteners, shall match the color of the standing seam roof panels as selected by the Architect. No exceptions will be allowed.

2.08 GUTTERS AND DOWNSPOUTS

- A. Gutters and downspouts shall be fabricated in sizes indicated. Gutters shall be seamless. Downspouts shall have sealed joints at bends, continuous seamless lengths at straight sections.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Inspection: Examine substrates to receive roofing. Do not proceed until all defects are corrected.

Verify that decks are sound, dry, and securely attached, and that provisions for flashings, expansion joints, and all items attaching or penetrating through the work of this Section have been provided for and that roofing work may proceed.

Field check dimensions and support alignment.

Provide all fastener alignment markings necessary so that marks can be transferred onto vapor retarder, as appropriate.

- B. Sheathing: Installed as specified - Rough Carpentry Section.
- C. Ice/Waterproofing Membrane: After the sheathing installation has been approved by the roofing system manufacturer's representative, apply ice/waterproofing membrane over sheathing in accordance with the approved Shop Drawings and the membrane manufacturer's installation instructions, taking care to provide 6 inch weatherlapped head joints and 18 inch lapped end joints in a manner to drain any entrapped moisture to the exterior.
- D. Installation of Metal Roofing and Flashing
 - 1. Install roofing in strict accordance with the approved Shop Drawings and installation instructions.
 - 2. Metal workmanship shall conform to applicable standards set forth in the "Architectural Sheet Metal Manual" as published by SMACNA.
 - 3. Isolate dissimilar metals and masonry or concrete from metals with an Engineer approved bituminous coating. Use gasketed fasteners where required to prevent corrosive action between fastener, substrate and panels.
 - 4. Limit exposed fasteners to extent indicated on Shop Drawings.
 - 5. Anchorage shall allow for temperature expansion and contraction movement without stress or elongation of panels or fasteners. Attach continuous panel anchor to structural substrate using fasteners of size and spacing as determined by manufacturer's design analysis to resist specified uplift and thermal movement forces.
 - 6. Coordinate flashing and sheet metal work to provide weathertight conditions at roof terminations. Fabricate and install in accordance with standards of SMACNA Manual using continuous cleats at all exposed edges.
 - 7. Roofing, fascia overlay, gutter and accessories shall be installed in accordance with the approved Shop Drawings and installation instructions such that in plan and elevation, horizontal and vertical lines are true and square, and that other lines are as shown on the approved Shop Drawings. Provide adjustment within system to accommodate variations of existing structure. Deviation from designated locations shall not exceed 1/8 inch per 12 feet of length of any member or 1/4 inch in any total run in any line.
 - 8. Verify with manufacturer locations of fixed connections and expansion connections.

9. Roll form panels on site taking care to properly support long panels (support at maximum 6 foot intervals).
10. Install starter and edge trim and fascia overlay before installing roof panels.
11. Install panels to continuous anchors (ribs) in accordance with the manufacturer's details.
12. Seam panel sidelaps using power-driven seamer as recommended by manufacturer to ensure watertightness.
13. Erect metal roofing with lines, planes, arrises and angles sharp and true, and plane surfaces free from waves, warp, dents, buckles, or other physical defects, with minimum oil canning.
14. Do not allow traffic on completed roof. If required, provided cushioned walk boards.
15. Protect installed roof panels and trim from damage caused by adjacent construction until completion of installation.
16. Remove and replace any panels or components which are damaged beyond successful repair.
17. Fit components accurately together to form joints that will be weathertight.
18. Do not install components which are observed to be defective, including, but not limited to those that are warped, bowed, twisted, dented, abraded, or otherwise damaged, including damage to finish.
19. Do not cut, trim, weld, or braze component parts during erection in a manner which would damage the finish, decrease strength, or result in a visual imperfection or a failure in performance.
20. Do not allow panels to come into contact with dissimilar materials. Apply an Engineer approved isolator between surfaces. Use gasketed fasteners to eliminate the possibility of corrosive or electrolytic action between metals.
21. Coordinate the roofing work with that of other trades as necessary.
22. Thoroughly wipe-down roofing and other surfaces as erection progresses.
23. Install sealant as shown on the approved Shop Drawings and installation instructions.

F. Flashing

1. Comply with "SMACNA" Architectural Sheet Metal Manual" recommendations for installation of work.
2. Conceal fasteners and expansion provisions wherever possible.
3. Fold back edges of concealed side of exposed edge to form hem.
4. Insert metal flashings into reglets, anchor with fasteners and wedges and seal joints.
5. Set sheet metal items level, true to line, and plumb.
6. Secure to wood with screws.
7. Set metal already partly formed in place and fasten by means of cleats.
8. Use cleats to keep laps closed when face width exceeds 8 inches for 24 gauge steel.

G. Damaged Finishes: Repair damaged finish of panels, trim, closures, flashing, etc., to the satisfaction of the Engineer. If any item cannot be repaired to the Engineer's satisfaction, it shall be promptly replaced.

H. Snow Guards: Install as indicated on the Plans and as recommended by the manufacturer.

I. Fall Protection Roof Anchors: Install in accordance with the roof anchor manufacturer's written instructions and in accordance with the metal roofing manufacturer.

H. Gutters and Downspouts: Install in lengths and locations indicated using straps and hangers matching material and finish of gutters and downspouts.

3.03 FIELD QUALITY CONTROL

A. Manufacturer's Field Service:

1. Manufacturer's representative shall be present at each pre-installation and pre-roofing conference, and during set-up of manufacturer's field forming equipment.
2. Manufacturer's representative shall examine the roof structures with installer prior to beginning roof installation.
3. Manufacturer's representative shall be present during initial layout and installation of roofing system. Observe minimum of initial one week period of roof panel installation on daily basis, ensuring installer follows manufacturer's installation

recommendations and shop drawings. Observe initial forming passes for fabrication with acceptable tolerances.

4. Manufacturer's representative shall be on site for the duration of the installation period.
5. Manufacturer's representative shall examine completed installation for conformance to Shop Drawings. Notify installer and Contractor in writing of discrepancies.

3.04 CLEANING

- A. Clean exposed surfaces of work promptly after completion of installation. To prevent rust staining on finished surfaces, immediately removing fillings produced by drilling or cutting.
- B. Clean roof in accordance with manufacturer's recommendations.
- C. Clean exposed surfaces of roofing and accessories after completion of installation. Leave in clean condition at date of Substantial Completion of Project. Touch up minor abrasions and scratches in finish.
- D. Remove all scrap and construction debris from the site.

3.05 FINAL INSPECTION

- A. Final inspection and certification will be provided by the manufacturer's representative.

3.06 PROTECTION AND CLEAN-UP

- A. Leave all work clean, free from grease, finger marks, sealant stains, etc. Remove excess sealant, dirt and other substances from roofing system components and from abutting and surrounding construction. Cleaning materials and procedures shall be approved by the Engineer and be acceptable to the manufacturers of the materials to be cleaned. Advise the Contractor of protective measures and precautions required to ensure that roofing installations will be without damage or deterioration (other than normal weathering) at time of acceptance.
- B. Remove all debris and rubbish caused by the work of this Section as the work progresses.

END OF SECTION 074113.16

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

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Adhered ethylene-propylene-diene-terpolymer (EPDM) roofing system.
2. Substrate board.
3. Roof insulation.
4. Cover board.

B. Related Requirements:

1. Section 061000 "Rough Carpentry" for wood nailers, curbs, and blocking.
2. Section 076200 "Sheet Metal Flashing and Trim" for metal roof flashings and counterflashings.
3. Section 079200 "Joint Sealants" for joint sealants, joint fillers, and joint preparation.

1.3 DEFINITIONS

- A. Roofing Terminology: Definitions in ASTM D 1079 and glossary of NRCA's "The NRCA Roofing Manual: Membrane Roof Systems" apply to work of this Section.

1.4 PREINSTALLATION MEETINGS

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

1. Meet with Owner, Architect, Construction Manager, Owner's insurer if applicable, roofing Installer, roofing system manufacturer's representative, deck Installer, air barrier Installer, and installers whose work interfaces with or affects roofing, including installers of roof accessories and roof-mounted equipment.
2. Review methods and procedures related to roofing installation, including manufacturer's written instructions.

3. Review and finalize construction schedule, and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
4. Examine deck substrate conditions and finishes, including flatness and fastening.
5. Review structural loading limitations of roof deck during and after roofing.
6. Review base flashings, special roofing details, roof drainage, roof penetrations, equipment curbs, and condition of other construction that affects roofing system.
7. Review governing regulations and requirements for insurance and certificates if applicable.
8. Review temporary protection requirements for roofing system during and after installation.
9. Review roof observation and repair procedures after roofing installation.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 1. For insulation and roof system component fasteners, include copy of FM Approvals.
- B. Shop Drawings: Include roof plans, sections, details, and attachments to other work, including the following:
 1. Layout and thickness if insulation.
 2. Base flashings and membrane terminations.
 3. Flashing details at penetrations.
 4. Tapered insulation, thickness, and slopes.
 5. Roof plan showing orientation of steel roof deck and orientation of roof membrane and fastening spacings and patterns for mechanically fastened roofing system.
 6. Insulation fastening patterns for corner, perimeter, and field-of-roof locations.
- C. Samples for Verification: For the following products:
 1. Roof membrane and flashings of color required.
- D. Wind Uplift Resistance Submittal: For roofing system, indicating compliance with wind uplift performance requirements.

1.6 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer and manufacturer.
- B. Manufacturer Certificates:

1. Performance Requirement Certificate: Signed by roof membrane manufacturer, certifying that roofing system complies with requirements specified in "Performance Requirements" Article.
 - a. Submit evidence of complying with performance requirements.
 2. Special Warranty Certificate: Signed by roof membrane manufacturer, certifying that all materials supplied under this Section are acceptable for special warranty.
- C. Product Test Reports: For components of roof membrane and insulation, for tests performed by a qualified testing agency, indicating compliance with specified requirements.
- D. Evaluation Reports: For components of roofing system, from ICC-ES.
 1. Fastener-pullout test results and manufacturer's revised requirements for fastener patterns.
- E. Sample Warranties: For manufacturer's special warranties.

1.7 CLOSEOUT SUBMITTALS

- A. Maintenance Data: For roofing system to include in maintenance manuals.
- B. Certified statement from existing roof membrane manufacturer stating that existing roof warranty has not been affected by Work performed under this Section.

1.8 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified firm that is approved, authorized, or licensed by roofing system manufacturer to install manufacturer's product and that is eligible to receive manufacturer's special warranty.

1.9 DELIVERY, STORAGE, AND HANDLING

- A. Deliver roofing materials to Project site in original containers with seals unbroken and labeled with manufacturer's name, product brand name and type, date of manufacture, approval or listing agency markings, and directions for storing and mixing with other components.
- B. Store liquid materials in their original undamaged containers in a clean, dry, protected location and within the temperature range required by roofing system manufacturer. Protect stored liquid material from direct sunlight.
 1. Discard and legally dispose of liquid material that cannot be applied within its stated shelf life.

- C. Protect roof insulation materials from physical damage and from deterioration by sunlight, moisture, soiling, and other sources. Store in a dry location. Comply with insulation manufacturer's written instructions for handling, storing, and protecting during installation.
- D. Handle and store roofing materials, and place equipment in a manner to avoid permanent deflection of deck.

1.10 FIELD CONDITIONS

- A. Weather Limitations: Proceed with installation only when existing and forecasted weather conditions permit roofing system to be installed according to manufacturer's written instructions and warranty requirements.

1.11 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of roofing system that fail in materials or workmanship within specified warranty period.
 - 1. Special warranty includes roof membrane, base flashings, roof insulation, fasteners, cover boards, substrate board, and other components of roofing system.
 - 2. Warranty Period: 20 years from Date of Substantial Completion.
- B. Special Project Warranty: Submit roofing Installer's warranty, on warranty form at end of this Section, signed by Installer, covering the Work of this Section, including all components of roofing system such as roof membrane, base flashing, roof insulation, fasteners, cover boards, and substrate boards for the following warranty period:
 - 1. Warranty Period: Two years from Date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. General Performance: Installed roofing system and base flashings shall withstand specified uplift pressures, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Roofing and flashings shall remain watertight.
 - 1. Accelerated Weathering: Roof membrane shall withstand 2000 hours of exposure when tested according to ASTM G 152, ASTM G 154, or ASTM G 155.
 - 2. Impact Resistance: Roof membrane shall resist impact damage when tested according to ASTM D 3746, ASTM D 4272, or the Resistance to Foot Traffic Test in FM Approvals 4470.

- B. Material Compatibility: Roofing materials shall be compatible with one another and adjacent materials under conditions of service and application required, as demonstrated by roof membrane manufacturer based on testing and field experience.
- C. Wind Uplift Resistance: Design roofing system to resist the following wind uplift pressures when tested according to UL 580, or UL 1897:
 - 1. Zone 1 (Roof Area Field): -19.8 lbf/sq. ft.
 - 2. Zone 2 (Roof Area Perimeter): -33.3 lbf/sq. ft.
 - a. Location: From roof edge to 3-ft inside roof edge.
 - 3. Zone 3 (Roof Area Corners): -50.1 lbf/sq. ft.
 - a. Location: 3-ft in each direction from building corner.
- D. Energy Performance: Roofing system shall have an initial solar reflectance of not less than 0.70 and an emissivity of not less than when tested according to CRRC-1.

2.2 ETHYLENE-PROPYLENE-DIENE-TERPOLYMER (EPDM) ROOFING

- A. EPDM Sheet: ASTM D 4637/D 4637M, Type II, scrim or fabric internally reinforced.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Carlisle SynTec Incorporated.
 - b. Firestone Building Products.
 - c. GenFlex Roofing Systems.
 - 2. Thickness: 60 mils, nominal.
 - 3. Exposed Face Color: White on black.
 - 4. Source Limitations: Obtain components for roofing system from roof membrane manufacturer or manufacturers approved by roof membrane manufacturer.

2.3 AUXILIARY ROOFING MATERIALS

- A. General: Auxiliary materials recommended by roofing system manufacturer for intended use and compatible with other roofing components.
 - 1. Adhesive and Sealants: Comply with VOC limits of authorities having jurisdiction.
- B. Sheet Flashing: 60-mil- thick EPDM, partially cured or cured, according to application.
- C. Protection Sheet: Epichlorohydrin or neoprene nonreinforced flexible sheet, 55 to 60 mils thick, recommended by EPDM manufacturer for resistance to hydrocarbons, non-aromatic solvents, grease, and oil.

- D. Slip Sheet: Manufacturer's standard, of thickness required for application.
- E. Prefabricated Pipe Flashings: As recommended by roof membrane manufacturer.
- F. Bonding Adhesive: Manufacturer's standard.
- G. Seaming Material: Single-component, butyl splicing adhesive and splice cleaner or Manufacturer's standard, synthetic-rubber polymer primer and 3-inch- wide minimum, butyl splice tape with release film.
- H. Lap Sealant: Manufacturer's standard, single-component sealant, colored to match membrane roofing.
- I. Water Cutoff Mastic: Manufacturer's standard butyl mastic sealant.
- J. Metal Termination Bars: Manufacturer's standard, predrilled stainless steel or aluminum bars, approximately 1 by 1/8-inch-thick; with anchors.
- K. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening components to substrate, and acceptable to roofing system manufacturer.
- L. Miscellaneous Accessories: Provide pourable sealers, preformed cone and vent sheet flashings, molded pipe boot flashings, preformed inside and outside corner sheet flashings, reinforced EPDM securement strips, T-joint covers, in-seam sealants, termination reglets, cover strips, and other accessories.
 - 1. Provide white flashing accessories for white EPDM membrane roofing.

2.4 SUBSTRATE BOARDS

- A. Substrate Board: ASTM C 1177/C 1177M, glass-mat, water-resistant gypsum board or ASTM C 1278/C 1278M, fiber-reinforced gypsum board.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. CertainTeed Corporation.
 - b. Georgia-Pacific Building Products.
 - c. National Gypsum Company.
 - d. United States Gypsum Company.
 - 2. Thickness: 1/2 inch.
- B. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening substrate panel to roof deck.

2.5 ROOF INSULATION

- A. General: Preformed roof insulation boards manufactured or approved by EPDM roof membrane manufacturer.
- B. Polyisocyanurate Board Insulation: ASTM C 1289, Type II, Class 1, Grade 2, felt or glass-fiber mat facer on both major surfaces.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Carlisle SynTec Incorporated.
 - b. Firestone Building Products.
 - c. GAF.
 - d. Insulfoam-a division of Carlisle Construction Materials Inc.
 - e. Johns Manville; a Berkshire Hathaway company.
 - f. Rmax, Inc.
 - 2. Compressive Strength: 20 psi.
 - 3. Size: 48 by 96 inches.
 - 4. Thickness: Multiple layers (1-1/2" minimum) as required to meet minimum R-Value indicated.
- C. Tapered Insulation: Provide factory-tapered insulation boards.
 - 1. Material: Match roof insulation.
 - 2. Minimum Thickness: 1/4 inch.
 - 3. Slope:
 - a. Roof Field: 1/4 inch per foot unless otherwise indicated on Drawings.
 - b. Saddles and Crickets: 1/2 inch per foot unless otherwise indicated on Drawings.

2.6 INSULATION ACCESSORIES

- A. General: Roof insulation accessories recommended by insulation manufacturer for intended use and compatibility with other roofing system components.
- B. Fasteners: Factory-coated steel fasteners and metal or plastic plates complying with corrosion-resistance provisions in FM Approvals 4470, designed for fastening roof insulation and cover boards to substrate, and acceptable to roofing system manufacturer.
- C. Cover Board: DOC PS 2, Exposure 1, oriented strand board, 7/16 inch thick.
- D. Cover Board: ASTM C 1177/C 1177M, glass-mat, ASTM C 1278/C 1278M, fiber-reinforced gypsum board.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following similar to DensDeck:
 - a. CertainTeed Corporation.
 - b. Georgia-Pacific Building Products.
 - c. National Gypsum Company.
 - d. United States Gypsum Company.
2. Thickness: 5/8 inch.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.
 1. Verify that roof openings and penetrations are in place, curbs are set and braced, and roof-drain bodies are securely clamped in place.
 2. Verify that wood blocking, curbs, and nailers are securely anchored to roof deck at penetrations and terminations and that nailers match thicknesses of insulation.
 3. Verify that surface plane flatness and fastening of steel roof deck complies with requirements in Section 053100 "Steel Decking."
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Clean substrate of dust, debris, moisture, and other substances detrimental to roofing system installation according to roofing system manufacturer's written instructions. Remove sharp projections.
- B. Prevent materials from entering and clogging roof drains and conductors and from spilling or migrating onto surfaces of other construction. Remove roof-drain plugs when no work is taking place or when rain is forecast.
- C. Perform fastener-pullout tests according to roof system manufacturer's written instructions.
 1. Submit test result within 24 hours of performing tests.
 - a. Include manufacturer's requirements for any revision to previously submitted fastener patterns required to achieve specified wind uplift requirements.

3.3 ROOFING INSTALLATION, GENERAL

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

3.4 SUBSTRATE BOARD INSTALLATION

- A. Install substrate board with long joints in continuous straight lines, with end joints staggered not less than 24 inches in adjacent rows.
 - 1. At steel roof decks, install substrate board at right angle to flutes of deck.
 - a. Locate end joints over crests of steel roof deck.
 - 2. Tightly butt substrate boards together.
 - 3. Cut substrate board to fit tight around penetrations and projections, and to fit tight to intersecting sloping roof decks.
 - 4. Fasten substrate board to top flanges of steel deck to resist uplift pressure at corners, perimeter, and field of roof according to roofing system manufacturers' written instructions.

3.5 INSULATION INSTALLATION

- A. Coordinate installing roofing system components so insulation is not exposed to precipitation or left exposed at end of workday.
- B. Comply with roofing system and insulation manufacturer's written instructions for installing roof insulation.
- C. Installation Over Metal Decking:
 - 1. Install base layer of insulation with joints staggered not less than 24 inches in adjacent rows and with long joints continuous at right angle to flutes of decking.
 - a. Locate end joints over crests of decking.
 - b. Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
 - c. Make joints between adjacent insulation boards not more than 1/4 inch in width.
 - d. At internal roof drains, slope insulation to create a square drain sump with each side equal to the diameter of the drain bowl plus 24 inches.
 - 1) Trim insulation so that water flow is unrestricted.
 - e. Fill gaps exceeding 1/4 inch with insulation.

- f. Cut and fit insulation within 1/4 inch of nailers, projections, and penetrations.
 - g. Mechanically attach base layer of insulation and substrate board using mechanical fasteners specifically designed and sized for fastening specified board-type roof insulation to metal decks.
 - 1) Fasten insulation to resist specified uplift pressure at corners, perimeter, and field of roof.
2. Install upper layers of insulation and tapered insulation with joints of each layer offset not less than 12 inches from previous layer of insulation.
- a. Staggered end joints within each layer not less than 24 inches in adjacent rows.
 - b. Install with long joints continuous and with end joints staggered not less than 12 inches in adjacent rows.
 - c. Trim insulation neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
 - d. Make joints between adjacent insulation boards not more than 1/4 inch in width.
 - e. At internal roof drains, slope insulation to create a square drain sump with each side equal to the diameter of the drain bowl plus 24 inches.
 - f. Trim insulation so that water flow is unrestricted.
 - g. Fill gaps exceeding 1/4 inch with insulation.
 - h. Cut and fit insulation within 1/4 inch of nailers, projections, and penetrations.
 - i. Loosely lay each layer of insulation units over substrate.
 - j. Adhere each layer of insulation to substrate using adhesive according to FM Approvals' RoofNav assembly requirements and FM Global Property Loss Prevention Data Sheet 1-29 for specified Windstorm Resistance Classification, as follows:
 - 1) Set each layer of insulation in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.

3.6 INSTALLATION OF COVER BOARDS

- A. Install cover boards over insulation with long joints in continuous straight lines with end joints staggered between rows. Offset joints of insulation below a minimum of 6 inches in each direction.
 - 1. Trim cover board neatly to fit around penetrations and projections, and to fit tight to intersecting sloping roof decks.
 - 2. At internal roof drains, conform to slope of drain sump.
 - a. Trim cover board so that water flow is unrestricted.
 - 3. Cut and fit cover board tight to nailers, projections, and penetrations.

4. Adhere cover board to substrate using adhesive according to FM Approvals' RoofNav assembly requirements and FM Global Property Loss Prevention Data Sheet 1-29 for specified Windstorm Resistance Classification, as follows:
 - a. Set cover board in a uniform coverage of full-spread insulation adhesive, firmly pressing and maintaining insulation in place.

B. Install slip sheet over cover board and immediately beneath roofing.

3.7 ADHERED ROOFING INSTALLATION

- A. Adhere roof membrane over area to receive roofing according to roofing system manufacturer's written instructions.
- B. Unroll membrane roof membrane and allow to relax before installing.
- C. Start installation of roofing in presence of roofing system manufacturer's technical personnel.
- D. Accurately align roof membrane, and maintain uniform side and end laps of minimum dimensions required by manufacturer. Stagger end laps.
- E. Bonding Adhesive: Apply to substrate and underside of roof membrane at rate required by manufacturer, and allow to partially dry before installing roof membrane. Do not apply to splice area of roof membrane.
- F. In addition to adhering, mechanically fasten roof membrane securely at terminations, penetrations, and perimeters.
- G. Apply roof membrane with side laps shingled with slope of roof deck where possible.
- H. Adhesive Seam Installation: Clean both faces of splice areas, apply splicing cement.
 1. Firmly roll side and end laps of overlapping roof membrane to ensure a watertight seam installation.
 2. Apply lap sealant and seal exposed edges of roofing terminations.
 3. Apply a continuous bead of in-seam sealant before closing splice if required by roofing system manufacturer.
- I. Tape Seam Installation: Clean and prime both faces of splice areas, apply splice tape.
 1. Firmly roll side and end laps of overlapping roof membrane to ensure a watertight seam installation.
 2. Apply lap sealant and seal exposed edges of roofing terminations.
 3. Firmly roll side and end laps of overlapping roof membrane to ensure a watertight seam installation.
 4. Apply lap sealant and seal exposed edges of roofing terminations.

- J. Repair tears, voids, and lapped seams in roof membrane that do not comply with requirements.
- K. Spread sealant or mastic bed over deck-drain flange at roof drains, and securely seal roof membrane in place with clamping ring.

3.8 BASE FLASHING INSTALLATION

- A. Install sheet flashings and preformed flashing accessories, and adhere to substrates according to roofing system manufacturer's written instructions.
- B. Apply bonding adhesive to substrate and underside of sheet flashing at required rate, and allow to partially dry. Do not apply to seam area of flashing.
- C. Flash penetrations and field-formed inside and outside corners with cured or uncured sheet flashing.
- D. Clean splice areas, apply splicing cement, and firmly roll side and end laps of overlapping sheets to ensure a watertight seam installation. Apply lap sealant and seal exposed edges of sheet flashing terminations.
- E. Terminate and seal top of sheet flashings and mechanically anchor to substrate through termination bars.

3.9 PROTECTING AND CLEANING

- A. Protect roofing system from damage and wear during remainder of construction period. When remaining construction does not affect or endanger roofing system, inspect roofing system for deterioration and damage, describing its nature and extent in a written report, with copies to Architect and Owner.
- B. Correct deficiencies in or remove roofing system that does not comply with requirements, repair substrates, and repair or reinstall roofing system to a condition free of damage and deterioration at time of Substantial Completion and according to warranty requirements.
- C. Clean overspray and spillage from adjacent construction using cleaning agents and procedures recommended by manufacturer of affected construction.

3.10 ROOFING INSTALLER'S WARRANTY

- A. WHEREAS _____ of _____, herein called the "Roofing Installer," has performed roofing and associated work ("work") on the following project:

1. Owner: <Insert name of Owner>.
2. Address: <Insert address>.

3. Building Name/Type: <Insert information>.
4. Address: <Insert address>.
5. Area of Work: <Insert information>.
6. Acceptance Date: _____.
7. Warranty Period: <Insert time>.
8. Expiration Date: _____.

- B. AND WHEREAS Roofing Installer has contracted (either directly with Owner or indirectly as a subcontractor) to warrant said work against leaks and faulty or defective materials and workmanship for designated Warranty Period,
- C. NOW THEREFORE Roofing Installer hereby warrants, subject to terms and conditions herein set forth, that during Warranty Period Roofing Installer will, at Roofing Installer's own cost and expense, make or cause to be made such repairs to or replacements of said work as are necessary to correct faulty and defective work and as are necessary to maintain said work in a watertight condition.
- D. This Warranty is made subject to the following terms and conditions:
1. Specifically excluded from this Warranty are damages to work and other parts of the building, and to building contents, caused by:
 - a. lightning;
 - b. peak gust wind speed exceeding <Insert mph (m/s)>;
 - c. fire;
 - d. failure of roofing system substrate, including cracking, settlement, excessive deflection, deterioration, and decomposition;
 - e. faulty construction of parapet walls, copings, chimneys, skylights, vents, equipment supports, and other edge conditions and penetrations of the work;
 - f. vapor condensation on bottom of roofing; and
 - g. activity on roofing by others, including construction contractors, maintenance personnel, other persons, and animals, whether authorized or unauthorized by Owner.
 2. When work has been damaged by any of foregoing causes, Warranty shall be null and void until such damage has been repaired by Roofing Installer and until cost and expense thereof have been paid by Owner or by another responsible party so designated.
 3. Roofing Installer is responsible for damage to work covered by this Warranty but is not liable for consequential damages to building or building contents resulting from leaks or faults or defects of work.
 4. During Warranty Period, if Owner allows alteration of work by anyone other than Roofing Installer, including cutting, patching, and maintenance in connection with penetrations, attachment of other work, and positioning of anything on roof, this Warranty shall become null and void on date of said alterations, but only to the extent said alterations affect work covered by this Warranty. If Owner engages Roofing Installer to perform said alterations, Warranty shall not become null and

void unless Roofing Installer, before starting said work, shall have notified Owner in writing, showing reasonable cause for claim, that said alterations would likely damage or deteriorate work, thereby reasonably justifying a limitation or termination of this Warranty.

- 5. During Warranty Period, if original use of roof is changed and it becomes used for, but was not originally specified for, a promenade, work deck, spray-cooled surface, flooded basin, or other use or service more severe than originally specified, this Warranty shall become null and void on date of said change, but only to the extent said change affects work covered by this Warranty.
- 6. Owner shall promptly notify Roofing Installer of observed, known, or suspected leaks, defects, or deterioration and shall afford reasonable opportunity for Roofing Installer to inspect work and to examine evidence of such leaks, defects, or deterioration.
- 7. This Warranty is recognized to be the only warranty of Roofing Installer on said work and shall not operate to restrict or cut off Owner from other remedies and resources lawfully available to Owner in cases of roofing failure. Specifically, this Warranty shall not operate to relieve Roofing Installer of responsibility for performance of original work according to requirements of the Contract Documents, regardless of whether Contract was a contract directly with Owner or a subcontract with Owner's General Contractor.

E. IN WITNESS THEREOF, this instrument has been duly executed this _____ day of _____, _____.

- 1. Authorized Signature: _____.
- 2. Name: _____.
- 3. Title: _____.

END OF SECTION 075323

SECTION 076200
SHEET METAL FLASHING AND TRIM

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Drawings, Contract Conditions and other Technical Specifications Sections apply to work of this Section insofar as applicable.
- B. Coordinate work with that of all other trades affecting, or affected by work of this Section. Cooperate with such trades to assure the steady progress of all Project work.

1.02 DESCRIPTION

- A. The work in this section consists of furnishing all materials, equipment, transportation, labor and supervision, and performing all operations required to provide all sheet metal work including crickets as shown on the Drawings, as specified herein, and as is additionally required to properly complete the work.

1.03 SPECIFIED ELSEWHERE

- A. Ductwork is specified under Division 23 – Heating, Ventilating and Air Conditioning.

1.04 GENERAL REQUIREMENTS

- A. All sheet metal shall have the manufacturer's trade name and thickness or weight marked on each sheet.
- B. Surface to which sheet metal is to be applied shall be even, smooth, sound, thoroughly clean, dry and free from all defects that might affect the installation. Materials furnished under this section which are to be built in by others shall be delivered to the site in time to avoid delays in construction progress. All cutting, fitting, drilling, and other operations in connection with sheet metal required to accommodate the work of other trades shall be performed under this section. All accessories and other related items not specifically shown or specified also shall be provided under this section.
- C. During construction, care shall be taken to prevent damage to roofing and flashing in place by not walking over or placing materials on or against them.

1.05 SUBMITTALS

- A. Submit samples of all materials and copies of pertinent literature for approval before proceeding with the work.
- B. Submit Shop Drawings detailing all flashing installations.

PART 2 - MATERIALS

2.01 MATERIALS

- A. All copper shall be cold-rolled, 16 oz. lead-coated, as detailed or noted on the Drawings and specified herein.
- B. Nails and other accessories used for fastening copper shall be copper, bronze or brass of the required sizes.
- C. Solder shall be 40 percent pig lead and 60 percent block tin. Flux shall be muriatic acid killed with zinc, or an approved brand of soldering paste.

PART 3 - EXECUTION

3.01 INSTALLATION

All work shall be as shown on the Drawings, performed in strict compliance with the recommended practice and standard specifications of the Copper and Brass Research Association and "Copper and Common Sense" as published by Revere Copper and Brass.

END OF SECTION 076200

SECTION 078413
PENETRATION FIRESTOPPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings, Contract Conditions and other Technical Sections apply to work of this Section insofar as applicable.
- B. Coordinate work with that of all other trades affecting, or affected by work of this Section. Cooperate with such trades to assure the steady progress of all Project work.

1.2 SUMMARY

- A. Section Includes:
 - 1. Penetrations in fire-resistance-rated walls.
 - 2. Penetrations in horizontal assemblies.
 - 3. Penetrations in smoke barriers.

1.3 PREINSTALLATION MEETINGS

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

1.4 ACTION SUBMITTALS

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

1.5 INFORMATIONAL SUBMITTALS

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

1.6 CLOSEOUT SUBMITTALS

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

1.7 QUALITY ASSURANCE

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

1.8 PROJECT CONDITIONS

- A. Environmental Limitations: Do not install penetration firestopping system when ambient or substrate temperatures are outside limits permitted by penetration firestopping system manufacturers or when substrates are wet because of rain, frost, condensation, or other causes.
- B. Install and cure penetration firestopping materials per manufacturer's written instructions using natural means of ventilations or, where this is inadequate, forced-air circulation.

1.9 COORDINATION

- A. Coordinate construction of openings and penetrating items to ensure that penetration firestopping systems can be installed according to specified firestopping system design.
- B. Coordinate sizing of sleeves, openings, core-drilled holes, or cut openings to accommodate penetration firestopping systems.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

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

2.2 PENETRATION FIRESTOPPING SYSTEMS

- A. Penetration Firestopping Systems: Systems that resist spread of fire, passage of smoke and other gases, and maintain original fire-resistance rating of construction penetrated. Penetration firestopping systems shall be compatible with one another, with the substrates forming openings, and with penetrating items if any.
- B. Penetrations in Fire-Resistance-Rated Walls: Penetration firestopping systems with ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg.
 - 1. F-Rating: Not less than the fire-resistance rating of constructions penetrated.
- C. Penetrations in Horizontal Assemblies: Penetration firestopping systems with ratings determined per ASTM E 814 or UL 1479, based on testing at a positive pressure differential of 0.01-inch wg.
 - 1. F-Rating: At least one hour, but not less than the fire-resistance rating of constructions penetrated.
 - 2. T-Rating: At least one hour, but not less than the fire-resistance rating of constructions penetrated except for floor penetrations within the cavity of a wall.
 - 3. W-Rating: Provide penetration firestopping systems showing no evidence of water leakage when tested according to UL 1479.
- D. Penetrations in Smoke Barriers: Penetration firestopping systems with ratings determined per UL 1479, based on testing at a positive pressure differential of 0.30-inch wg.
 - 1. L-Rating: Not exceeding 5.0 cfm/sq. ft. of penetration opening at and no more than 50-cfm cumulative total for any 100 sq. ft. at both ambient and elevated temperatures.
- E. Exposed Penetration Firestopping Systems: Flame-spread and smoke-developed indexes of less than 25 and 450, respectively, per ASTM E 84.
- F. VOC Content: Penetration firestopping sealants and sealant primers shall comply with the following limits for VOC content:
 - 1. Sealants: 250 g/L.
 - 2. Sealant Primers for Nonporous Substrates: 250 g/L.
 - 3. Sealant Primers for Porous Substrates: 775 g/L.
- G. Low-Emitting Materials: Penetration firestopping sealants and sealant primers shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
- H. Accessories: Provide components for each penetration firestopping system that are needed to install fill materials and to maintain ratings required. Use only those components specified by penetration firestopping system manufacturer and approved by qualified testing and inspecting agency for conditions indicated.
 - 1. Permanent forming/damming/backing materials.

2. Substrate primers.
3. Collars.
4. Steel sleeves.

2.3 FILL MATERIALS

- A. Cast-in-Place Firestop Devices: Factory-assembled devices for use in cast-in-place concrete floors and consisting of an outer sleeve lined with an intumescent strip, a flange attached to one end of the sleeve for fastening to concrete formwork, and a neoprene gasket.
- B. Latex Sealants: Single-component latex formulations that do not re-emulsify after cure during exposure to moisture.
- C. Firestop Devices: Factory-assembled collars formed from galvanized steel and lined with intumescent material sized to fit specific diameter of penetrant.
- D. Intumescent Composite Sheets: Rigid panels consisting of aluminum-foil-faced intumescent elastomeric sheet bonded to galvanized-steel sheet.
- E. Intumescent Putties: Nonhardening, water-resistant, intumescent putties containing no solvents or inorganic fibers.
- F. Intumescent Wrap Strips: Single-component intumescent elastomeric sheets with aluminum foil on one side.
- G. Mortars: Prepackaged dry mixes consisting of a blend of inorganic binders, hydraulic cement, fillers and lightweight aggregate formulated for mixing with water at Project site to form a nonshrinking, homogeneous mortar.
- H. Pillows/Bags: Reusable heat-expanding pillows/bags consisting of glass-fiber cloth cases filled with a combination of mineral-fiber, water-insoluble expansion agents, and fire-retardant additives. Where exposed, cover openings with steel-reinforcing wire mesh to protect pillows/bags from being easily removed.
- I. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.
- J. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants.

2.4 MIXING

- A. Penetration Firestopping Materials: For those products requiring mixing before application, comply with penetration firestopping system manufacturer's written instructions for accurate proportioning of materials, water (if required), type of mixing equipment, selection of mixer speeds, mixing containers, mixing time, and other items or procedures needed to produce products of uniform quality with optimum performance characteristics for application indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions, with Installer present, for compliance with requirements for opening configurations, penetrating items, substrates, and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Cleaning: Before installing penetration firestopping systems, clean out openings immediately to comply with manufacturer's written instructions and with the following requirements:
 - 1. Remove from surfaces of opening substrates and from penetrating items foreign materials that could interfere with adhesion of penetration firestopping materials.
 - 2. Clean opening substrates and penetrating items to produce clean, sound surfaces capable of developing optimum bond with penetration firestopping materials. Remove loose particles remaining from cleaning operation.
 - 3. Remove laitance and form-release agents from concrete.
- B. Prime substrates where recommended in writing by manufacturer using that manufacturer's recommended products and methods. Confine primers to areas of bond; do not allow spillage and migration onto exposed surfaces.

3.3 INSTALLATION

- A. General: Install penetration firestopping systems to comply with manufacturer's written installation instructions and published drawings for products and applications.
- B. Install forming materials and other accessories of types required to support fill materials during their application and in the position needed to produce cross-sectional shapes and depths required to achieve fire ratings.
 - 1. After installing fill materials and allowing them to fully cure, remove combustible forming materials and other accessories not forming permanent components of firestopping.
- C. Install fill materials by proven techniques to produce the following results:
 - 1. Fill voids and cavities formed by openings, forming materials, accessories and penetrating items to achieve required fire-resistance ratings.
 - 2. Apply materials so they contact and adhere to substrates formed by openings and penetrating items.
 - 3. For fill materials that will remain exposed after completing the Work, finish to produce smooth, uniform surfaces that are flush with adjoining finishes.

3.4 IDENTIFICATION

- A. Wall Identification: Permanently label walls containing penetration firestopping systems with the words "FIRE AND/OR SMOKE BARRIER - PROTECT ALL OPENINGS," using lettering not less than 3 inches high and with minimum 0.375-inch strokes.
 - 1. Locate in accessible concealed floor, floor-ceiling, or attic space at 15 feet from end of wall and at intervals not exceeding 30 feet.
- B. Penetration Identification: Identify each penetration firestopping system with legible metal or plastic labels. Attach labels permanently to surfaces adjacent to and within 6 inches of penetration firestopping system edge so labels are visible to anyone seeking to remove penetrating items or firestopping systems. Use mechanical fasteners or self-adhering-type labels with adhesives capable of permanently bonding labels to surfaces on which labels are placed. Include the following information on labels:
 - 1. The words "Warning - Penetration Firestopping - Do Not Disturb. Notify Building Management of Any Damage."
 - 2. Contractor's name, address, and phone number.
 - 3. Designation of applicable testing and inspecting agency.
 - 4. Date of installation.
 - 5. Manufacturer's name.
 - 6. Installer's name.

3.5 FIELD QUALITY CONTROL

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

3.6 CLEANING AND PROTECTION

- A. Clean off excess fill materials adjacent to openings as the Work progresses by methods and with cleaning materials that are approved in writing by penetration firestopping system manufacturers and that do not damage materials in which openings occur.
- B. Provide final protection and maintain conditions during and after installation that ensure that penetration firestopping systems are without damage or deterioration at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, immediately cut out and remove damaged or deteriorated penetration firestopping material and install new materials to produce systems complying with specified requirements.

3.7 PENETRATION FIRESTOPPING SYSTEM SCHEDULE

- A. Where UL-classified systems are indicated, they refer to system numbers in UL's "Fire Resistance Directory" under product Category XHEZ.
- B. Where FM Global-approved systems are indicated, they refer to design numbers listed in FM Global's "Building Materials Approval Guide" under "Wall and Floor Penetration Fire Stops."
- C. Penetration Firestopping Systems with No Penetrating Items: UL Classified System Group 0001-1000.
 - 1. F-Rating: 1 & 2 hour.
 - 2. T-Rating: 1 & 2 hour.
 - 3. W-Rating: No leakage of water at completion of water leakage testing.
 - 4. Type of Fill Materials: As required to achieve rating.
- D. Penetration Firestopping Systems for Metallic Pipes, Conduit, or Tubing: UL Classified System Group 1001-1999.
 - 1. F-Rating: 1 & 2 hour.
 - 2. T-Rating: 1 & 2 hour.
 - 3. W-Rating: No leakage of water at completion of water leakage testing.
 - 4. Type of Fill Materials: As required to achieve rating.
- E. Penetration Firestopping Systems for Nonmetallic Pipe, Conduit, or Tubing: UL Classified System Group 2001-2999.
 - 1. F-Rating: 1 & 2 hour.
 - 2. T-Rating: 1 & 2 hour.
 - 3. W-Rating: No leakage of water at completion of water leakage testing.
 - 4. Type of Fill Materials: As required to achieve rating.
- F. Penetration Firestopping Systems for Electrical Cables: UL Classified System Group 3001-3999.
 - 1. F-Rating: 1 & 2 hour.
 - 2. T-Rating: 1 & 2 hour.
 - 3. W-Rating: No leakage of water at completion of water leakage testing.
 - 4. Type of Fill Materials: As required to achieve rating.
- G. Penetration Firestopping Systems for Cable Trays with Electric Cables: UL Classified System Group 4001-4999.
 - 1. F-Rating: 1 & 2 hour.
 - 2. T-Rating: 1 & 2 hour.
 - 3. W-Rating: No leakage of water at completion of water leakage testing.
 - 4. Type of Fill Materials: As required to achieve rating.
- H. Penetration Firestopping Systems for Insulated Pipes: UL Classified System Group 5001-5999.
 - 1. F-Rating: 1 & 2 hour.
 - 2. T-Rating: 1 & 2 hour.
 - 3. W-Rating: No leakage of water at completion of water leakage testing.
 - 4. Type of Fill Materials: As required to achieve rating.

- I. Penetration Firestopping Systems for Miscellaneous Electrical Penetrants: UL Classified System Group 6001-6999.
 - 1. F-Rating: 1 & 2 hour.
 - 2. T-Rating: 1 & 2 hour.
 - 3. W-Rating: No leakage of water at completion of water leakage testing.
 - 4. Type of Fill Materials: As required to achieve rating.

- J. Penetration Firestopping Systems for Miscellaneous Mechanical Penetrants: UL Classified System Group 7001-7999.
 - 1. F-Rating: 1 & 2 hour.
 - 2. T-Rating: 1 & 2 hour.
 - 3. W-Rating: No leakage of water at completion of water leakage testing.
 - 4. Type of Fill Materials: As required to achieve rating.

- K. Penetration Firestopping Systems for Groupings of Penetrants: UL Classified System Group 8001-8999.
 - 1. F-Rating: 1 & 2 hour.
 - 2. T-Rating: 1 & 2 hour.
 - 3. W-Rating: No leakage of water at completion of water leakage testing.
 - 4. Type of Fill Materials: As required to achieve rating.

END OF SECTION 078413

SECTION 079200
JOINT SEALANTS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Examine Drawings, Contract Conditions all other Sections of the Specifications for requirements which affect work of this Section whether or not such work is specifically mentioned in this Section.
- B. Coordinate work with that of all other trades affecting, or affected by work of this Section. Cooperate with such trades to assure the steady progress of all Project work.

1.02 DESCRIPTION

- A. In general, the conditions requiring joint sealers are shown on the Drawings. This phase of work includes the furnishing all equipment, labor and materials necessary to provide joint sealant installations which are complete in every respect and of the composition and quality as specified herein.
- B. The required applications include, but are not necessarily limited to the following:
 - 1. Pavement and sidewalk joints subjected to foot or vehicular traffic.
 - 2. Exterior building wall joints, including joints at windows, doors and louvers.
 - 3. Flashing and coping joints.
 - 4. Miscellaneous concrete construction joints.
 - 5. Partition, ceiling, and door frame joints.
 - 6. Masonry expansion joints; exterior and interior.
 - 7. Construction joints in islands, curbing, pavement and barrier walls
- C. Sealants for glazing are specified in Section 088000.

1.03 SUBMITTALS

- A. Manufacturer's Data: Submit eight (8) copies of manufacturers' specifications, recommendations and installation instructions for each type of material and application required. Include manufacturer's published data, or letter of certification, or certified test laboratory report indicating that each material complies with the requirements and is intended generally for the applications shown.

- B. Samples: Submit three 12-inch-long samples of each color required for each type of joint sealer exposed to view. Install sample between 2 strips of material similar to or representative of typical surfaces where sealer will be used, held apart to represent typical joint widths. Samples will be reviewed by the Engineer for color and texture only. Compliance with all other requirements is exclusively the responsibility of the Contractor.
- C. Guarantee: Submit two copies of written guarantee agreeing to repair or replace joint sealers which fail to perform as airtight and watertight, or fail in joint adhesion, cohesion, abrasion resistance, weather resistance, extrusion resistance, migration resistance, stain resistance, or general durability, or appear to deteriorate in any other manner not clearly specified by submitted manufacturer's data as an inherent quality of the material for the exposure indicated. The Contractor shall provide signed guarantee for a period of two years.

1.04 QUALITY ASSURANCE AND COORDINATION

- A. Prior to commencing work required by this Section, the Contractor shall examine the areas and conditions which exist where joint sealer work is to be performed and notify the Engineer in writing of any conditions which are in conflict with requirements of the Contract Documents and are detrimental to the proper and timely completion of the Work. Do not proceed with the work until unsatisfactory conditions have been corrected.
- B. Do not proceed with installation of sealants under adverse weather conditions, or when temperatures are below or above the manufacturer's recommended limitations for installation. Proceed with the work only when temperatures are below or above manufacturer's recommended limitations for installation. Proceed with the work only when forecasted weather conditions are favorable for proper cure and development of high early bond strength. Wherever joint width is affected by ambient temperature variations, install elastomeric sealants only when temperatures are in the lower third of manufacturer's recommended installation temperature range.

PART 2 - MATERIALS

2.01 MATERIALS

- A. Colors: For exposed materials provide color as indicated or, if not indicated, as selected by Engineer from manufacturer's standard colors. For concealed materials, provide the color which has the best overall performance characteristics.
- B. Hardness: As recommended by manufacturer for application shown, unless otherwise indicated or required by the Engineer.

- C. Modulus of Elasticity: Provide the lowest available modulus of elasticity which is consistent with exposure to weathering, indentation, vandalism, abrasion, support of loading, and other requirements.
- D. Compatibility: Before purchase of each required material, confirm its compatibility with each material it will be exposed to in the joint system. Notify the Resident of potential problems.
- E. Size and Shape: As shown or, if not shown, as recommended by the manufacturer and approved by the Resident for the type and condition of joint, and for the indicated joint performance or movement.
- F. Grade of Sealant: For each application, provide the grade of sealant (non-sag, self-leveling, no-track, knife grade, preformed, etc.) as recommended by the manufacturer and approved by the Resident for the particular condition of installation (location, joint shape, ambient temperature, and similar conditions), to achieve the best possible appearance and overall performance. Grades specified herein are for normal conditions of installation.

2.02 ELASTOMERIC SEALANTS

- A. Foot Traffic Joints: Two-component polyurethane sealant; polyurethane- based, 2-part elastomeric sealant, complying with FS TT-S00227E, Type 1, Self-leveling, Class A. Provide one of the following:

Pecora NR-200; Pecora
Sonolastic Pavement Joint Sealant; Sonneborn/Contech, Inc.
Tremco THC - 900/901; Tremco

- B. Exterior Joints and Interior Moving Joints: Polymeric base sealant; modified polyurethane rubber, 2 or 3-part elastomeric sealant complying with FS TT-S00227E, Type II, Non-sag, Class A. Provide one of the following:

Dymeric Sealant; Tremco
Dynatrol II; Pecora
Sonolastic NP-2; Sonneborn/Contech Inc.

Note: Wherever polyurethane sealants are in contact with anodized aluminum, the sealant manufacturer's recommended primer shall be used.

2.03 NON-ELASTOMERIC SEALANTS

Interior Non-moving and Non-watertight Joints: One-component, non-staining, non-sagging, non-bleeding acrylic emulsion base latex sealant. Use only at interior joints where movement is not likely and watertightness is not necessary. Sealant shall be "Mono" by Tremco or approved equal by Pecora or Sika.

2.04 JOINT FILLERS

- A. Bituminous and Fiber Joint Filler:
- B. Provide resilient and non-extruding type premolded bituminous impregnated fiberboard units complying with ASTM D 1751, FS HH-F-341, Type 1 and AASHTO M 213. Provide where concrete slabs meet walls and similar isolation points as shown on the Drawings or directed by the Engineer.
- C. Joint Primer/Sealer: Provide the type of joint primer/sealer recommended by the sealant manufacturer for the joint surfaces to be primed or sealed.
- D. Bond Breaker Tape: Self-adhering polyethylene tape or other plastic tape as recommended by the sealant manufacturer to be applied to surfaces where bond of sealant to the substrate or joint filler or backer rod must be avoided for proper performance of sealant.
- E. Sealant Backer Rod: Compressible rod stock of polyethylene foam, polyethylene jacketed polyurethane foam, butyl rubber foam, neoprene foam or other flexible, permanent, durable, closed-cell, non-absorptive, non-gassing material as recommended for compatibility with sealant by the sealant manufacturer and approved by the Engineer. Install backer rod behind the sealant in all exterior and interior masonry expansion joints unless otherwise detailed.
- F. Compressible Filler and Fire-rated Sealant: Filler shall be "Polytite" precompressed expanding tape as manufactured by Sandell Mfg. Co. or approved equal by W. R. Grace or Willseal. Sealant shall be approved gun-grade material by 3M Co. or Hilti.

PART 3 - EXECUTION

3.01 MANUFACTURER'S INSTRUCTIONS

Comply with manufacturer's printed instructions except where more stringent requirements are shown or specified, and except where manufacturer's technical representative directs otherwise.

3.02 JOINT PREPARATION

- A. Clean joint surfaces immediately before installation of sealant. Remove dirt, insecure coatings, moisture and other substances which would interfere with bond of sealant. Etch concrete and masonry joint surfaces as recommended by sealant manufacturer. Roughen vitreous or glazed joint surfaces if recommended by sealant manufacturer.
- B. Prime joint surfaces wherever shown or recommended by the sealant manufacturer. Do not allow primer to spill or migrate onto adjoining surfaces.

- C. At exterior masonry joints where flexible thru-wall flashing has been left extended 4 inches beyond the wall, carefully secure the flashing to the upper masonry wall in order to prepare the joint to receive sealant.

3.03 INSTALLATION

- A. Set joint filler units at proper depth and position in the joint to coordinate with other work, including the installation of bond breakers and backer rods. Do not leave voids or gaps between the ends of joint filler units; bond ends together as recommended by the manufacturer.
- B. Install sealant backer rod for elastomeric sealants, except where shown to be omitted or recommended to be omitted by sealant manufacturer for the application shown.
- C. Take care to ensure that sealant does not cover any weep holes.
- D. After the joints where the flexible thru-wall flashing occurs have been sealed and the sealant has cured sufficiently to prevent deformation of the joint, carefully cut off the extended thru-wall flashing to protrude 1/8 inch beyond the end of the horizontal leg of any exposed steel lintel at a window or door opening.
- E. Install bond breaker tape wherever shown and required by the manufacturer's recommendations to ensure that elastomeric sealants will perform properly.
- F. Employ only proven installation techniques which will ensure that sealants will be deposited in uniform, continuous ribbons without gaps or air pockets, and with complete "wetting" of the joint bond surfaces on opposite sides. Except as otherwise indicated, fill sealant rabbet to a slightly concave surface, slightly below adjoining surfaces. Where horizontal joints are between a horizontal surface and vertical surface, fill joint to form a slight cove so that joint will not trap moisture and dirt.
- G. Install sealant to depths as shown or, if not shown, as recommended by the sealant manufacturer but within the following general limitations, measured at the center (thin) section of the bead.

For sidewalks, pavements and similar joints sealed with elastomeric sealants and subject to traffic and other types of abrasion and indentation exposures, fill joints to a depth equal to 75% of joint width, but neither more than 3/4-inch-deep nor less than 3/8 inch deep.

For normal moving joints sealed with elastomeric sealants but not subject to traffic, fill joints to a depth equal to 50% of joint width, but neither more than 1/2-inch-deep nor less than 1/4 inch deep.

For joints sealed with non-elastomeric sealants fill joints to a depth in the range of 75% to 125% of joint width.

- H. Do not allow sealants or compounds to overflow or spill onto adjoining surfaces or glass, or to migrate into the voids of adjoining surfaces. Clean such surfaces by whatever means may be necessary to eliminate evidence of spillage, as approved by the Engineer.
- I. Recess exposed edges of gaskets and joint fillers slightly behind adjoining surfaces, unless otherwise shown, so that compressed units will not protrude from the joint.
- J. Bond ends of gaskets together with adhesive or by other means as recommended by the manufacturer to ensure continuous watertight and airtight performance. Miter-cut and bond ends at corners unless molded corner units are provided.

3.04 CURING AND PROTECTION

Cure sealants in compliance with manufacturer's instructions and recommendations to obtain high early bond strength, internal cohesive strength and surface durability. Advise the Contractor of procedures required for the cure and protection of joint sealers during the construction period, so that they will be without deterioration or damage (other than normal wear and weathering) at the time of Authority's acceptance.

END OF SECTION 079200

SECTION 081113
HOLLOW METAL DOORS AND FRAMES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Examine Drawings, Contract Conditions all other Sections of the Specifications for requirements which affect work of this Section whether or not such work is specifically mentioned in this Section.
- B. Coordinate work with that of all other trades affecting, or affected by work of this Section. Cooperate with such trades to assure the steady progress of all Project work.

1.02 DESCRIPTION

- A. Standard steel doors and frames (including transoms and louver frames) are indicated on the Drawings and details, and are itemized in the Door Schedule. The work includes furnishing all materials, equipment, labor and supervision, and performing all operations necessary to furnish and install steel doors and frames complete in every respect, as shown on the Drawings, as specified herein, and as is additionally required to properly complete the work.
- B. The application of finish hardware for steel doors is part of the work of this section but hardware is provided under Section 087100.
- C. Furnishing and installing steel frames for louvers is part of the work of this section. Furnishing and installing louvers is specified under Section 101010.
- D. Glass and glazing will be performed under Section 088000.

1.03 QUALITY ASSURANCE

- A. Provide doors and frames complying with Steel Door Institute "Recommended Specifications: Standard Steel Doors and Frames" (SDI-100) and complying with these specifications. Doors shall be Grade II, Heavy Duty, Model 1, galvanized at exterior locations; face sheets for exterior doors shall be 16 gage, face sheets for interior doors shall be 18 gage. If a conflict should exist between the standard and the specifications, the more stringent or conservative requirement shall apply.
- B. Temperature Rise Rating: At stairwell enclosures, provide doors which have a Temperature Rise Rating of 450°F (232°C) maximum in 30 minutes of fire exposure.

1.04 SUBMITTALS

- A. Product Data: Submit for the Engineer's approval, eight (8) copies of manufacturer's specifications for fabrication and installation, including data substantiating that products comply with specified codes and requirements. Also provide technical data for prime paint material and application.
- B. Shop Drawings: Submit for the Engineer's approval, one transparency and three prints of drawings to be used for the fabrication and installation of steel doors and frames. Include details of each frame type, elevations of door design types, conditions at openings, details of construction, location and installation requirements of finish hardware and reinforcements, and details of joints, connections, anchorages and accessory items.
- C. Provide a schedule of doors and frames using same reference numbers for details and openings as those on the Contract Drawings.

1.05 DELIVERY, STORAGE AND HANDLING

- A. Deliver materials cartoned or crated to provide protection during transit and jobsite storage.
- B. Inspect materials upon delivery for damage. Minor damage may be repaired provided finished items are equal in all respects to new work and acceptable to the Engineer, otherwise, remove and replace damaged items at no additional cost.
- C. Store doors and frames at the site under cover in accordance with the manufacturer's recommendations. Place units on wood dunnage at least 4 inches high, or otherwise store on floors in manner that will prevent rust and damage. Avoid use of non-vented plastic or canvas shelters which could create humidity chambers. If cartons become wet, remove them immediately. Provide 1/4 inch to 1/2 inch space between stacked doors and frames to promote air circulation.

PART 2 – MATERIALS

2.01 ACCEPTABLE MANUFACTURERS

- A. Provide steel doors and frames by Steelcraft, Republic, or Curries.

2.02 MATERIALS

- A. Hot-Rolled Steel Sheets and Strip: Commercial quality carbon steel, pickled and oiled, complying with ASTM A 568 and ASTM A 569.
- B. Cold-Rolled Steel Sheets: Commercial quality carbon steel, complying with ASTM A 366 and ASTM A 568.

- C. Galvanized Steel Sheets: Zinc-coated carbon steel sheets of commercial quality, complying with ASTM A 526 having ASTM A 525, G60 zinc coating, mill phosphatized.
- D. Supports and Anchors:
 - 1. Furnish wall anchors as required to secure frames to adjacent construction, formed of not less than 18 gage galvanized steel sheet (before galvanizing), as follows:
 - a. Concrete Masonry Unit Construction: Adjustable, T-shape flat, corrugated or perforated, to suit frame size with leg not less than 3 inches wide by 10 inches long. Furnish at least 4 anchors per jamb.
 - b. Floor Anchors: Provide floor anchors for each jamb and for mullions which extend to the floor, formed of not less than 0.0625 inch thick (No. 16 gage) galvanized steel sheet, as follows:
 - Monolithic Concrete Slabs: Clip type anchors, with 2 holes to receive fasteners, welded to bottom of jamb and mullions.
 - Head Anchors: Provide 2 anchors at head of frames exceeding 36 inch wide.
 - 2. Spreader Bars: Provide 2 removable spreader bars across the bottom of frames, tack welded to jambs and mullions.
- E. Inserts, Bolts and Fasteners: Manufacturer's standard units, except hot-dip galvanize items to be built into exterior walls, complying with ASTM A 153, Class C or D, as applicable. Expansion anchors shall be "Kwik-Bolts" as manufactured by Hilti Fastening Systems or approved equal.
- F. Shop-Applied Paint: High quality rust-inhibitive baked-on enamel suitable as a base for specified finish paints.

2.03 FABRICATION

- A. Fabricate steel door and frame units (including transoms), to be rigid, neat in appearance, and free from defects, warp or buckle. Wherever practicable, fit and assemble units in manufacturer's plant. Clearly identify and match-mark work that cannot be permanently factory-assembled before shipment to assure proper assembly at the site.
- B. Fabricate exposed faces of doors, and frames for exterior door and louver units from cold-rolled steel only.
- C. Fabricate frames for interior doors, concealed stiffeners, reinforcement, edge channels, louvers and moldings from either cold-rolled or hot-rolled steel at manufacturer's option.

D. Doors prepared for glass lights shall have the openings securely framed and shall be complete with screwless snap-in glazing beads on the non-security side.

E. Finish Hardware Preparation:

Prepare doors and frames to receive mortised and concealed finish hardware in accordance with the approved Finish Hardware Schedule and templates provided by hardware manufacturer. Comply with applicable requirements of ANSI A 115 series specifications for door and frame preparation for hardware. Where surface mounted hardware is to be applied, frames shall have reinforcing plates.

Minimum thickness of hardware reinforcing plates shall be as follows:

Hinge reinforcements - 7 gage 1-1/4" x 10" minimum size.

Strike reinforcements - 12 gage.

Flush bolt reinforcements - 12 gage.

Closer reinforcements - 12 gage.

Reinforcements for surface-mounted hardware - 12 gage.

Locate knobs, levers, panic devices, push plates, and pulls in accordance with the requirements of ANSI A117.1-86, "Specifications for Making Buildings and Facilities Accessible to and Usable by, Physically Handicapped People" and ADA Guidelines. Locate other finish hardware items in accordance with "Recommended Locations for Builder's Hardware", published by Door and Hardware Institute.

F. Door Silencers: Except on weatherstripped frames, drill stops to receive 3 silencers on strike jambs of single-swing frames and 2 silencers on heads of double-swing frames.

G. Plaster Guards: Provide 26 gage (minimum) steel plaster guards or mortar boxes, welded to frame at back of finish hardware cutouts where mortar or other materials might obstruct hardware installation or operation.

H. Shop Painting:

Clean, treat and paint exposed surfaces of steel door and frame units, including galvanized surfaces.

Clean steel surfaces of mill scale, rust, oil, grease, dirt and other foreign materials before application of paint.

Apply shop coat of prime paint of even consistency and bake to provide a uniformly finished surface ready to receive finish paint.

2.04 STANDARD STEEL DOORS

- A. Provide metal doors of the types and styles indicated on the Drawings or Schedules and complying with SDI SD 100, Grade II, Heavy Duty, Model 1, galvanized for exterior locations. Doors shall be made of commercial quality, level cold-rolled steel and free of scale, pitting or other surface defects. Face sheets for interior doors shall be not less than 18 gage. Face sheets for exterior doors shall be not less than 16 gage and shall be hot dip galvanized.

- B. Flush Door Construction:

All doors shall be of the types and nominal sizes shown on the Door Schedule and approved shop drawings. Minimum door thickness shall be 1-3/4 inches.

All doors shall be strong, rigid and neat in appearance, free from warpage and buckle. Corner bends shall be true, straight and of the minimum radius for the gage of metal used.

Doors shall be reinforced, stiffened and sound deadened with impregnated kraft honeycomb core (or approved closed-cell insulation at exterior locations), completely filling the inside of the door and laminated to the inside faces of panels. Other core construction, standard with approved manufacturer's meeting specified U.L. Label requirements and providing effective sound deadening, are acceptable.

Top and bottom edges of all doors shall be closed with a continuous recessed steel channel not less than 16 gage extending the full width of the door and spot welded to both faces (hot-dip galvanized for exterior doors). Exterior doors shall have an additional flush closing hot-dip galvanized channel at their top and bottom edges with suitable openings be provided in the bottom closure to permit the escape of entrapped moisture.

Beveled edge profiles shall be provided on both vertical edges of doors.

- C. Door Louvers:

Provide sightproof stationary louvers for interior doors where indicated, constructed of inverted V-shaped or Y-shaped blades formed of 24 gage cold-rolled steel set into 20 gage steel frames.

2.05 STANDARD STEEL FRAMES

Provide metal frames for doors and transoms, including frames for wood doors, of types and styles as shown on Drawings and schedules (butted and wrap-around), utilizing concealed fastenings, unless otherwise indicated.

Frames for exterior openings and interior U.L. labeled doors shall be made of commercial grade cold-rolled steel, not less than 14 gage. Exterior frames shall be hot dip galvanized steel. Frames shall be designed for a minimum 25 pounds per square foot horizontal load.

Frames for other interior openings shall be either commercial grade cold-rolled steel or commercial grade hot-rolled and pickled steel. Metal thickness for frames shall be not less than 16 gage.

Frames for exterior doors, interior masonry walls and drywall openings shall be press brake formed with 5/8" high integral stops. Corners shall be back seam and face welded with face welds ground neatly smooth.

Fabricate frames of full welded unit construction, with corners mitered, reinforced, continuously welded the full depth and width of frame, with welds dressed smooth and flush. Knock-down type frames are not acceptable. Frames shall be manufactured by the same manufacturer who is supplying the hollow metal doors.

PART 3 - EXECUTION

3.01 INSPECTION

Examine substrate and conditions under which steel doors and frames are to be installed and notify the Engineer in writing of any conditions detrimental to proper and timely completion of work. Do not proceed with work until unsatisfactory conditions have been corrected in an acceptable manner.

3.02 INSTALLATION

- A. Install hollow metal units and accessories in accordance with final shop drawings, the manufacturer's approved installation instructions, and as specified herein.
- B. Placing Frames: Comply with provisions of SDI-105 "Recommended Erection Instructions For Steel Frames", unless otherwise indicated.

Place frames prior to construction of enclosing walls and ceilings. Protect hardware securements from mortar spillage, joint compound, and other damage. Set frames accurately in position, plumbed, aligned, and securely braced until permanent anchors are set. After wall construction is completed, remove temporary braces and spreaders leaving surfaces smooth and undamaged. Door frame installation also includes setting of thresholds where applicable.

In masonry construction, locate 4 wall anchors per jamb. Building-in of anchors and grouting of frames is specified in Division 4.

Install fire-rated frames in accordance with NFPA Pamphlet No. 80.

- C. Finish Hardware:

Install finish hardware in strict accordance with the final approved shop drawings and the manufacturers' instructions, and adjust for easy action. Set locksets level and true with the proper backset. Adjust striking plates to be in exact alignment with bolts and

latches. Adjust spindles and latch bolts for easy action. Set all screws flush with the metal surface without any broken or damaged heads.

All wrapping on knobs, handles, pulls, etc., furnished by the manufacturer shall be replaced on the hardware after it is installed and shall remain until final acceptance of the work, at which time the Contractor shall remove and dispose of all coverings.

D. Door Installation:

Hang doors plumb and true with a uniform clearance at the head and jambs, in accordance with SDI-100 and NFPA Pamphlet 80, and with all hardware in perfect working order.

3.03 ADJUST AND CLEAN

- A. Prime Coat Touch-up: Immediately after erection, sand smooth rusted and damaged areas of prime coat and touch-up with compatible air-drying primer.
- B. Final Adjustments: Check and re-adjust operating finish hardware items leaving steel doors and frames undamaged and in complete and proper operating condition. Remove and replace defective work.

END OF SECTION 081113

SECTION 084113
ALUMINUM-FRAMED ENTRANCES AND STOREFRONTS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Examine Drawings, Contract Conditions all other Sections of the Specifications for requirements which affect work of this Section whether or not such work is specifically mentioned in this Section.
- B. Coordinate work with that of all other trades affecting, or affected by work of this Section. Cooperate with such trades to assure the steady progress of all Project work.

1.02 DESCRIPTION

The work in this section consists of furnishing all materials, equipment, transportation, labor and supervision, and performing all operations required to furnish and install an aluminum entrance door, frame, transom, sidelite, associated hardware, and joint sealing as shown on the Drawings, as specified herein, and as is additionally required to properly complete the work.

1.03 SPECIFIED ELSEWHERE

- A. Joint sealing related to aluminum frames is part of the work of this section and shall be performed in accordance with the requirements of Section 079200, Joint Sealers.
- B. Glass and glazing shall be performed under Section 088000.

1.04 GENERAL REQUIREMENTS

- A. Aluminum entrance door, frame and transom, as detailed on the Drawings and specified herein are as manufactured by Kawneer Architectural Products. Products of similar quality and appearance manufactured by Vistawall or Wausau will be considered for use. The door detailed is a Wide Stile Kawneer "350 Entrance Door" with "451T" framing.
- B. Performance: The design and construction of the aluminum entrance doors shall be such as to pass the tests listed below.
 - 1. Dual Moment Load Test as follows:
 - a. Test sections shall consist of a standard top door corner assembly. Side rail section shall be 24 inch long and top rail section shall be 12 inch long.
 - b. Anchor "top rail" positively to test bench so that corner protrudes 3 inches beyond bench edge.

- c. Anchor a lever arm (capable of supporting 300 pounds) positively to "side rail" at a point 19 inches from inside edge of "top rail". Attach weight support pad at a point 19 inches from inner edge of "side rail".
- d. Test section shall withstand a load of 270 pounds on the lever arm before reaching the point of failure which shall be considered a rotation of the lever arm in excess of 45°.

1.05 SHOP DRAWINGS AND PRODUCT DATA

Submit eight (8) copies of shop drawings showing door and frame details for approval. Submit seven copies of manufacturers' product data for door, framing, and each type of hardware required.

1.06 SAMPLES

- A. Submit two (2) sets of 12 inch long samples of extrusions and formed shapes. Include 3 or more samples in each set showing near-limits of variations in color and finish. Once approved, samples submitted under this section will establish the extreme variation in color acceptable.
- B. Submit samples of each type of hardware required.

PART 2 - MATERIALS

2.01 MATERIALS

- A. Sections shall be extruded from 6063-T3 aluminum alloy (ASTM B 221, alloy GS 10A-T5).
- B. Major portions of the door stiles shall be .125 inch in thickness; glazing molding shall be .050 inch thick.

2.02 CONSTRUCTION

- A. Doors. - The Kawneer "350 Entrance Door" shall have vertical stiles of 5 inches, top rails of 5 inches, and bottom rails of 6-1/2 inches. Corner construction shall consist of both SIGMA deep penetration welds and mechanical clip fastening. Glazing stops shall be of the snap-in type with neoprene bulb-type glazing for 1 inch insulated glass units, located on the non-security side of the door. No exposed screws shall be required to secure stops. Stops on exterior side shall be lock-in tamper proof type.
- B. Framing. - The Kawneer "451T" framing system shall provide for flush glazing on all sides with no projecting stops. Vertical and horizontal members shall have a nominal face dimension of 2 inches, a nominal depth of 4 1/2 inches, and shall provide for 1 inch insulated glass units. All entrance framing members shall be weatherstripped.

- C. Weather-stripping: Provide Kawneer "Sealair" weather-stripping system in the doors and frames consisting of a dense, semi-rigid polymeric material which remains resilient and retains its weathering ability through temperature extremes. The system shall be provided with an EPDM blade gasket sweep strip attached to the door bottom with concealed fasteners. Weather-stripping and sweep shall be compatible with the threshold provided.

2.03 FINISH

All exposed members shall be free of scratches and other surface blemishes. All aluminum shall have fluoropolymer paint coating conforming to requirements of AAMA 605.2-92. Custom color will be selected.

2.04 HARDWARE

- A. Hardware for aluminum entrance doors (including the interior vestibule doors) shall be furnished and installed by the door manufacturer except otherwise noted, and shall include the following hardware items by the manufacturers specified or approved equal.
 - 1. Pivots shall be Rixson 195xM190 (with intermediate pivot).
 - 2. Rim Exit Device shall be Von Duprin CD 98 x less pull x US 32D with cylinder and interchangeable core provided under Section 087100.
 - 3. LCN Cush-N-Stop surface closer with adjustable hold open feature or approved equal by Russwin or Sargent.
 - 4. Pull shall be Rockwood No. 158 x US 32D or approved equal by Brookline or Ives.
 - 5. Aluminum threshold shall be supplied and installed under Section 087100.
- B. Anchors and Fastenings: Furnish and install all bolts, nuts, anchors, sleeves and clips necessary for proper anchorage and support of aluminum work. All fastening devices shall be aluminum or non-magnetic stainless steel. Expansion bolts shall be stainless steel "Kwik-Bolts" as manufactured by Hilti Fastening Systems or approved equal.
- C. Brackets and Reinforcements: Manufacturer's standard high-strength aluminum units where feasible, otherwise nonmagnetic stainless steel; except, at fabricator's option, brackets not exposed to weather or abrasion may be hot-dip galvanized steel complying with ASTM A 386. Provide nonstaining, nonferrous shims for installation and alignment of metal work.
- D. Concealed Flashing: Non-magnetic stainless steel, 26 gage, type selected by manufacturer for compatibility.

PART 3 - EXECUTION

3.01 INSPECTION AND PREPARATION

Furnish inserts at proper times for setting in concrete formwork, masonry, and similar construction indicated to support work of this Section.

3.02 INSTALLATION/ERECTION

- A. General: Comply with manufacturer's instructions for protection, handling and installation of the door, fabricated components, and hardware with particular attention and care to the preservation of applied finishes and to provide a weathertight installation. Discard and/or remove and replace damaged members immediately upon discovery.
- B. Framing Erection: Install components plumb, level, accurately aligned and accurately located. Anchor components securely in place in the manner indicated on the approved shop drawings, shimming and allowing for required movement, and providing separators and insulators to prevent corrosion and electrolytic deterioration, and to prevent "freeze-up" of moving joints.
- C. Installation of Door and Finish Hardware:
 - 1. Make sure that the door, frame and transom are properly installed with square corners, plumb sides, level at the head, securely attached to surrounding construction and of the size and hand shown on the Drawings. Do not install the door in an improperly installed frame.
 - 2. Door openings shall not have more than the clearance specified by the manufacturer at sides, top, and bottom.
 - 3. Apply finish hardware in strict accordance with the final approved shop drawings and the manufacturers' instructions. Use care not to damage adjacent surfaces when installing hardware. Adjust door to be in exact alignment and hardware for easy action. Set all screws flush with the metal surface without any broken or damaged heads.
- D. Dissimilar Contact Surfaces:
 - 1. Metals - Where aluminum is placed in contact with any metal other than non-magnetic stainless steel, the aluminum contact surface shall be given a heavy brush coating of zinc chromate primer made with a synthetic resin vehicle followed by two coats of an aluminum metal paint or shall be separated with an approved non-absorptive tape or gasket.
 - 2. Masonry - Aluminum placed in contact with masonry, mortar or concrete shall be given a heavy brush coating of an approved alkali-resistant, non-migrating, bituminous paint.

- E. Sealants and Joint Fillers: Furnish and install in accordance with Section 079200, Joint Sealants.
- F. Glazing: Provided under Section 088000, Glazing.

3.03 ADJUST AND CLEAN

- A. Just prior to the completion of all work under this section, the Contractor, with the Engineer, shall inspect all portions of the work, and shall make all required adjustments and corrections to the work, leaving all operable portions in proper operating condition and insuring that all jointing is tight. In addition, each piece of finish hardware shall be inspected to see that it is undamaged and in perfect working order.
- B. Clean completed work, inside and out, promptly after erection to the Engineer's satisfaction. Remove dirt and other substances from aluminum and other affected surfaces.
- C. Remove protective coating (if any) when completion of construction activities no longer requires its retention. Removal shall be in accordance with manufacturer's instructions.
- D. Perform minor touch-up work to members with finish damage to the Engineer's satisfaction. Should the Engineer, as sole judge of acceptability of repairs, deem a repair as unsatisfactory, the Contractor shall promptly remove and replace such damaged members at no additional cost.
- E. Institute protective measures and other precautions required to assure that all metal work and doors will be without damage or deterioration, other than normal weathering, at time of acceptance.

END OF SECTION 084113

SECTION 085113
ALUMINUM WINDOWS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Examine Drawings, Contract Conditions all other Sections of the Specifications for requirements which affect work of this Section whether or not such work is specifically mentioned in this Section.
- B. Coordinate work with that of all other trades affecting, or affected by work of this Section. Cooperate with such trades to assure the steady progress of all Project work.

1.02 DESCRIPTION

- A. The work in this section consists of furnishing all materials, equipment, supplies, transportation, labor and supervision, and performing all operations required to furnish and install, weathertight, all aluminum windows, including insulating glass, as shown on the Drawings, as specified herein, and as is additionally required to properly complete the work.
- B. Related sealant and glass and glazing work are included as part of the work of this section and shall be provided in accordance with the requirements of Sections 079200 and 088000, respectively.

1.03 GENERAL

- A. The Contractor shall verify all measurements at the building site and shall be responsible for dimensions, fitting, and the proper attachment of items related to the aluminum windows. Windows shall be fixed type. Window units shall be factory fabricated insofar as possible, consisting of, as applicable, frame, sash, sills, panning, mullions, insulating glass, sealants and anchors.
- B. Storage and Protection: Materials shall be stored out of contact with the ground and under a weathertight covering. Storage shall be arranged to avoid bending, warping, or otherwise damaging the materials and to provide adequate ventilation.
- C. Window frames, mullions, panning, screens, etc., shown on the Drawings are Kawneer 451T framing system as manufactured by Kawneer Co., Inc. Similar thermal-break windows by other reputable manufacturers will be considered provided they meet or exceed the requirements of the Kawneer windows specified. The Contractor shall obtain preliminary approval of the manufacturer's stock details from the Resident before complete shop drawings are prepared. Final approval will be based upon complete shop drawings showing all features of window fabrication and conditions of installation as detailed on the Drawings. All detailed requirements must be met.

- D. Performance Requirements: Windows shall exceed the current specifications of the Architectural Aluminum Manufacturers Association (AAMA) and shall bear the Quality Certified Seal of AAMA for PA3-A3HP.

1.04 SUBMITTALS

- A. Submit eight (8) copies of product data for all materials and shop drawings to the Engineer for approval. Shop drawings shall indicate the location and elevation of each type of window and shall show type and location of hardware, weather-stripping, locations of sealants, details of construction, including insulated glass/aluminum spandrel panels, glazing, anchorages, methods of assembly, and installation of all components.
- B. Submit two (2) sets of 12 inch long samples of extrusions and formed shapes. Include 3 or more samples in each set showing near-limits of variations in color and finish. Once approved, samples will establish the extreme variation in color acceptable.
- C. Submit samples of each type of hardware required.

PART 2 - MATERIALS

2.01 GENERAL

- A. Frames unless otherwise noted shall be fabricated from extruded aluminum sections incorporating a continuous rigid polyurethane thermal barrier (break). Members shall not be less than 4-1/2 inches deep from front to back. Face dimensions of frames shall be approximately 2 inches; webs and flanges shall be not less than .090 inch thick.
- B. Glass: Shall be 1" insulating units as specified in Section 088000, Glazing.
- C. Sealants: Shall be as specified in Section 079200, Joint Sealants.

2.02 CONSTRUCTION

- A. Fabricate aluminum windows in accordance with the approved shop drawings.
- B. All joints in aluminum framing shall be hairline and mechanically fastened.
- C. The back wall of the polyurethane pocket shall be removed to form a thermal barrier system. There shall be no frame members, corner construction or hardware application that bridges or violates the thermal barrier in any way.
- D. Special acrylic or butyl small-joint sealer shall be applied at all intersections to provide permanent watertight joints. Sections shall be designed to provide a flush condition of frame and vent members on the exterior and to position all glass in the same vertical plane.

2.03 GLAZING

Windows shall be arranged for inside glazing with aluminum extruded snap-in glazing beads designed to accommodate 1 inch insulating glass units and 1 inch insulated spandrel panels. Snap-in glazing beads shall securely interlock into the extruded window sections without extending underneath the glass or spandrel panel, or bridging the thermal barrier. Glazing rabbet legs shall be a minimum of 3/4 inches in height.

2.04 FINISH

All exposed aluminum for windows, sills, panning, and flashing shall have a fluoropolymer paint coating conforming to requirements of AAMA 605.2-92. Custom color will be selected to match aluminum storefront framing and door specified in Section 084113.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Windows shall be installed in strict accordance with the approved shop drawings and the manufacturer's approved installation instructions, without forcing or distortion so that sills and heads are level and jambs are plumb. Window frames shall be securely anchored in place with heavy gauge anchors, four (4) per jamb.
- B. Glass units shall be furnished, installed and cleaned in accordance with the applicable requirements of Section 088000, Glazing.
- C. Sealants shall be furnished and installed in accordance with the requirements of Section 079200, Joint Sealants.

3.02 ADJUSTMENT AND CLEANING

- A. After installation, glass and metal surfaces shall be cleaned and any staining or discoloring of the finish shall be restored to the Engineer's satisfaction or the unit shall be replaced at no additional cost. All other work detrimentally affected by the installation of the windows shall also be cleaned or otherwise restored to the Resident's satisfaction.

END OF SECTION 085113

SECTION 087100
DOOR HARDWARE

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Examine Drawings, Contract Conditions all other Sections of the Specifications for requirements which affect work of this Section whether or not such work is specifically mentioned in this Section.
- B. Coordinate work with that of all other trades affecting, or affected by work of this Section. Cooperate with such trades to assure the steady progress of all Project work.

1.02 DESCRIPTION

The work in this section consists of furnishing all labor, materials, equipment and transportation and performing all operations required to furnish all finish hardware as shown on the drawings and specified herein.

1.03 SPECIFIED ELSEWHERE

- A. The following related work items shall be furnished and installed under other sections of these specifications as indicated.
 - 1. Hardware for Aluminum Entrance Door - Section 084113.
 - 2. Hardware for Cabinets - Section 062013.
 - 3. Installation of hardware for metal doors will be performed under Section 081113.

1.04 GENERAL

- A. No finish hardware shall be delivered until all operations causing dampness have been completed. Care shall be taken to protect hardware from scratching and foreign matter, such as paint, joint compound, etc.
- B. All items of hardware shall be packed in approved manufacturers' containers with all trimmings, bolts, screws, etc., as required. Each container shall be accurately labeled and marked with an item location corresponding to the number listed on the approved Finish Hardware Schedule.
- C. Strikes for locks shall be box type with sufficient lip protection to protect frames and trim.

- D. All locks shall be construction master keyed. Four (4) construction master keys shall be furnished. All locks shall be set to new building master keys as directed by the Resident. Furnish six (6) master keys and two keys for each lock.
- E. Where size or shape of members is such as to prevent the use of the types specified, hardware shall be furnished of suitable type having as near as practicable the same operation and quality as the specified type; sized to be adequate for the required service, and approved by the Engineer.

1.05 SUBMITTALS

As part of the submission of shop drawings, the Contractor shall submit to the Engineer for review eight (8) copies of the schedule of finish hardware to be provided, giving manufacturers' names, catalog number references, type numbers, finish, and location of each item of hardware (identified with the door for which it is intended), and also the catalog cuts for each hardware item.

PART 2 - MATERIALS

2.01 MATERIALS

- A. All finish hardware shall be of the best grade of solid metal, entirely free from imperfections in manufacture and finish. Finish shall be US 26D Satin Chromium Plated and US 32D Satin Stainless Steel, as applicable. Door closer units shall have sprayed lacquer finish to match balance of hardware.
- B. The following items and manufacturers thereof indicate the quality and design of the hardware required.
 - 1. Hinges: All door butts shall be Stanley No. FBB199 (US 32D), shall conform to ANSI A156.1 (A2111). Equivalent hinges manufactured by Hager Hinge Co. are also acceptable.
 - 2. Locksets shall Best Lock 35H x 16H x L x US 32D with anti-friction latch bolts and interchangeable cores. Function will be determined at time of hardware submittal by the Resident at no additional cost.
 - 3. Door Closers shall be LCN Smoothee Series with parallel arm "Cush-N-Stop" for push side and LCN's heaviest duty arm for pull side. Comparable closers manufactured by Sargent and Russwin will be considered for use. Provide coordinator at pairs of doors with adjustable safety release and internal override.
 - 4. Silencers shall be manufactured by Trimco, Sargent & Co. or Glynn-Johnson.
 - 5. Thresholds shall be of a style approved by the Resident, manufactured by Reese, National Guard or Pemko. All exterior doors shall have an extruded aluminum threshold with an integral slip-resistant surface set in sealant to provide watertight condition. Thresholds shall be secured to floor construction

with suitable stainless steel flat head screws in expansion shields. Slip-resistant coating shall be equal to "PemKote" by Pemko. If size is not shown, provided threshold width equal to jamb depth.

Threshold - Type A: Pemko 171A w/PemKote
Threshold - Type B: Pemko 270A and 282A, each with 1/4" high w/PemKote.

6. Kick plates and mop plates shall be 22 gage stainless steel, 8" high by width of door less 2", attached with stainless steel screws, as manufactured by Brookline, Ives or Rockwood.
7. Weather-stripping Systems shall be provided at all exterior doors and frames consisting of a dense, semi-rigid polymeric material which remains resilient and retains its weathering ability through temperature extremes. Weather-stripping and sweep shall be compatible with the threshold provided. Weather-stripping shall be of a style approved by the Resident, manufactured by Reese, National Guard or Pemko.

Door Shoe: Pemko 234AV (cold weather seal)
Jamb & Head: Pemko 319CR

8. Floor Stops, and Wall Stops shall be manufactured by H.B. Ives Co., Brookline Industries Inc., Stanley, or Glynn-Johnson.
9. Exit Device and Pull: Refer to Section 084113.
10. Flush Bolts: Provide mortised manual and automatic self-latching flush bolts with 3/4" minimum throw by Burns Manufacturing Company, DCI, Hiawatha, or Trimco.
11. Electric Strike: Provide Galaxy Model 1006-12/24D-630 X KM-630 with removable core for Best Cylinder.
12. Electric Lock: Provide self-contained mortised unit with internal, battery-powered, self-contained electronic lock; consisting of complete lockset, motor-driven lock mechanism, and actuating device, enclosed zinc-dichromatic-plated, wrought steel case, and strike that suits installation condition. Provide key override, low battery detection and warning, LED status indicators, and ability to program the lock. Provide Best Access Systems Mortised latchbolt.
13. Electric Hinges: Provide heavy duty electric hinge by Stanley or Hager.
14. Electric Hold Open Devices: Wall-mounted unit with strike plate attached to swinging door; coordinated with fire detectors and interface with fire alarm system for labeled fire-rated door assemblies. Provide units by Dorma, Hager, or Sargent.

2.02 FINISH HARDWARE SCHEDULE

SET NO. 1

For Door Nos. 101 & 102 and All Tunnel Stair Enclosure Doors (Aluminum Entrance Door)

- 1 Electric Strike
- 1 Threshold
- 1 Card Reader (provided by The Authority)
- 1 Power Supply
- Balance of hardware specified in Section 08400

SET NO. 2

For Door No. 103

- 1 1/2 Pair Butts
- 1 Card Reader (provided by The Authority)
- 1 Electric Strike
- 1 Lockset – Store Room Function
- 1 Closer
- 1 Kick Plate
- 1 Head and Jamb Weatherstripping Set
- 1 Door Bottom
- 1 Threshold
- 1 Power Supply

SET NO. 3

For Door No. 104

- 1 1/2 Pair Butts
- 1 Lockset – Office Function
- 1 Door Stop
- 3 Silencers

SET NO. 4

For Door No. 105

- 1 1/2 Pair Butts
- 1 Push/Pull Set
- 1 Closer
- 1 Kickplate
- 1 Door Stop
- 3 Silencers

SET NO. 5

For Door Nos. 106 & 107

- 1 ½ Pair Butts
- 1 Lockset – Privacy Function with Occupancy Indicator
- 1 Closer
- 1 Kickplate
- 1 Door Stop
- 3 Silencers

SET NO. 6

For Door No. 108 (Rated)

- 1 1/2 Pair Butts
- 1 Latchset
- 1 Closer
- 1 Kickplate
- 1 Electro-Magnetic Hold-Open Device
- 3 Silencers
- 1 Power Supply

SET NO. 7

For Door No. 109

- 1 ½ Pair Butts
- 1 Latchset – Passage Function
- 1 Closer
- 1 Kickplate
- 3 Silencers

SET NO. 8

For Pair Doors No. 001 (Rated)

- 5 Butts
- 1 Electrified Butt (Active Leaf)
- 1 Electrified Lockset (Active Leaf)
- 2 Closers
- 1 Coordinator
- 2 Automatic Flush Bolts (Inactive Leaf)
- 2 Kickplates
- 2 Electro-Magnetic Hold-Open Devices
- 2 Silencers
- 1 Card Reader (provided by The Authority)
- 1 Power Supply

SET NO. 9

For Pair Doors No. 002

3 Pair Butts
2 Exit Devices (No Exterior Hardware)
2 Closers with Hold-Open Arms
1 Coordinator
2 Kickplates
1 Threshold
1 Head Jamb Weatherstripping
2 Door Bottoms

SET NO. 10

For Pair Doors Nos. 003 & 004 (Rated)

3 Pair Butts
1 Lockset (Active Leaf) – Store Room Function
1 Dummy trim (Inactive Leaf)
2 Flush Bolts (Inactive Leaf)
2 Closers
1 Coordinator
2 Kickplates
1 Door Stop (Door 002 Only)
2 Silencers

SET NO. 11

For Door Nos. 005 & 006 (Rated)

1 ½ Pair Butts
1 Latchset – Passage Function
1 Closer
1 Kickplate
1 Door Stop
3 Silencers

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Hardware shall be installed accurately in accordance with the manufacturers' templates and approved instructions.
- B. All knobs, levers, panic devices, push plates, pulls and other hardware shall be installed in accordance with the requirements of ANSI A117 and ADAAG.

END OF SECTION 087100

SECTION 088000
GLAZING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Examine Drawings, Contract Conditions all other Sections of the Specifications for requirements which affect work of this Section whether or not such work is specifically mentioned in this Section.
- B. Coordinate work with that of all other trades affecting, or affected by work of this Section. Cooperate with such trades to assure the steady progress of all Project work.

1.02 DESCRIPTION

- A. The term "glass" includes prime, processed and fabricated glass products. "Glazing" includes glass installation and all materials used to install glass. Types of work include glass and glazing for:
 - 1. Exterior aluminum entrance door, associated windows, and transom.
 - 2. Exterior hollow metal door vision lights.
 - 3. Glass for aluminum windows.
 - 4. Aluminum Spandrel Panels

1.03 QUALITY ASSURANCE

- A. Prime Glass Standard: Comply with FS DD-G-451.
- B. Heat Strengthened and Fully Tempered Glass Standard: FS DD-G-1403.
- C. Safety Standards for Hazardous Locations: Conform to requirements of Building Code which applies to the Project and to all local ordinances and regulations.

1.04 SUBMITTALS

- A. Submit 2 samples, 12 inches square, of each glass type specified. Submit 12 inch lengths of installed (mocked-up) glazing systems including metal framing and sealant components. Submit insulating glass samples with completed edge seal construction. Hermetic seal need not be maintained.
- B. Submit eight (8) copies of manufacturer's specifications, product information sheets, warranties, and installation instructions and recommendations.

1.05 JOB CONDITIONS

Meet with glazier and other trades affected by glass installation prior to beginning of installation. Do not perform work under adverse weather or job conditions. Install liquid sealants only when temperatures are within lower or middle third of temperature range recommended by manufacturer.

1.06 SPECIFIED PRODUCT WARRANTY

- A. Provide insulating glass manufacturer's written warranty, agreeing to, within specified warranty period, furnish FOB project site, replacement units for insulating glass units which have defective hermetic seals (excluding that due to glass breakage); defined to include intrusion of moisture or dirt, internal condensation at temperatures above -20°F (-31°C), deterioration of internal glass coatings, and other visual evidence of seal failure or performance failure; provided manufacturer's instructions for handling, installing, protecting and maintaining units have been adhered to during warranty period.
- B. Warranty period is 10 years after seal date permanently imprinted on units, but in no case less than 9 years after the date of substantial completion.

PART 2 - MATERIALS

2.01 ACCEPTABLE MANUFACTURERS

Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work include, but are not limited to, the following:

Pilkington
PPG Industries, Inc.
Guardian Industries
Ford Glass Company
Laminators, Inc.

2.02 PRIME GLASS

Float Glass: Type I, Quality q3, clear or tinted glass as indicated.

2.03 PROCESSED GLASS

Tempered Glass: Provide clear or tinted glass as indicated, which has been heat treated to strengthen glass in bending to not less than 4.5 times annealed strength. Tong marks shall not be visible in glass after it is glazed in openings. Glass shall be of the thicknesses indicated, equal to Pilkington Tempered Glass. Color will be selected by the Architect.

2.04 FABRICATED GLASS UNITS

- A. Laminated Safety Glass: Laminate 2 sheets of clear or tinted float or tempered glass (as specified) with a 30-mil interlayer of poly-vinyl butyral, by manufacturer's standard heat-plus-pressure process with dirt, air pockets and foreign substances excluded; 1/4 inch thick if not otherwise indicated. Units shall be equal to Pilkington Laminated Glass. Color will be Pilkington Artic Blue High Performance Tint.
- B. Tinted Sealant-Edged Insulating Glass: Provide manufacturer's standard double-pane with a seal classification of "A" as tested and certified by IGCC, with a permanent hermetically sealed, dry air or gas filled space of width indicated, dual-sealed edge construction, edge seal consisting of twin primary sealant beads of polyisobutylene, positioned and retained by tubular aluminum spacer bar. Provide manufacturer's standard protective, rust resistant metal edge banding on insulating glass units, labeled with fabricator's name and date of seal. Units shall be equal to Pilkington Insulated Glass. Color will be Pilkington Artic Blue High Performance Tint.

2.05 SPANDREL PANELS

- A. Spandrel panels shall be 1" thick aluminum clad units in color indicated and shall be sealed into aluminum storefront frame system per manufacturer's instructions.

2.06 GLASS TYPES

Provide the following glass types as indicated in the Glazing Schedule:

Type A - 1 inch tinted insulated: 1/4 inch tinted exterior light, 1/2 inch desiccated air space, 1/4 inch interior light.

Type B - Same as Type A but both lights tempered.

Type C - 1 inch obscured tinted insulated: 1/4 inch tinted exterior light, 1/2 inch desiccated air space; 1/4 inch clear obscure (frosted or sandblasted) interior light.

Type D – 1/4" clear tempered interior light.

Type E – 1/4" clear fire rated interior light, similar to Firelite.

Type F – 1" spandrel panel: "Omega-Lite" panels by Laminators, Inc. Color shall be "Slate Blue Smooth".

2.07 GLAZING SEALANTS AND COMPOUNDS

Provide color of exposed sealant/compound as selected by Engineer from manufacturer's standard colors. Comply with manufacturer's recommendations for selection of hardness, depending upon the location of each application, conditions at time of installation, and performance requirements. Carefully select materials for compatibility with surfaces contacted in the installation.

2.08 GLAZING GASKETS

- A. Molded Neoprene Glazing Gaskets: Molded or extruded neoprene gaskets of the profile and hardness required for watertight construction. Glazing gaskets shall be standard for the glass framing systems supplied and shall be purchased from the frame manufacturer unless otherwise approved.
- B. Vinyl Foam Glazing Tape: Closed cell, flexible, self-adhesive, non-extruding, polyvinyl chloride foam tape; recommended by manufacturer for exterior, exposed, watertight installation of glass, with only nominal pressure in the glazing channel; complying to ASTM D 1667.

2.09 MISCELLANEOUS GLAZING MATERIALS

- A. Cleaners, Primers and Sealers: Type recommended by sealant and gasket manufacturers.
- B. Setting Blocks: Neoprene or EPDM, 70-90 durometer hardness, with proven compatibility with sealants used.
- C. Spacers: Neoprene or EPDM, 40-50 durometer hardness, with proven compatibility with sealants used.
- D. Compressible Filler (Rod): Closed cell or waterproof-jacketed rod stock of synthetic rubber or plastic foam, proven to be compatible with sealants used, flexible and resilient, with 5-10 psi compression strength for 25% deflection.

PART 3 - EXECUTION

3.01 STANDARDS AND PERFORMANCE

- A. Watertight and airtight installation of each piece of glass is required. Each installation must withstand normal temperature changes, wind loading, impact loading (for operating units) without failure, including loss or breakage of glass, failure of sealants or gaskets to remain watertight and airtight, deterioration of glazing materials and other defects.
- B. Protect glass from edge damage during handling and installation, and subsequent operation of glazed components of the work. During installation, discard units with edge damage and other imperfections.
- C. Glazing channel dimensions shown are intended to provide for necessary bite on glass, minimum edge clearance and adequate sealant thicknesses, with reasonable tolerances. Adjust as required by job conditions at time of installation.
- D. Comply with combined recommendations and technical reports of manufacturers of glass and glazing products as used in each glazing application, and with

recommendations of Flat Glass Marketing Association "Glazing Manual," except where more stringent requirements are indicated or specified.

- E. Install insulating glass units to comply with recommendations by Sealed Insulating Glass Manufacturers Association, except as otherwise specifically indicated or recommended by glass and sealant manufacturers.

3.02 PREPARATION FOR GLAZING

- A. Clean glazing channel and other framing members to receive glass immediately before glazing. Remove coatings which are not firmly bonded to substrate. Remove lacquer from metal surfaces where elastomeric sealants are used.
- B. Apply primer or sealer to joint surfaces where recommended by sealant manufacturer.

3.03 GLAZING

- A. Install setting blocks of proper size in sill rabbet, located 1/4 of the glass width from each corner. Set blocks in thin course of heel-bead compound.
- B. Provide spacers inside and out, of proper size and spacing, for glass sizes larger than 50 united inches, except where gaskets or preshimmed tapes are used for glazing. Provide 1/8 inch minimum bite of spacers on glass and use thickness equal to sealant width, except with sealant tape use thickness slightly less than final compressed thickness of tape.
- C. Set units of glass in each series with uniformity of pattern, draw, bow and similar characteristics.
- D. Miter cut and bond ends together at corners where gaskets are used for channel glazing so that gaskets will not pull away from corners and result in voids or leaks in the glazing system.

3.04 CURING, PROTECTION AND CLEANING

- A. Protect glass from breakage immediately upon installation. Do not apply markers to surfaces of glass. Remove non-permanent labels and clean surfaces. Cure sealants as necessary to provide high early strength and durability.
- B. Remove and replace glass which is broken, chipped, cracked, abraded or damaged in other ways during the construction period, including natural causes, accidents and vandalism.
- C. Wash and polish glass on both faces not more than 4 days prior to date scheduled for inspection intended to establish date of Substantial Completion. Comply with glass manufacturers' recommendations for final cleaning.

END OF SECTION 088000

SECTION 088813
FIRE-RESISTANT GLAZING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings, Contract Conditions and other Technical Sections apply to work of this Section insofar as applicable.
- B. Coordinate work with that of all other trades affecting, or affected by work of this Section. Cooperate with such trades to assure the steady progress of all Project work.

1.2 SUMMARY

- A. Section Includes:
 - 1. Fire-protection-rated glazing.

1.3 DEFINITIONS

- A. Glass Manufacturers: Firms that produce primary glass, fabricated glass, or both, as defined in referenced glazing publications.

1.4 COORDINATION

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

1.5 ACTION SUBMITTALS

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

1.6 INFORMATIONAL SUBMITTALS

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

- C. Sample Warranties: For special warranties.

1.7 QUALITY ASSURANCE

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

1.8 DELIVERY, STORAGE, AND HANDLING

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

1.9 FIELD CONDITIONS

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

1.10 WARRANTY

- A. Manufacturer's Special Warranty on 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.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

2.2 PERFORMANCE REQUIREMENTS

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

2.3 GLASS PRODUCTS, GENERAL

- A. Glazing Publications: Comply with published recommendations of glass product manufacturers and organization below unless more stringent requirements are indicated. Refer to these publications for glazing terms not otherwise defined in this Section or in referenced standards.
 - 1. GANA Publications: "Glazing Manual."
- B. Safety Glazing Labeling: Permanently mark glazing with certification label of the Safety Glazing Certification Council or another certification agency acceptable to authorities having jurisdiction. Label shall indicate manufacturer's name, type of glass, glass thickness, and safety glazing standard with which glass complies.

2.4 GLASS PRODUCTS

- A. Tempered Float Glass: ASTM C 1048, Kind FT (fully tempered), Condition A (uncoated) unless otherwise indicated, Type I, Class I (clear) unless otherwise indicated, Quality-Q3.
 - 1. Fabrication Process: By horizontal (roller-hearth) process with roll-wave distortion parallel to bottom edge of glass as installed unless otherwise indicated.

2.5 FIRE-PROTECTION-RATED GLAZING

- A. Fire-Protection-Rated Glazing: Listed and labeled by a testing agency acceptable to authorities having jurisdiction, for fire-protection ratings indicated, based on positive-pressure testing according to NFPA 257 or UL 9, including the hose-stream test, and shall comply with NFPA 80.
- B. Fire-Protection-Rated Glazing Labeling: Permanently mark fire-protection-rated glazing with certification label of a testing agency acceptable to authorities having jurisdiction. Label shall indicate manufacturer's name; test standard; whether glazing is permitted to be used in doors or openings; if permitted in openings, whether or not glazing has passed the hose-stream test; whether or not glazing meets 450 deg F (250 deg C) temperature-rise limitation; and the fire-resistance rating in minutes.
- C. Fire-Protection-Rated Tempered Glass: 1/4" thickness, fire-protection-rated tempered glass; and complying with 16 CFR 1201, Category II. Provide product similar to "Firelite" by Technical Glass Products.
 - 1. Glass Type "E".

2.6 GLAZING ACCESSORIES

- A. Provide glazing gaskets, glazing sealants, glazing tapes, setting blocks, spacers, edge blocks, and other glazing accessories that are compatible with glazing products and each other and are approved by testing agencies that listed and labeled fire-resistant glazing products with which products are used for applications and fire-protection ratings indicated.
- B. Glazing Sealants for Fire-Rated Glazing Products: Neutral-curing silicone glazing sealant complying with ASTM C 920, Type S, Grade NS, Class 50, Use NT. Comply with sealant and

glass manufacturers' written instructions for selecting glazing sealants suitable for applications indicated.

1. Sealants shall have a VOC content of 250 g/L or less.
 2. Colors of Exposed Glazing Sealants: As selected by Architect from manufacturer's full range.
- C. Back-Bedding Mastic Glazing Tapes: Preformed, butyl-based, 100 percent solids elastomeric tape; nonstaining and nonmigrating in contact with nonporous surfaces; with or without spacer rod as recommended in writing by tape and glass manufacturers for application indicated; and complying with ASTM C 1281 and AAMA 800 for products indicated below:
1. AAMA 804.3 tape, where indicated.
 2. AAMA 806.3 tape, for glazing applications in which tape is subject to continuous pressure.
 3. AAMA 807.3 tape, for glazing applications in which tape is not subject to continuous pressure.
- D. Expanded Cellular Glazing Tapes: Closed-cell, PVC foam tapes; factory coated with adhesive on both surfaces; and complying with AAMA 800 for the following types:
1. AAMA 810.1, Type 1, for glazing applications in which tape acts as the primary sealant.
 2. AAMA 810.1, Type 2, for glazing applications in which tape is used in combination with a full bead of liquid sealant.

2.7 MISCELLANEOUS GLAZING MATERIALS

- A. General: Provide products of material, size, and shape complying with referenced glazing standard, requirements of manufacturers of glass and other glazing materials for application indicated, and with a proven record of compatibility with surfaces contacted in installation.
- B. 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 GLAZING UNITS

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

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine framing, glazing channels, and stops, with Installer present, for compliance with manufacturing and installation tolerances, including those for size, squareness, and offsets at corners, and for compliance with minimum required face and edge clearances.

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

3.2 PREPARATION

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

3.3 GLAZING, GENERAL

- A. Use methods approved by testing agencies that listed and labeled fire-resistant glazing products.
- B. Comply with combined written instructions of manufacturers of glass, sealants, gaskets, and other glazing materials unless more stringent requirements are indicated, including those in referenced glazing publications.
- C. Protect glass edges from damage during handling and installation. Remove damaged glass from Project site and legally dispose of off Project site. Damaged glass is glass with edge damage or other imperfections that, when installed, could weaken glass and impair performance and appearance.
- D. Apply primers to joint surfaces where required for adhesion of sealants, as determined by preconstruction testing.
- E. Install setting blocks in sill rabbets, sized and located to comply with referenced glazing publications unless otherwise required by glass manufacturer. Set blocks in thin course of compatible sealant suitable for heel bead.
- F. Do not exceed edge pressures stipulated by glass manufacturers for installing glass lites.
- G. Provide spacers for glass lites where length plus width is larger than 50 inches.
 - 1. Locate spacers directly opposite each other on both inside and outside faces of glass. Install correct size and spacing to preserve required face clearances unless gaskets and glazing tapes are used that have demonstrated ability to maintain required face clearances and to comply with system performance requirements.
 - 2. Provide 1/8-inch
 - 3. 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 with proper orientation so that coatings face fire side or protected side as specified.

- J. 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.
- K. 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 SEALANT GLAZING (WET)

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

3.5 CLEANING AND PROTECTION

- A. Immediately after installation, remove nonpermanent labels and clean surfaces.
- B. Protect glass from contact with contaminating substances resulting from construction operations. Examine glass surfaces adjacent to or below exterior concrete and other masonry surfaces at frequent intervals during construction, but not less than once a month, for buildup of dirt, scum, alkaline deposits, or stains.
 - 1. If, despite such protection, contaminating substances do come into contact with glass, remove substances immediately as recommended in writing by glass manufacturer.
- C. Remove and replace glass that is damaged during construction period.
- D. Wash glass on both exposed surfaces in each area of Project not more than four days before date scheduled for inspections that establish date of Substantial Completion. Wash glass as recommended in writing by glass manufacturer.

3.6 FIRE-PROTECTION-RATED GLAZING SCHEDULE

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

END OF SECTION 088813

SECTION 092116.23
GYPSUM BOARD SHAFT WALL ASSEMBLIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings, Contract Conditions and other Technical Sections apply to work of this Section insofar as applicable.
- B. Coordinate work with that of all other trades affecting, or affected by work of this Section. Cooperate with such trades to assure the steady progress of all Project work.

1.2 SUMMARY

- A. Section Includes: Gypsum board shaft wall assemblies.

1.3 ACTION SUBMITTALS

- A. Product Data: For each component of gypsum board shaft wall assembly.

1.4 INFORMATIONAL SUBMITTALS

- A. Evaluation Reports: For shaft wall assemblies firestop tracks, from ICC-ES.

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.

1.6 FIELD CONDITIONS

- A. Environmental Limitations: Comply with ASTM C 840 requirements or with gypsum board manufacturer's written recommendations, whichever are more stringent.
- B. Do not install interior products until installation areas are enclosed and conditioned.
- C. Do not install panels that are wet, moisture damaged, or mold damaged.
 - 1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, and 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.

2.2 GYPSUM BOARD SHAFT WALL ASSEMBLIES

- A. Fire-Resistance Rating: 1 hour.
- B. Studs: Manufacturer's standard profile for repetitive members, corner and end members, and fire-resistance-rated assembly indicated.
 - 1. Depth: 2-1/2 inches.
 - 2. Minimum Base-Metal Thickness: 0.018 inch.
- C. Runner Tracks: Manufacturer's standard J-profile track with manufacturer's standard long-leg length, but at least 2 inches long and matching studs in depth.
 - 1. Minimum Base-Metal Thickness: 0.018 inch.
- D. Firestop Tracks: Provide firestop track at head of shaft wall on each floor level.
- E. Room-Side Finish: Gypsum board, type X.
- F. Shaft-Side Finish: Gypsum shaftliner board, Type X.
- G. Insulation: Sound attenuation blankets.

2.3 PANEL PRODUCTS

- A. Regional Materials: Gypsum panel products shall be manufactured within 500 miles of Project site.
- B. Panel Size: Provide in maximum lengths and widths available that will minimize joints in each area and that correspond with support system indicated.
- C. Gypsum Shaftliner Board, Type X: ASTM C 1396/C 1396M; manufacturer's proprietary fire-resistive liner panels with paper faces.
 - 1. Thickness: 1 inch.
 - 2. Long Edges: Double bevel.
- D. Gypsum Board: As specified in Section 092900 "Gypsum Board."

2.4 NON-LOAD-BEARING STEEL FRAMING

- A. Steel Framing Members: Comply with ASTM C 645 requirements for metal unless otherwise indicated.
 - 1. Protective Coating: Coating with equivalent corrosion resistance of ASTM A 653/A 653M, G40 unless otherwise indicated.
- B. Firestop Tracks: Top runner manufactured to allow partition heads to expand and contract with movement of the structure while maintaining continuity of fire-resistance-rated assembly indicated; in thickness not less than indicated for studs and in width to accommodate depth of studs.

2.5 AUXILIARY MATERIALS

- A. General: Provide auxiliary materials that comply with manufacturer's written recommendations.
- B. Trim Accessories: Cornerbead, edge trim, and control joints of material and shapes as specified in Section 092900 "Gypsum Board" that comply with gypsum board shaft wall assembly manufacturer's written recommendations for application indicated.
- C. Steel Drill Screws: ASTM C 1002 unless otherwise indicated.
- D. Track Fasteners: Power-driven fasteners of size and material required to withstand loading conditions imposed on shaft wall assemblies without exceeding allowable design stress of track, fasteners, or structural substrates in which anchors are embedded.
 - 1. Expansion Anchors: Fabricated from corrosion-resistant materials, with capability to sustain, without failure, a load equal to 5 times design load, as determined by testing according to ASTM E 488 conducted by a qualified testing agency.
 - 2. Power-Actuated Anchors: Fastener system of type suitable for application indicated, fabricated from corrosion-resistant materials, with capability to sustain, without failure, a load equal to 10 times design load, as determined by testing according to ASTM E 1190 conducted by a qualified testing agency.
- E. Sound Attenuation Blankets: As specified in Section 092900 "Gypsum Board."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates to which gypsum board shaft wall assemblies attach or abut, with Installer present, including hollow-metal frames, cast-in anchors, and structural framing. Examine for compliance with requirements for installation tolerances and other conditions affecting performance.
- B. Examine panels before installation. Reject panels that are wet, moisture damaged, or mold damaged.

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

3.2 INSTALLATION

- A. General: Install gypsum board shaft wall assemblies to comply with requirements of fire-resistance-rated assemblies indicated, manufacturer's written installation instructions, and ASTM C 754 other than stud-spacing requirements.
- B. Do not bridge building expansion joints with shaft wall assemblies; frame both sides of expansion joints with furring and other support.
- C. Install supplementary framing in gypsum board shaft wall assemblies around openings and as required for blocking, bracing, and support of gravity and pullout loads of fixtures, equipment, services, heavy trim, furnishings, wall-mounted door stops, and similar items that cannot be supported directly by shaft wall assembly framing.
- D. Penetrations: At penetrations in shaft wall, maintain fire-resistance rating of shaft wall assembly by installing supplementary steel framing around perimeter of penetration and fire protection behind boxes containing wiring devices, elevator call buttons, elevator floor indicators, and similar items.
- E. Isolate perimeter of gypsum panels from building structure to prevent cracking of panels, while maintaining continuity of fire-rated construction.
- F. Firestop Tracks: Where indicated, install to maintain continuity of fire-resistance-rated assembly indicated.
- G. Control Joints: Install control joints according to ASTM C 840 and in specific locations approved by Architect while maintaining fire-resistance rating of gypsum board shaft wall assemblies.
- H. Installation Tolerance: Install each framing member so fastening surfaces vary not more than 1/8 inch from the plane formed by faces of adjacent framing.

3.3 PROTECTION

- A. Protect installed products from damage from weather, condensation, direct sunlight, construction, and other causes during remainder of the construction period.
- B. Remove and replace panels that are wet, moisture damaged, or mold damaged.
 - 1. Indications that panels are wet or moisture damaged include, but are not limited to, discoloration, sagging, and 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 092116.23

SECTION 092900
GYP SUM BOARD

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Examine Drawings, Contract Conditions all other Sections of the Specifications for requirements which affect work of this Section whether or not such work is specifically mentioned in this Section.
- B. Coordinate work with that of all other trades affecting, or affected by work of this Section. Cooperate with such trades to assure the steady progress of all Project work.

1.02 DESCRIPTION

- A. This section provides minimum standards for gypsum drywall work. The work required consists of furnishing all materials, equipment, accessories, labor and supervision, and performing all operations necessary to provide finished gypsum drywall work as shown on the Drawings, as specified herein, and as is additionally required to properly complete the work.
- B. Without in any way limiting the work to be performed, the following gypsum drywall work items are mentioned:
 - 1. Gypsum board and metal furring over concrete masonry units.
 - 2. Gypsum board and metal drywall framing for partitions and fire rated ceilings.
 - 3. Drywall finishing of gypsum boards (joint tape-and-compound treatment).
 - 4. Ceiling access doors.
 - 5. Cement backer panels for ceramic tile.

1.03 QUALITY ASSURANCE

- A. Gypsum Board Standard: GA-216 by Gypsum Association.
- B. Metal Support Standard: ASTM C 754.
- C. Manufacturer: Obtain gypsum board products and accessories from a single manufacturer, or from manufacturers recommended by the manufacturer of gypsum boards.
- D. Allowable Tolerances: 1/16" offsets between planes of board faces, and 1/8" in 8'-0" for plumb, level, warp and bow.

1.04 SUBMITTALS

Submit manufacturer's product specifications and installation instructions for each gypsum drywall material (i.e., gypsum board, furring, etc.), component, including other data as may be required to show compliance with these specifications.

1.05 PRODUCT HANDLING

Deliver, identify, store and protect gypsum drywall materials to comply with Gypsum Association Specification GA-216.

PART 2 - MATERIALS

2.01 ACCEPTABLE MANUFACTURERS

Subject to compliance with requirements, manufacturers offering products which may be incorporated in the work are listed in the following paragraphs.

2.02 METAL SUPPORT MATERIALS

A. Furring Members: ASTM C 645; 20 gage, hat-shaped (C-shaped studs in some locations).

B. Studs: ASTM C 645; 20 gage unless otherwise indicated. Studs, runners and accessories in or abutting exterior walls shall be galvanized; otherwise primed. Studs shall be 3-5/8" except as otherwise indicated. Studs at designated plumbing walls shall be 6". Runners shall be the type recommended by stud manufacturer for floor and ceiling support of studs, and for abutment of drywall work at other work. Provide stud manufacturer's standard clips, ties, reinforcements, fasteners, grommets, and other accessories as needed for a complete stud system.

C. Fasteners: Type and size recommended by furring manufacturer for the substrate and application indicated.

D. Manufacturers: Provide materials by one of the following firms:

Allied Structural Industries
Dale Industries, Inc.
United States Gypsum Co.

2.03 GYPSUM DRYWALL

A. Gypsum Drywall and Related Products:

Provide materials by one of the following firms:

The Flintkote Company
Gold Bond Building Products Div., National Gypsum Co.

United States Gypsum Co.
Georgia-Pacific

- B. Exposed Gypsum Drywall: Regular type with tapered long edges.

Thickness: Provide gypsum drywall of the thicknesses indicated on the Drawings. Where not indicated, comply with thickness requirements of GA-216 for each application and support spacing. Comply with requirements for indicated fire-resistance ratings.

Sheet Size: Maximum length available which will minimize end joints.

Insulating Type: Provide in all exterior walls (aluminum foil backing).

Type WR: Provide in Toilet and Storage.

Type X: Provide at Fire Rated assemblies and as indicated.

- C. Cement Backer Panels for Ceramic Tile: Provide Durock brand by United States Gypsum Company.

2.04 TRIM ACCESSORIES

Provide manufacturer's standard trim accessories of types indicated for drywall work, formed of galvanized steel unless otherwise indicated, with either knurled and perforated or expanded flanges for nailing and beaded for concealment of flanges in joint compound. Provide corner beads, L-type edge trim-beads, U-type edge trim-beads, special L-kerf-type edge trim-beads, and one-piece control joint beads.

2.05 JOINT TREATMENT MATERIALS

- A. ASTM C 475; type recommended by the manufacturer for the application indicated, except as otherwise noted.
- B. Joint Tape: Perforated or plain type.
- C. Joint Compound: Provide chemical-hardening-type for bedding and filling, ready-mixed vinyl-type or vinyl-type powder for topping.

2.06 MISCELLANEOUS MATERIALS

- A. Provide auxiliary materials for gypsum drywall work of the type and grade recommended by the gypsum board manufacturer.
- B. Gypsum Drywall Fasteners: Comply with GA-216.

2.07 ACCESS DOORS

Ceiling hatch shall be 2-hour fire rated (2'-0" X 2'-6") with 16 gauge galvanized steel frame and 20 gauge galvanized steel upward acting door. Door shall be insulated with 1 inch mineral wool insulation. Door shall be equipped with a spring lever, as manufactured by the Bilco Co., Cedrex/Intertek, or approved equal.

PART 3 - EXECUTION

3.01 PREPARATION FOR METAL SUPPORT SYSTEMS

- A. Coordinate work of this section with other work to ensure that all inserts and other items have been provided for.
- B. Furnish concrete inserts, clips and similar devices to other trades for installation well in advance of time needed for such other work.

3.02 INSTALLATION OF METAL SUPPORT SYSTEMS

- A. Do not bridge building expansion joints with furring system; frame both sides of joints with furring.
- B. Space wall furring members 16" o.c., except as otherwise indicated.
- C. Install supplementary framing, runners, furring, blocking and bracing at openings and terminations in the work, and at locations required to support fixtures, equipment, services, heavy trim, furnishings and similar work which cannot be adequately supported directly on gypsum drywall alone.

3.03 GENERAL GYPSUM DRYWALL INSTALLATION REQUIREMENTS

- A. Pre-Installation Conference: Meet at the Project site with the installers of related work and review the coordination and sequencing of work to ensure that all work to be concealed by gypsum drywall has been accomplished and approved.
- B. Locate exposed end-butt joints as far from center of walls as possible, and stagger not less than 1'-0" in alternate courses of drywall.
- C. Install drywall boards vertically to avoid end-butt joints wherever possible.
- D. Install exposed gypsum drywall board with face side out. Do not install imperfect, damaged or damp boards. Butt boards together for a light contact at edges and ends with not more than 1/16" open space between boards. Do not force into place.
- E. Locate edge joints over supports. Position boards so that tapered edges abut, and mill-cut or field-cut ends abut. Do not place tapered edges against cut edges or ends.

- F. Attach gypsum drywall to framing and blocking as required for additional support at openings and cutouts.
- G. Form control joints and expansion joints with space between edges of boards, prepared to receive trim accessories.

3.04 METHOD OF GYPSUM DRYWALL APPLICATION

Apply gypsum boards to supports with recommended screws. Follow the manufacturer's recommendations for single layer applications.

3.05 INSTALLATION OF DRYWALL TRIM ACCESSORIES

- A. Where feasible, use the same fasteners to anchor trim accessory flanges as required to fasten gypsum board to supports. Otherwise, fasten flanges by screwing in accordance with manufacturer's instructions and recommendations.
- B. Install metal corner beads at external corners of drywall work.
- C. Install metal edge trim whenever edge of gypsum board would otherwise be exposed or semi-exposed. Provide type with face flange to receive joint compound. Install L-type trim where work is tightly abutted to other work, and install special kerf-type where other work is kerfed to receive long leg of L-type trim. Install U-type where edge is exposed, revealed, gasketed, or sealant-filled.
- D. Install metal control joint (beaded-type) where indicated.

3.06 ACCESS DOORS

Install access doors in the locations shown, in strict accordance with the manufacturer's instructions and recommendations.

3.07 DRYWALL FINISHING

- A. Apply drywall treatment at gypsum board joints (both directions), flanges of trim accessories, penetrations, fastener heads, surface defects and elsewhere as required to prepare work for subsequent application of finishes. Prefill open joints and tapered edges, using type of compound recommended by manufacturer.
- B. Apply joint tape at joints between gypsum boards, except where a trim accessory is indicated or required.
- C. Apply joint compound in 3 coats (not including prefill of openings in base), and sand between coats and after last coat.
- D. Drywall finishing shall be performed so that all joints, fastener locations, trim flanges, etc., are indiscernible after painting.

E. Refer to Section 099123 for painting finishes to be applied to drywall work.

3.08 PROTECTION OF WORK

Protect gypsum drywall work from damage and deterioration during the entire construction period.

END OF SECTION 092900

SECTION 093013
CERAMIC TILING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Examine Drawings, Contract Conditions all other Sections of the Specifications for requirements which affect work of this Section whether or not such work is specifically mentioned in this Section.
- B. Coordinate work with that of all other trades affecting, or affected by work of this Section. Cooperate with such trades to assure the steady progress of all Project work.

1.02 DESCRIPTION

The work in this section consists of furnishing all materials, equipment, supplies, transportation, labor and supervision, and performing all operations required to install all ceramic tile work as shown on the Drawings and schedules, as specified herein, and as is additionally required to properly complete the work.

1.03 SPECIFIED ELSEWHERE

- A. Cement backer board for ceramic tile – Section 092900
- B. Grab bars and bath accessories – Section 102800

1.04 GENERAL REQUIREMENTS

- A. Ceramic mosaic floor tiles over concrete and glazed ceramic wall tiles over gypsum board shall be manufactured by American Olean Tile Co., United States Ceramic Tile Co., or Dal-Tile.
- B. Deliver all materials to the site in manufacturers' unopened containers with grade seals unbroken and labels intact; keep tile cartons dry.
- C. Maintain temperature at 50°F. minimum during tile work and for 7 days after completion.
- D. All work shall be installed in strict accordance with the requirements of the latest revision of the Tile Council of America (TCA), "Handbook for Ceramic Tile Installation".

1.05 SUBMITTALS

- A. The Contractor shall submit samples of the tiles to the Resident for selection and approval.
- B. Submit eight (8) copies of manufacturers' specifications and installation instructions for each material required.

PART 2 - MATERIALS

2.01 CERAMIC FLOOR TILE

- A. Tile shall be "Ayers Rock" by Daltile. Tile shall be colorbody, impervious porcelain type, 5/16 inch thick. Tile shall be standard colors, all as selected from samples submitted to the Architect. Tile size shall be 13" x 13".
- B. Tile shall be standard grade conforming to ANSI A137.1.

2.02 GLAZED CERAMIC WALL TILE

- A. Tile shall be "Unity" by Daltile. Tile shall be polished colorbody impervious porcelain type, 5/16 inch thick. Tile shall be standard colors, all as selected from samples submitted to the Architect. Tile size shall be 12" x 24".
- B. Tile and base shall be standard grade conforming to ANSI A137.1.

2.03 DRY SET MORTAR

Dry set mortar shall conform to ANSI A118.1.

2.04 GROUTING MATERIAL

Grouting material shall conform to ANSI A118.6. Color of grout for walls and floors shall be selected by the Architect. Grout shall have integral sealer component.

2.05 SEALANT

Sealant shall be #784 white silicone as manufacturer by Dow Corning Co. Similar sealant by General Electric may be submitted for the Engineer's approval.

2.06 METAL TRIM UNITS

Provide metal trim units with cove profile at wall and floor interior corner transitions. Provide flat edge metal trim units at top of wall tile. Similar to Schluter brushed stainless steel finish.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Before tiling, be sure variations of surface to be tiled is not more than 1/8 inch in 8 feet for walls and 1/8 inch in 10 feet for floors and that all plumbing fixtures, fittings and connections are in place and surfaces are free of curing membranes, oil, grease, wax and dust.
- B. Tile applied shall be properly spaced, and set true, plumb and straight.
- C. Install metal trim strips at all tile interior corners in walls and floors and wall top cap.
- D. Ceramic tile shall be set with dry set mortar conforming to ANSI A108.5.
 - 1. Floor: TCA Method F113.
 - 2. Wall: TCA Method W202.
- E. Grout shall be placed and thoroughly worked in to all tile joints to form a smooth dense surface free of voids. Clean all tile surfaces with water as soon as grout becomes firm.
- F. Where tile abuts steel, wood or other material, seal the joint with sealant.
- G. It will be the responsibility of the tile contractor to protect the work in this section and the work of others from damage resulting from this work. Damaged items shall be refinished, replaced or repaired, as determined by the Engineer, at no additional cost.
- H. Cover tile completely with heavy reinforced non-staining sisal kraft paper, lapped a minimum of three inches, with joints sealed and taped. No traffic shall be allowed on tile floor for at least three days after installation.

END OF SECTION 093013

SECTION 095123
ACOUSTICAL TILE CEILINGS

PART 1 – GENERAL

1.01 RELATED DOCUMENTS

- A. Examine Drawings, Contract Conditions all other Sections of the Specifications for requirements which affect work of this Section whether or not such work is specifically mentioned in this Section.
- B. Coordinate work with that of all other trades affecting, or affected by work of this Section. Cooperate with such trades to assure the steady progress of all Project work.

1.02 DESCRIPTION

The work in this section consists of furnishing all materials, equipment, supplies, incidentals, labor and supervision, and performing all operations required to furnish and install all lay-in suspended ceiling components as shown on the schedules and Drawings, and as specified herein and as is additionally required to properly complete the work.

1.03 GENERAL REQUIREMENTS

- A. All ceilings shall be installed in accordance with the approved instructions of the manufacturer of the suspension system and ceiling panels.
- B. All overhead mechanical and electrical work, excluding surface mounted equipment, shall be completed and in-place prior to the installation of the ceilings.
- C. Installation of lay-in ceiling panels shall not begin until residual moisture from concrete and masonry work has dissipated. Before installation, the building shall be enclosed and permanent heating equipment in operation.

1.04 SUBMITTALS

- A. One linear foot of main runner, cross tee, edge molding and hanger wire.
- B. One square foot of panel.
- C. Shop drawings shall be submitted and approval obtained prior to delivery of ceiling system components to the site. Drawings shall clearly delineate all components of the system and shall show proposed layout of ceiling grid.
- D. Submit manufacturer's product data for all materials.

PART 2 - MATERIALS

2.01 MATERIALS

- A. All materials shall be delivered in their original unopened packages.
- B. Hanger wires shall be galvanized carbon steel, ASTM A 641, soft temper, prestraightened, prestretched, yield-stress load of at least 3 times design load but not less than 12 gage. Wire coils will not be permitted.
- C. Ceiling panels shall be 24" x 48" x 3/4" thick regular lay-in type commercial ceiling tile "Dune Second Look II (2712) by Armstrong World Industries, conforming to Class A (Fed. Spec. SS-S-118B) flame spread rating.
- D. Suspension system shall be an exposed interlocking grid assembly complying with ASTM C 635, Standard Specification for Metal Suspension Systems for "Acoustical Lay-in Panel Ceilings." Suspension system shall be classified heavy duty. Exposed members shall have a factory applied low gloss white baked enamel finish. System shall be "Prelude ML" by Armstrong World Industries or approved equal.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Installation shall be in accordance with ASTM Recommended Practice C 636. Grid system shall be true, straight and level to a tolerance of one in 1000, with border units of the greatest possible size. Install hangers directly to supporting structure. All members and panels shall be installed in strict accordance with the manufacturer's recommendations. All joints around electric outlets, ducts, pipes and other work extending through the ceiling treatment shall be sealed tight with Engineer approved nonhardening caulking compound. At completion of the ceiling treatment, joints in grid shall be straight and true-to-line, with exposed surfaces flush and level with hairline joints. Units shall be neatly jointed to connecting work. Provide angles at intersections of all vertical surfaces.
- B. Following erection, dirty and discolored surfaces of acoustical units and/or support system shall be cleaned in accordance with the manufacturer's recommendations and left free from defects. Grid components and acoustical tiles that are damaged in any way or improperly installed shall be removed and replaced as directed, at no additional cost.

END OF SECTION 095123

SECTION 096513
RESILIENT BASE & ACCESSORIES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Examine Drawings, Contract Conditions all other Sections of the Specifications for requirements which affect work of this Section whether or not such work is specifically mentioned in this Section.
- B. Coordinate work with that of all other trades affecting, or affected by work of this Section. Cooperate with such trades to assure the steady progress of all Project work.

1.02 DESCRIPTION

The work includes furnishing all materials, equipment, supplies, labor and supervision, and performing all operations required to provide resilient accessories as shown on the Drawings, as specified herein and as is additionally required to properly complete the work. Location of wall base and accessories are shown or scheduled on the Drawings.

1.03 QUALITY ASSURANCE

Provide each type of resilient accessory as produced by a single manufacturer, and include manufacturers' recommended primers, adhesives, sealants, leveling compounds, etc.

1.04 SUBMITTALS

- A. Product Data: Submit 8 copies of manufacturer's technical data and installation instructions for each type of resilient wall base, accessory, and installation materials such as adhesive, leveling compound, etc.
- B. Samples: Submit samples of each type, color, and pattern of resilient wall base, and accessory required, indicating full range of color and pattern variations. Provide 6" long sections of wall base and accessories.

For initial selection of colors and patterns submit, prior to above, samples in form of actual sections of resilient wall base and accessory, showing full range of colors and patterns available for each.
- C. Certification for Fire Test Performance: Submit manufacturer's certification that resilient wall base and accessories furnished comply with required fire test performance and have been tested and meets indicated standards.
- D. Maintenance Instructions: Submit 8 copies of manufacturer's recommended maintenance practices for each type of resilient wall base and accessory required.

1.05 JOB CONDITIONS

Maintain minimum temperature of 65°F (18°C) in spaces to receive resilient wall base and accessories for at least 48 hours prior to installation, during installation, and for not less than 48 hours after installation. Store materials in spaces where they will be installed for at least 48 hours before beginning installation. Subsequently, maintain minimum temperature of 55°F (13°C) in areas where work is completed.

Where possible, install resilient wall base and accessories after other finishing operations, such as painting, have been completed.

1.06 MAINTENANCE STOCK

A. Provide Owner will all non-installed undamaged product in original packaging at the completion of the work

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

Subject to compliance with requirements, provide products of one of the following manufacturers:

Armstrong Company, Floor Division
Azrock Industries, Inc., Floor Division
Burke Industries Inc.
Flexco
Johnsonite; a Tarkett Company
Kentile Floors, Inc.
Roppe Corporation, USA
VPI Corporation

2.02 MATERIALS

- A. Colors and Patterns: As selected by the Architect from the manufacturer's standards.
- B. Vinyl Wall Base: Standard straight base 1/8 inch thick by 4 inches high, with preformed or molded corner units, equal to Kentile VC-100 matte finish.
- C. Rubber Stair Treads: Type TS or TP, Class 2 pattern (embossed, grooved, or ribbed); Group 1 (imbedded abrasive strips); Round nosing (1-1/2 inch minimum height); 1/4" minimum thickness and tapered to back edge.
- D. Adhesives (Cements): Waterproof stabilized type as recommended by resilient materials manufacturers to suit material and substrate conditions.

PART 3 - EXECUTION

3.01 PREPARATION

- A. Broom clean or vacuum surfaces to be covered and inspect subfloor. Start of installation indicates acceptance of conditions and full responsibility for completed work.

3.03 INSTALLATION OF WALL BASE AND ACCESSORIES

- A. Apply vinyl wall base to walls, casework and other permanent fixtures and vertical surfaces in rooms or areas where base is required, including closets. Install base in lengths as long as practicable, with preformed or molded corner units. Tightly bond base to substrate throughout length of each piece, with continuous contact at horizontal and vertical surfaces.
- B. Apply rubber stair treads and nosings full width of each tread and in accordance with the manufacturer's instructions. Install manufacturer's two-part epoxy compound recommended by stair tread manufacturer to fill nosings that do not conform to stair tread contours.

3.04 CLEANING AND PROTECTION

- A. Remove excess adhesive and other surface blemishes using neutral type cleaners as recommended by manufacturer.
- B. Finishing: After completion of the work, just prior to inspection of the work for Substantial Completion, thoroughly clean floors, wall base and accessories.

END OF SECTION 096513

SECTION 099123
PAINING

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Examine Drawings, Contract Conditions all other Sections of the Specifications for requirements which affect work of this Section whether or not such work is specifically mentioned in this Section.
- B. Coordinate work with that of all other trades affecting, or affected by work of this Section. Cooperate with such trades to assure the steady progress of all Project work.

1.02 DESCRIPTION

- A. The work includes furnishing all materials, equipment, tools, supplies, transportation, staging, drop cloths, wet-paint signs, labor and supervision, etc., and performing all operations required for interior and exterior "on site" painting as noted on the Drawings, as described herein, and as is additionally required to properly complete the work.
- B. Unless otherwise indicated in the Paint Schedule, prepare surfaces and apply the number of coats scheduled herein regardless of shop or field coats specified elsewhere. Surface preparation and touch-up of shop coats is included in the work.
- C. In general, it is intended that all non-shop finished exposed surfaces throughout the interior and exterior of the building be painted as described herein and as indicated on the Drawings.
 - 1. Except as otherwise noted or directed by the Architect, the following are not to be painted: bronze; stainless steel; aluminum and other non-ferrous metals; prefinished metals; concrete sidewalks; finish hardware; glass and glazing materials; acoustical ceilings; resilient floor/wall coverings and base; plastic laminate; lighting units and pipes, ducts, conduit, insulation, etc., in mechanical rooms except where they abut surfaces scheduled to be painted.
 - 2. Except as otherwise noted, paint all steel doors, steel door and louver frames; exposed structural steel and miscellaneous metals, interior and exterior; gypsum board walls; exposed concrete masonry units; exposed interior concrete; standing and running trim; shelving and drawers in casework; exposed rough carpentry work (e.g., plywood, back-up panels etc.); all exterior woodwork; back-priming all exterior woodwork; piping/conduit, hangers, supports, and related equipment and accessories in areas designated to be finish painted (except where finish painted by the manufacturer or specifically excluded by this specification, the Drawings or the Architect).

- D. The Contractor shall perform all work in accordance with this Specification Section and shall complete all incidental details, whether or not such details are specified herein, as is required to produce thoroughly finish painted work of the best quality.

PART 2 - PRODUCTS

2.01 MATERIALS

- A. All paints and associated materials shall be first quality products manufactured by the following companies:

Benjamin Moore
Dur-A-Flex
Tnemec Company, Inc.
Sherwin Williams

- B. Insofar as possible, paints used for this Contract shall be produced by a single manufacturer.
- C. All materials used in the work are to be of the best of their brand or class, brought to the site in original unopened containers. Containers of materials must have original labels intact in order to be accepted for use on the Project. Driers, thinners and solvents shall be as recommended by the manufacturer of the paint being used.
- D. No claim as to the unsuitability of any material used will be considered unless such claim is made in writing before the materials are approved by the Resident. By submitting a product for approval, the Contractor assumes complete responsibility for the suitability of the paint and for the results obtained therewith.
- E. The Schedule of Painting listed herein designates specific manufacturers to denote the standard of quality and the type of finish desired. Materials of other manufacturers listed above shall be submitted to the Engineer for approval prior to purchase of any materials. Requests for substitution shall list the material specified and the specific material being offered as a substitute, including appropriate supportive technical data.

2.02 COLORS AND FINISHES

- A. All colors and finishes shall be as selected and/or scheduled by the Architect. Prepare for approval by the Architect, two (2) panels for each color and finish selected (i.e., semi-gloss, flat, etc.). Submit these samples at least 3 weeks in advance of the date scheduled for beginning painting work.
- B. Panels shall be at least 12 inches by 12 inches.
- C. Approved samples shall be kept in the Contractor's field office for reference for the duration of the painting work.

2.03 GENERAL REQUIREMENTS

- A. Inspect all surfaces requiring painter's finish and remedy all remaining defects.
- B. All surfaces to be painted shall receive a prime coat and two finish coats, unless otherwise noted.
- C. Take adequate precautions for protection against soiling and damage to adjacent equipment, structures, and surfaces. Protect floors, paved areas and all other adjacent surfaces against spatter and spillage. Leave and maintain protection in place until all final painting has been performed and approved in the affected area.
- D. Erect, maintain and dismantle scaffolding and access equipment without damage to structures, machinery, pipes, etc.
- E. Store rags, cleaning cloths, and waste materials smeared or contaminated with paint, oils, solvents, and other flammable materials in approved covered metal containers and remove them from buildings and dispose of them off-site after each shift and as otherwise directed by the Resident.
- F. Take precautions so that surface preparation, including dust blow-off, does not do any damage. With the approval of the Resident, equipment, machinery and items that could be damaged by grit and dust may be masked and sealed dust-tight in a suitable manner. Take precautions so that grit and dust does not fall on surfaces ready for painting or onto newly painted surfaces.
- G. As necessary, remove solvent and paint fumes by suitable means.
- H. Do not perform spray painting in areas where welding is in progress nor near operations involving open flames, sparks or high heat.
- I. Do not perform painting near or on energized electrical equipment or rotating equipment without proper precautions being taken nor until approval to proceed is received from the Engineer.
- J. Take all necessary precautions to ensure that paint is not introduced into working parts of equipment, machinery, filters, motors, controls, etc. Where the indicated application method may cause damage, notify the Resident so that the Resident and manufacturer can agree on an alternate method of application.
- K. Mask and otherwise protect nameplates, gauges, glass, fire rating labels, instructions, lubrication fittings, instruments and similar items as necessary to retain their original conditions after completion of the painting work. Remove protection after painting is completed.
- L. Follow the manufacturers' recommendations and OSHA regulations regarding precautions and protective clothing and equipment to be used by painters.

- M. Adequately provide for the proper electric and static grounding of spray equipment, of items being painted and other static-producing equipment and electrical tools. The motors on painting and coating related equipment shall be explosion proof. Supply all ventilation equipment, respirators, safety lines, and eye, face, head and body protection.
- N. The Contractor shall be responsible for all damage done to other work and for repairing same to the satisfaction of the Engineer. Replace all materials damaged to such an extent that they cannot be restored to their original condition. This work shall be done at the Contractor's expense.

2.04 SUBMITTALS

Submit 8 copies of the manufacturers' technical information including paint label analysis and application instructions for each material proposed for use.

2.05 DELIVERY AND STORAGE

- A. Deliver all materials to the jobsite in original, new and unopened packages and containers bearing the manufacturer's name and label. Technical data sheets covering use of the product shall be included with every consignment delivered. Each container shall bear the label of the manufacturer and be clearly marked in a durable manner to show the following information:
 - 1. Type of paint by generic description.
 - 2. Manufacturer's paint name and reference number.
 - 3. Gross and net weights and/or volumes.
 - 4. Date of manufacture and shelf-life.
 - 5. Recommended thinner and mix ratios.
 - 6. Recommended safety precautions and antidotes in case of contact or ingestion.
- B. Store materials in an enclosed, protected storage area with provisions for maintaining the materials in storage at not less than 60°F nor more than 95°F unless more restrictive temperatures are required by the paint manufacturer to guarantee shelf-life. Provide adequate ventilation in storage areas. No paint stored longer than the manufacturer's specified shelf-life shall be used in the work. Keep the storage space neat and clean and repair all damage to the space and surroundings.

PART 3 - EXECUTION

3.01 APPLICATION CONDITIONS

- A. Apply water-base paints only when the temperature of the surface to be painted and the surrounding air temperature is between 50°F and 90°F., unless otherwise permitted by the paint manufacturers' printed instructions.
- B. Apply solvent thinned paints only when the temperature of the surface to be painted and the surrounding air temperature is between 45° and 95°F., unless otherwise permitted by the paint manufacturers' printed instructions.
- C. Do not apply paint in snow, rain, fog or mist, or when the relative humidity exceeds 85%. Do not apply paint to damp or wet surfaces nor when the temperature of the surface to be painted is lower than the corresponding wet-bulb temperature for the existing air temperature and relative humidity, unless otherwise permitted by the paint manufacturers' printed instructions.
- D. Continue painting during inclement weather only if the areas and surfaces to be painted are enclosed and maintained within the temperature and humidity limits specified by the paint manufacturer during both the application and drying periods.
- E. Do not perform exterior painting when windblown dust or debris may contaminate the work. Isolate interior painting areas as required to prevent dust circulation. Provide temporary closures where isolation cannot be effected by closing doors and windows.
- F. Prepare trial coats as requested by the Resident for coats differing in color, shade, application method, etc.
- G. Each coat of paint must be dry before the succeeding coat is applied or any surface preparation (i.e., sandpapering) is done.
- H. Perform painting and finishing in the best and most workmanlike manner known to the trade. No paint shall be applied by other than skilled workmen. All surfaces are to be left smooth, even and free from brush marks and visible paint laps. If surfaces are not thoroughly covered, apply additional coats or otherwise remedy problems until finished surfaces are of an acceptable uniform color, texture and sheen, at no additional cost.
- I. Provide specified and approved finish coats which are compatible with prime paints. Review other sections of these specifications in which prime paints are to be provided to ensure compatibility of total coating system for various substrates. Upon request from other trades, furnish information on the characteristics of finish materials proposed for use to ensure that compatible prime coats are used. Provide barrier coats over incompatible primers or remove primer and reprime as required. Notify the Resident in writing of any anticipated problems using the specified coating systems over substrates primed by others.

- J. If a prime coat does not dry to a uniform sheen over the entire surface, spot prime the areas that indicate suction before applying the finish coat.
- K. After the first coat is applied, if the surface is not smooth, sand and refinish it.
- L. Maintain a record, in a form approved by the Resident, of all painting work performed. Indicate on the record the locations and types of surfaces painted, manufacturers' stock numbers, color numbers, quantity of each paint type applied, surface preparation, and the number and mil thickness of each coat applied.

3.02 INSPECTION

- A. Examine the areas and conditions under which painting work is to be applied and notify the Resident in writing of conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.
- B. Commencement of painting work will be construed as the Contractor's acceptance of the surfaces and conditions within that particular area.

3.03 SURFACE PREPARATION

- A. General:
 - 1. Perform surface preparation and cleaning procedures in strict accordance with the paint manufacturers' instructions and recommendations, and as is additionally specified herein.
 - 2. Thoroughly inspect, clean and repair all surfaces which have received a shop coat of paint under other sections of the specifications prior to application of additional coats. Where shop primer has been damaged, the field painting work includes surface preparation and touch-up painting of abraded and otherwise defective primer, as well as priming of uncoated field welds, field bolting, and all other bare surfaces before application of the first field coat. Feather edges of sound primer into defective prime areas, bare field welds, etc., and apply touch-up paint to overlap the adjacent sound primer by at least 2 inches.
 - 3. Provide non-damaging protection for all hardware, hardware accessories, machined surfaces, plates, and similar items in place which are not to be finish painted, prior to surface preparation and painting operations.
 - 4. Clean all surfaces to be painted before applying paint or surface treatments. Remove oil and grease prior to mechanical cleaning. Schedule cleaning and painting operations so that contaminants from the cleaning process will not fall onto newly cleaned or newly painted surfaces.

5. Failure on the part of the Contractor to remedy surface imperfections that remain visible following the finish coat of paint shall be cause for rejection, solely at the discretion of the Engineer, and shall be considered due cause for refinishing the surface area involved by the Contractor, at no additional cost.
 6. Cut out and fill with spackle or other approved compounds, all scratches, cracks, abrasions, etc., adjoining trim materials. Make all patches flush with adjoining surfaces and allow to dry and then properly seal before application of the prime coat. In general, interior caulking and sealants will be installed prior to start of field painting; however, certain sealants require that painting be applied first. It shall be the Contractor's responsibility to coordinate such work with the trades involved.
- B. Specific Surface Preparation: The painting systems will indicate one or more of the following methods of surface preparation for each item or surface to be painted.
1. Solvent Cleaning: Cleaning in accordance with Steel Structures Painting Council (SSPC) Specification SP 1.
 2. Alkaline Cleaning: Wash with weak alkaline solution consisting of 1 part trisodium phosphate to 32 parts of water, rinse thoroughly with clean, potable water, and dry.
 3. Masonry and Concrete: (Concrete Block and Concrete) - remove all form oil, dust, dirt, efflorescence, chalk, loose material, laitance, etc., by wire brushing, stone rubbing and other appropriate means (use of acid cleaners must be approved by the Engineer). Comply with paint manufacturers' recommendations regarding neutralizing surface for oil base paints or wetting for water base paints. Patch all ratholes and rough spots with an Engineer approved compound. Keep patches damp (where applicable) for a period of at least 24 hours and then allow to dry thoroughly prior to application of paint. Patch in a neat and workmanlike manner. Test each patch for adhesion before painting. Do not paint new concrete and masonry for at least 28 days after placement to permit the concrete and mortar to cure and dry out sufficiently.
 4. Wood and PVC Surface: Perform alkaline cleaning to remove grease, oil, wax, etc. Remove alkali solution with water soaked wipers and then dry the surfaces. Smooth surface by fine sanding. Blunt sharp edges with light hand sanding. Seal knots and pitch streaks with shellac. For surfaces which are to receive an opaque finish, fill holes, cracks, etc., with a latex base compound and when hardened, sand smooth. In areas where the wood is to be stained, mix proper colored stain with the wood filler before application to ensure color match of the filler to surrounding woodwork. Do not apply paint or stain to unfinished wood having a moisture content of more than 10% (at a minimum 3/16 inch depth) as checked by a Painter's Moisture Register - Model 9.
 5. Ferrous Metals: Clean iron and steel surfaces that have not been previously shop coated, and which do not require sand blasting, of rust and scale in

accordance with Steel Structures Painting Council Specification SP-3, Power Tool Cleaning, prior to application of prime coat. Prior to mechanical cleaning, solvent or alkaline clean surfaces to remove oil, grease, and other contaminants. Clean surfaces the same day the surfaces are to be painted. Take special care to avoid burnishing surfaces by wire brushing.

6. Galvanized Surfaces: Solvent clean and scrub with scouring pads to remove all oil and "white rust". Follow by rinsing with clean, water soaked wipers, and then dry the surfaces. When required (i.e., prior to application of alkyd coatings), apply a "wash primer" in accordance with the paint manufacturers' recommendations.
7. Preparation for Touch-up Painting: Clean all field bolting, field welds, unprimed steel, and all other miscellaneous uncoated metal of rust, scale, welding contaminants, grease, oil and other foreign matter by alkaline and power tool cleaning. Remove all weld spatter, sharp edges and points by chipping and grinding. Remove damaged primer until sound primer is encountered. Feather the edge of paint surrounding damaged areas and overlap adjacent sound primer by at least 2 inches with touch-up primer.
8. Drywall (Gypsum Board): Prepare all drywall surfaces so that there are no cracks, holes or other physical damage present, nor any chalkiness, insufficiently slaked lime, excessively porous surfaces, crazing, joint compound fins and holidays. Do not apply any paint to plaster or drywall surfaces when the surface moisture, as measured by Painter's Moisture Register - Model 9, exceeds that allowed by the paint manufacturer.

3.04 MATERIALS PREPARATION

Mix and apply paint in compliance with the manufacturer's directions. Thoroughly stir paint materials until the ingredients therein are completely intermixed and, if necessary, strain prior to application. Do not mix any surface film into the paint. If required, use thinners furnished or recommended by the paint manufacturers for the specific materials and application conditions. Do not use thinner in excess of the manufacturer's recommendations. Proportion and prepare catalyzed paints in exact accordance with the manufacturer's directions. Make sure that personnel mixing paint are knowledgeable of the products being mixed.

3.05 APPLICATION

- A. In general, the painting systems specifications indicate the required method of application; brush, roller or spray. Where spray equipment is required, the equipment and application pressures shall conform to the paint manufacturer's recommendations, and shall be subject to acceptance by the Engineer. Where the indicated application method is not feasible or appropriate, obtain the Engineer's acceptance of an alternate method. Bring to the attention of the Engineer all discrepancies between these specifications and manufacturers' instructions and recommendations, and await the Engineer's decision of resolution before proceeding with the work in question.

Where more than one method of application is given, use the method recommended by the manufacturer for the particular application.

- B. Use only tools and equipment which are suitable, clean, in good condition, and recommended by the paint manufacturer. Spray equipment shall produce proper atomization and leave a satisfactory film on the surface. Do not leave brushes and rollers to harden before cleaning. Do not use paint mitts.
- C. Apply paint as necessary to produce tough, durable and well-bonded films that will provide long-term protective performance and satisfactory appearance. Apply paint to produce a uniform thickness, free of defects such as pinholes, holidays, skips, missed areas, blistering, runs, sags, wrinkles, excessive film build-up, lack of film build-up, uneven film thickness, bubbles, cratering, cracking, crazing, poor adhesion, delamination, lifting, peeling, dry spray, overspray, excessively thinned coatings, contaminated coatings, flattening, orange peel, brush marks, solvent traps, and embedded dust and dirt.
- D. Do not apply paint to a surface that has not been properly prepared, nor when the ambient and surface conditions are not satisfactory. Do not apply paint at humidities and temperatures that will cause blistering, porosity or be otherwise detrimental to the performance and life of the paint. Provide suitable air and surface thermometers, sling psychrometers, etc., at the jobsite as are essential for the work to monitor temperature and humidity conditions.
- E. As paint application is in progress, check each coating frequently by means of suitable wet film thickness gauge to achieve the proper dry film thickness, taking into account theoretical coverage versus actual coverage, as well as solvent loss.
- F. Strictly adhere to the manufacturers' recoat time. Do not apply paint over undercoats which have not properly cured. Conversely, adequately and properly prepare surfaces of paints which have cured past their critical recoat time. Before painting, prepare and repair undercoats deteriorated from long exposure to the weather or other adverse conditions.
- G. Use the cross-spray technique to insure uniform coverage, free of defects and missed areas. "Stripe paint" sharp edges to ensure proper build-up at the edges, prior to the application of the specified number of coats.
- H. Do not force dry paint.
- I. Protect newly painted surfaces from rain, condensation, dirt, debris, and other contamination until paint has cured.
- J. Apply additional top coats when undercoats, stains and other conditions show through the final coat. Take care to insure that all surfaces, including edges, corners, crevices, welds, exposed fasteners, etc., receive a dry film thickness equivalent to that of flat surfaces. To insure this, stripe or spot paint such areas first and then recoat as the remainder of the surface is being painted.

- K. Paint surfaces behind movable equipment and furniture the same as similar exposed surfaces.
- L. Paint interior surfaces of ducts that are visible through registers and grilles with an appropriate flat finish black paint.
- M. Paint the back and sides of access panels and removable and hinged covers to match the exposed surfaces.
- N. Finish tops and edges of exterior doors the same as the "pull" side faces.
- O. Sand lightly between coats if recommended by the manufacturer.
- P. If the dry film thickness at any of the inspection times is less than specified, apply an additional coat of the material specified, or increase the film thickness of the succeeding coat or coats, at the discretion of the Engineer, as required to ensure that the specified total dry film thickness for the finished work is obtained. Conceal all brush marks, laps, and joints between successive work days.
- Q. Scheduling Painting:
 - 1. Before applying paint, remove all dust, grit, loose rust particles, dirt, etc., from surfaces by vacuuming or blowing off with dry, oil-free air, as appropriate for the application.
 - 2. Apply paint as soon as possible after the surfaces have been cleaned, pretreated, or otherwise prepared for painting, and before subsequent surface deterioration.
 - 3. Allow sufficient time between coats to permit proper drying.

3.06 RETOUCHING

- A. Touch-up all work painted under this Contract which, for any reason, has been damaged during construction work.
- B. It is required that all finish work have acceptable surfaces when the building is ready for acceptance by the Engineer.

3.07 CLEAN-UP AND PROTECTION

- A. Upon completion of painting work, clean all paint-spattered surfaces. Remove spattered paint by approved methods, using care not to scratch or otherwise damage finished surfaces.
- B. Correct all damage caused by cleaning, repairing, replacing, and repainting, as acceptable to the Engineer.

- C. Remove temporary protective wrappings provided by others for protection of their work after completion of painting operations.

3.08 "AS-BUILT" RECORD

Submit, for record purposes, a finish paint schedule for each area and surface receiving "painter's finish", indicating actual paints applied, including manufacturer, type, gloss, color blend, etc.

3.09 GUARANTEE

Give the Authority a written guarantee that the materials and workmanship are of the highest quality and that the paint will not discolor, fade, peel, chalk, craze, chip, alligator, etc., and that any work which becomes defective within one (1) year of acceptance of the work will be promptly made good by the Contractor to the satisfaction of the Authority without cost.

3.10 PAINT SYSTEMS AND SCHEDULE

- A. The following paragraphs list the various paint systems to be used for the work, and most of the major items and surfaces requiring painting. The mention of specific items and surfaces to be painted shall not be construed as limiting the total number of items and surfaces that are to be painted. The intent of this section is to have all items and surfaces painted as specified for other materials in the same environment, except for those items which are specifically excluded.

- B. Systems

- 1. System A(1) - (Gloss Alkyd)

- a. Surface Preparation: For bare metal, alkaline clean, Power Tool Clean and solvent clean in accordance with SSPC SP-3 and SSPC-SP-1.
 - b. Touch-up: Prepare damaged shop primer and galvanizing in accordance with touch-up specifications.
 - c. Prime Coat: Prime touch-up areas and bare metal with Tnemec Series 4 Versare Rust Inhibitive Primer. Repair damaged galvanizing with ZRC Cold Galvanizing Compound or equal, and prime all galvanizing with Tnemec 32-1210 Tneme-Grip.
 - d. Finish Coat: Two coats of Tnemec Series 2H Hi-Build Tneme-Gloss Alkyd Enamel; 2.5 to 3.5 dry mils each coat (spray, brush or roller applied).

2. System A(2) - (Semi-Gloss Alkyd)
 - a. Surface Preparation: For bare metal, alkaline clean, Power Tool Clean and solvent clean in accordance with SSPC SP-3 and SSPC-SP-1.
 - b. Touch-up: Prepare damaged shop primer and galvanizing in accordance with touch-up specifications.
 - c. Prime Coat: Prime touch-up areas and bare metal with Benjamin Moore Retardo Rust Inhibitive Paint (163). Repair damaged galvanizing with ZRC Cold Galvanizing Compound or equal, and prime all galvanizing with Benjamin Moore Galvanized Metal Primer (155).
 - d. Finish Coats: Two (2) coats of Benjamin Moore Impervo (133) Semi-Gloss Alkyd Enamel; 1.5 dry mils for each coat (spray, brush or roller applied).
3. System B - Concrete Masonry Units (Satin Alkyd)
 - a. Surface Preparation: Prepare surfaces in accordance with specifications for masonry and concrete.
 - b. Prime Coat: Benjamin Moore Moorcraft Block Filler (145) applied as necessary to produce a smooth, dense surface.
 - c. Finish Coats: Two (2) coats of Benjamin Moore Moorcraft Satin Finish Enamel (250); 1.5 dry mils for each coat (spray, brush or roller applied).
4. System C - Drywall (Low-Sheen Latex)
 - a. Surface Preparation: Prepare surfaces in accordance with the specifications for drywall.
 - b. Prime Coat: Benjamin Moore Moorcraft Vinyl Latex Primer (252); 1 dry mil (spray, brush or roller applied).
 - c. Finish Coats: Two (2) coats of Benjamin Moore Moorcraft Vinyl Latex Flat (251); 1.5 dry mils for each coat (spray, brush or roller applied).
5. System D - Drywall (Satin Alkyd)
 - a. Surface Preparation: Prepare surfaces in accordance with the specifications for drywall.
 - b. Prime Coat: Benjamin Moore Moorcraft Vinyl Latex Primer (252); 1 dry mil (spray, brush or roller applied).

- c. Finish Coats: Two (2) coats of Benjamin Moore Moorcraft Satin Finish Enamel (250); 1.5 dry mils for each coat (spray, brush or roller applied).
- 6. System E – Wood, PVC and Plywood - Painted Finish (Satin Alkyd):
 - a. Surface Preparation: Prepare surfaces in accordance with specifications for wood surfaces.
 - b. Primer Coat: Benjamin Moore Moorcraft Alkyd Enamel Underbody (247); 1.5 dry mils (spray, brush or roller applied).
 - c. Finish Coats: Two (2) coats of Benjamin Moore Moorcraft Satin Finish Enamel (250); 1.5 dry mils for each coat (spray, brush or roller applied).
- 8. System F - Concrete Floors (Epoxy):
 - a. Surface Preparation: Brush blast concrete floors to provide a dense 2 mil anchor profile. Acid surface etching will be allowed.
 - b. Prime Coat: Benjamin Moore I.M.C Epoxy-Ester Enamel (M25) applied at a rate of 550 square feet per gallon.
 - c. Finish Coat: Same as prime coat except add and thoroughly mix dry, washed, 50 mesh silica sand to paint as directed by the Engineer to produce a satisfactory slip-resistant surface.

C. Mechanical and Electrical Work:

Except for manufacturer painted items, paint all exposed mechanical and fire protection piping, valves, fittings, traps, conduit, miscellaneous fittings and boxes, pipe and duct insulation, steel hangers and attachments, floor, ceiling and wall plates (except those which are plated), ducts, diffusers, grilles, supports, clamps, straps, etc., in rooms and spaces designated to be finish painted. Painting systems shall be based on the surface and its environment, as approved by the Resident.

D. Equipment:

In general, switchboards, disconnect switches, motors, light and power panels, etc., will be completely shop finished by the manufacturers. All equipment shall be touched-up by the installer where finish is damaged during installation.

3.11 PAINTING SCHEDULE

SURFACE	SYSTEM
A. Interior	
1. Concrete and Concrete Masonry Unit Walls	B
2. Concrete Floors (including equipment pads)	F
3. Metals	
a. Steel Doors and Steel Frames	A (2)
b. Exposed Conduit, Light Fixture Pendants, Pipe, etc.	A (2)
4. Gypsum Wallboard	
a. Walls	D
b. Exposed Ceilings	C
5. Wood and PVC	
a. Standing and Running Trim	E
b. Shelves	E
B. Exterior	
1. Metal	
a. Steel Doors and Frames	A(1)
b. Bollards	A(1)
c. Structural Steel for Canopy (Exposed)	A(1)
2. PVC	
a. Trim	E
b. Soffit	E
c. Back-priming (fascia backup-panels, trim, etc.)	E (primer only)

Note: All colors will be custom colors as selected by the Engineer.

- C. In general, miscellaneous brackets, angles, plates, etc., shall receive the same finish coats as the items to which they are associated. Surface preparation and prime coats shall be as specified for similar materials in the same space/environment or as otherwise directed by the Engineer.
- D. In general, ductwork, piping and conduit running exposed on walls and ceilings (including attachment devices, supports, accessories, etc.) shall receive the same type finish coat as adjacent surfaces. Surface preparation and prime coats shall be as specified for similar materials in the same space/environment or as otherwise directed by the Engineer.
- E. Prime galvanized steel and aluminum with Benjamin Moore Galvanized Metal Primer (155), or an approved equal, before applying finish coats.

END OF SECTION 099123

SECTION 101010
MISCELLANEOUS SPECIALTIES

PART 1 - DESCRIPTION

1.01 RELATED DOCUMENTS

- A. Examine Drawings, Contract Conditions all other Sections of the Specifications for requirements which affect work of this Section whether or not such work is specifically mentioned in this Section.
- B. Coordinate work with that of all other trades affecting, or affected by work of this Section. Cooperate with such trades to assure the steady progress of all Project work.

1.02 DESCRIPTION

The work in this section consists of furnishing all materials, equipment, labor and supervision, and performing all operations required to furnish and install all miscellaneous items as shown on the Drawings, as specified herein, and as is additionally necessary to properly complete the work.

1.03 SHOP DRAWINGS

Submit eight (8) copies of shop drawings for louvers, lockers, flagpole, mop hanger, shelving & supports. Submit eight (8) copies of catalog cuts for all items and materials supplied.

PART 2 - MATERIALS

2.01 MOP HANGER

Mop hanger shall be 24 inches long, 3 inches wide stainless steel with three (3) rubber tool grips equal to Catalog No. 889-CC as manufactured by Crane Plumbing and Fiat Products, or equal by Florestone or E.L. Mustee & Sons, Inc.

2.02 LOUVERS

- A. Where indicated on the Drawings, install Airolite type K6774 Horizontal drainable louvers with 4 inch deep blades. Blades and frame shall be extruded aluminum 12 gauge alloy 6063-T52, with "Kawneer 500" finish, custom color to match the windows and frames. Louvers shall be fitted with 16 gauge aluminum bird screen in extruded aluminum frames. Louvers shall bear AMCA certified ratings seals for air performance and water penetration. Similar louvers by Construction Specialties, Inc. or Rusken Mfg. Div., Phillip Industries Inc. will be considered for use. Where indicated, detail and fabricate louvers so as to be readily removable from the secure side (interior). Hollow metal frames shall be supplied under Section 081113.

B. Where indicated on the Drawings, install Airolite type K601D horizontal blade, sightproof louvers (inverted Y) with 4 inch deep blades. Blades and frame shall be extruded aluminum 12 gauge alloy 6063-T52, with "Kawneer 500" finish, custom color to match the windows and frames. Louvers shall be fitted with 16 gauge aluminum bird screen in extruded aluminum frames. The Contractor shall submit the manufacturer's data derived in accordance with AMCA Standard 500 on a 4 foot by 4 foot unit demonstrating that it provided a minimum of 4.11 square feet of free area and shall intake 600 fpm free area at a static pressure drop not exceeding 0.15 inch H₂O. Similar louvers by Construction Specialties, Inc. or Rusken Mfg. Div., Phillip Industries Inc. will be considered for use. Where indicated, detail and fabricate louvers so as to be readily removable from the secure side (interior). Provide blank-off interior panels at gable end louvers. Hollow metal frames shall be supplied under Section 08110.

C. See Mechanical Specifications for automatic dampers.

2.03 CASH DROP UNIT (SAFE)

Cash drop unit (safe) will be supplied by the Authority.

2.04 CURRENCY SCANNER & COIN SORTER UNITS

Currency Scanner and coin sorter units will be supplied by the Authority.

2.05 LOCKERS

A. Metal Lockers shall be similar to Global Industries "Infinity" Locker. Lockers shall be Double Tier 12" x 18" x 36" in 6-Door assembled profile. Each door shall have a stainless steel recessed door latch suitable for padlock. Each locker shall have 3 clothes hooks (one per side/rear).

B. Factory applied paint color shall be selected by the Architect.

2.06 SHELVING AND SUPPORTS

A. Shelving shall be ¾" plywood or particleboard core melamine-clad units in sizes indicated. All faces and edges shall be melamine clad. Color shall be white.

B. Supports shall be similar to Knape & Vogt steel heavy-duty #85 Series vertical standards and #185 Series brackets. Bracket shall be full depth of shelf, unless indicated otherwise. Color shall be white.

2.06 TRASH RECEPTACLES

A. Trash Receptacles will be supplied by the Authority.

2.07 FILE CABINETS

A. File cabinets will be supplied by the Authority.

2.08 FLAGPOLES

Flagpoles shall be seamless cone tapered aluminum 6063-T6 alloy, 30' (exposed) with a mechanical Class I clear anodized finish for two flags as manufactured by American Flagpole. All fittings, such as ball finial, double revolving truck, two halyard and four snaphooks, two cleats, and pole mounting assembly shall be as manufactured by or recommended by the flagpole manufacturer. Similar flagpoles and appurtenances manufactured by Concord Industries Inc., or EMC, a Division of Eder Manufacturing Corp. may also be acceptable.

PART 3 - EXECUTION

3.01 MOP HANGER

Install mop hanger in accordance with the manufacturer's instructions.

3.02 LOUVERS

Install louvers as shown on the approved shop drawings and in strict accordance with the manufacturers' instructions.

3.03 CASH DROP UNIT (SAFE), CURRENCY SCANNER AND COIN SORTER

Place cash drop unit, currency scanners and coin sorters in position after all surrounding work has been completed and approved. Safe, currency scanners and coin sorters supplied by the Authority.

3.04 FLAGPOLES

- A. Before installation, when flagpoles are to be stored on site for an extended period, remove all wrapping material and store poles in a dry place, off the ground.
- B. Flagpole shall be installed by a manufacturer trained and approved erection crew experienced in handling, assembling and erecting poles, in strict accordance with the manufacturer's instructions and as shown on the approved Shop Drawings.

3.06 SHELVES AND SUPPORTS

A. Install shelves and supports in accordance with the manufacturer's written installation instructions and as indicated.

3.07 LOCKERS

- A. Install lockers in location indicated and in accordance with manufacturer's installation instructions. Anchor lockers to wall framing.

END OF SECTION 101010

SECTION 101423
ROOM IDENTIFICATION SIGNAGE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings, Contract Conditions and other Technical Sections apply to work of this Section insofar as applicable.
- B. Coordinate work with that of all other trades affecting, or affected by work of this Section. Cooperate with such trades to assure the steady progress of all Project work.

1.2 SUMMARY

- A. Section includes room-identification signs that are directly attached to the building.

1.3 DEFINITIONS

- A. Accessible: In accordance with the accessibility standard.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For room-identification signs.
 - 1. Include fabrication and installation details and attachments to other work.
 - 2. Show sign mounting heights, locations of supplementary supports to be provided by other installers, and accessories.
 - 3. Show message list, timesteps, graphic elements, including raised characters and Braille, and layout for each sign at least half size.
- C. Samples for Initial Selection: For each type of sign assembly, exposed component, and exposed finish.
 - 1. Include representative Samples of available timesteps and graphic symbols.
- D. Product Schedule: For room-identification signs. Use same designations indicated on Drawings or specified.

1.5 INFORMATIONAL SUBMITTALS

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

1.6 CLOSEOUT SUBMITTALS

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

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

1.8 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace components of signs that fail in materials or workmanship within specified warranty period.
 - 1. Failures include, but are not limited to, the following:
 - a. Deterioration of finishes beyond normal weathering.
 - b. Deterioration of embedded graphic image.
 - c. Separation or delamination of sheet materials and components.
 - 2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Accessibility Standard: Comply with applicable provisions in the USDOJ's "2010 ADA Standards for Accessible Design", the ABA standards of the Federal agency having jurisdiction, and ICC A117.1.

2.2 ROOM-IDENTIFICATION SIGNS

- A. Room-Identification Sign: Sign with smooth, uniform surfaces; with message and characters having uniform faces, sharp corners, and precisely formed lines and profiles; and as follows:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Allen Industries Architectural Signage.
 - b. APCO Graphics, Inc.
 - c. ASE, Inc.
 - d. ASI Sign Systems, Inc.
 - e. Best Sign Systems, Inc.
 - f. InPro Corporation (IPC).
 - g. Mohawk Sign Systems.
 - h. Signature Signs, Inc.
 - i. Vomar Products, Inc.

2. Laminated-Sheet Sign: Photopolymer face sheet with raised graphics laminated over subsurface graphics to acrylic or phenolic backing sheet to produce composite sheet.
 - a. Composite-Sheet Thickness: Manufacturer's standard for size of sign.
 - b. Surface-Applied Graphics: Applied paint.
 - c. Color(s): As selected by Architect from manufacturer's full range.
3. Sign-Panel Perimeter: Finish edges smooth.
 - a. Edge Condition: Bullnosed.
 - b. Corner Condition in Elevation: Rounded to radius.
4. Mounting: Surface mounted to wall with hook-and-loop tape.
5. Text and Typeface: Accessible raised characters and Braille; typeface as selected by Architect from manufacturer's full range. Finish raised characters to contrast with background color, and finish Braille to match background color.

2.3 SIGN MATERIALS

- A. Acrylic Sheet: ASTM D 4802, category as standard with manufacturer for each sign, Type UVF (UV filtering).
- B. Paints and Coatings for Sheet Materials: Inks, dyes, and paints that are recommended by manufacturer for optimum adherence to surface and are UV and water resistant for colors and exposure indicated.

2.4 ACCESSORIES

- A. Fasteners and Anchors: Manufacturer's standard as required for secure anchorage of signs, noncorrosive and compatible with each material joined, and complying with the following:
- B. Hook-and-Loop Tape: Manufacturer's standard two-part tape consisting of hooked part on sign back and looped side on mounting surface.

2.5 FABRICATION

- A. General: Provide manufacturer's standard sign assemblies according to requirements indicated.
 1. Preassemble signs and assemblies in the shop to greatest extent possible. Disassemble signs and assemblies only as necessary for shipping and handling limitations. Clearly mark units for reassembly and installation; apply markings in locations concealed from view after final assembly.
 2. Mill joints to a tight, hairline fit. Form assemblies and joints exposed to weather to resist water penetration and retention.
 3. Conceal connections if possible; otherwise, locate connections where they are inconspicuous.

2.6 GENERAL FINISH REQUIREMENTS

- A. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.
- B. Appearance of Finished Work: Noticeable variations in same piece are not acceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General: Install signs using mounting methods indicated and according to manufacturer's written instructions.
 - 1. Install signs level, plumb, true to line, and at locations and heights indicated, with sign surfaces free of distortion and other defects in appearance.
 - 2. Install signs so they do not protrude or obstruct according to the accessibility standard.
 - 3. Before installation, verify that sign surfaces are clean and free of materials or debris that would impair installation.
- B. Accessibility: Install signs in locations on walls according to the accessibility standard.
- C. Mounting Methods:
 - 1. Hook-and-Loop Tape: Clean bond-breaking materials from substrate surface and remove loose debris. Apply sign component of two-part tape strips symmetrically to back of sign and of suitable quantity to support weight of sign without slippage; push to engage tape adhesive. Keep tape strips 0.250 inch away from edges to prevent visibility at sign edges when sign is initially installed or reinstalled. Apply substrate component of tape to substrate in locations aligning with tape on back of sign; push and rub well to fully engage tape adhesive to substrate.

3.2 ADJUSTING AND CLEANING

- A. Remove and replace damaged or deformed signs and signs that do not comply with specified requirements. Replace signs with damaged or deteriorated finishes or components that cannot be successfully repaired by finish touchup or similar minor repair procedures.
- B. Remove temporary protective coverings and strippable films as signs are installed.
- C. On completion of installation, clean exposed surfaces of signs according to manufacturer's written instructions, and touch up minor nicks and abrasions in finish. Maintain signs in a clean condition during construction and protect from damage until acceptance by Owner.

END OF SECTION 101423

SECTION 102800
TOILET, BATH AND LAUNDRY ACCESSORIES

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Examine Drawings, Contract Conditions all other Sections of the Specifications for requirements which affect work of this Section whether or not such work is specifically mentioned in this Section.
- B. Coordinate work with that of all other trades affecting, or affected by work of this Section. Cooperate with such trades to assure the steady progress of all Project work.

1.02 DESCRIPTION

The work in this section consists of furnishing all materials, equipment, supplies, labor and supervision, and performing all operations required to install all toilet accessories as shown on the Drawings, as specified herein, and as is additionally required to properly complete the work.

1.03 SUBMITTALS

Submit eight (8) copies of manufacturers' product data for approval. Product data shall indicate all materials, dimensions, gauges of steel, assembly, hardware and finishes.

PART 2 - MATERIALS

2.01 TOILET ACCESSORIES

- A. All toilet accessories shall be as manufactured by Bobrick Washroom Equipment Inc., Bradley Corp., or ASI.

Catalog numbers listed below are for Bobrick Products.

Mirror	B-290-2436
Sanitary Disposal Unit	B-270
Soap Dispenser with Shelf	Furnished by MTA, Install by GC
Paper Towel Dispenser	Furnished by MTA, Install by GC
Waste Receptacle	Furnished by MTA, Install by GC
Toilet Roll Holders	Furnished by MTA, Install by GC

- B. Grab Bars: Grab bars shall be satin finish stainless steel, 1 1/2 inch diameter, of the lengths shown, with concealed mounting flanges, and mounting flange cover plate with four set screws for securing. Bars shall be equal to Bobrick Products B 5806x36 & B 5806x42.
- C. Obtain all toilet accessories from a single manufacturer.

PART 3 - EXECUTION

3.01 INSTALLATION

Install accessories where shown on the Drawings, in accordance with the manufacturer's approved instructions.

END OF SECTION 102800

SECTION 104416
FIRE EXTINGUISHERS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

- A. Examine Drawings, Contract Conditions all other Sections of the Specifications for requirements which affect work of this Section whether or not such work is specifically mentioned in this Section.
- B. Coordinate work with that of all other trades affecting, or affected by work of this Section. Cooperate with such trades to assure the steady progress of all Project work.

1.02 DESCRIPTION

The work in this section consists of furnishing all materials, equipment, transportation, labor and supervision, and performing all operations required to install all fire extinguishers and mounting brackets as shown on the Drawings, as specified herein, and as is additionally required to properly complete the work.

1.03 SUBMITTALS

Submit eight (8) copies of material brochures and installation instructions and details for approval.

1.04 GENERAL

- A. Provide fire extinguishers, mounting brackets, and accessories manufactured by the same company.
- B. Provide fire extinguishers which are U.L. listed and bear U.L. "Listing Mark" for type, rating and classification of extinguisher indicated. All fire extinguishers shall be rechargeable.

PART 2 - MATERIALS

2.01 PRODUCTS

- A. Unless otherwise indicated, the fire extinguishers, brackets and accessories are as manufactured by J. L. Industries. Equivalent models manufactured by Ansul Co. or Walter Kidde and Co. are also acceptable.
- B. Fire extinguishers shall be multi-purpose 10 lb. dry chemical for A, B & C fires, complete with an accurate pressure safety gauge, Model Cosmic 10E with Bracket No. MB 846. Refer to the Drawings for locations.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install brackets and extinguishers in the locations indicated on the Drawings at mounting heights to comply with applicable regulations of governing authorities.
- B. Securely fasten mounting brackets to structure, with proper reinforcement, square and plumb, to comply with manufacturer's approved installation instructions.
- C. Check extinguishers for proper charge operations. Remove and replace damaged, defective and undercharged units.

END OF SECTION 104416

SECTION 113100
RESIDENTIAL APPLIANCES

PART 1 - DESCRIPTION

1.01 RELATED DOCUMENTS

- A. Examine Drawings, Contract Conditions all other Sections of the Specifications for requirements which affect work of this Section whether or not such work is specifically mentioned in this Section.
- B. Coordinate work with that of all other trades affecting, or affected by work of this Section. Cooperate with such trades to assure the steady progress of all Project work.

1.02 DESCRIPTION

The work in this section consists of furnishing all materials, equipment, supplies, transportation, and performing all operations required to install complete, in-place, kitchen equipment as shown on the drawings, as specified herein and as is additionally required to properly complete the work.

1.03 SHOP DRAWINGS

Submit eight (8) copies of shop drawings showing all details of equipment specified along with installation instructions and operations manuals.

PART 2 - MATERIALS

2.01 KITCHEN EQUIPMENT

- A. Provide the following appliances:
 - 1. Refrigerator: General Electric Model no. GTS18CTHWW
 - a. Size: 17.5 cu. ft.
 - b. Color: White
 - 2. Microwave Oven: General Electric Model no. JES1460DSWW
 - a. Size: 1.4 cu. ft.
 - b. Color: White
- B. The Contractor shall provide the Authority with a full one year warranty on the kitchen equipment.

PART 3 – INSTALLATION

3.01 INSTALLATION

- A. General: Comply with manufacturer's instructions and recommendations.
- B. Built-In Equipment: Securely anchor units to supporting cabinetry or countertops with concealed fasteners. Verify that clearances are adequate for proper functioning and rough openings are completely concealed.
- C. Freestanding Equipment: Place units in final locations after finishes have been completed in each area. Verify that clearances are adequate for proper appliance operation.
- D. Utilities: Refer to Divisions 22 and 26 for plumbing and electrical requirements.

3.02 ADJUST AND CLEAN

- A. Testing: Test each item of equipment to verify proper operation. Make any necessary adjustments to ensure proper operations.

END OF SECTION 113100

SECTION 123216
MANUFACTURED PLASTIC-LAMINATE-FACED CABINETS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. Examine Drawings, Contract Conditions all other Sections of the Specifications for requirements which affect work of this Section whether or not such work is specifically mentioned in this Section.
- B. Coordinate work with that of all other trades affecting, or affected by work of this Section. Cooperate with such trades to assure the steady progress of all Project work.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Plastic-laminate-faced kitchen cabinets.
 - 2. Plastic-laminate countertops.

1.3 DEFINITIONS

- A. Exposed Surfaces of Casework: Surfaces visible when doors and drawers are closed, including visible surfaces in open cabinets or behind glass doors.
- B. Semiexposed Surfaces of Casework: Surfaces behind opaque doors or drawer fronts, including interior faces of doors and interiors and sides of drawers. Bottoms of wall cabinets are defined as "semiexposed."
- C. Concealed Surfaces of Casework: Surfaces not usually visible after installation, including sleepers, web frames, dust panels, bottoms of drawers, and ends of cabinets installed directly against and completely concealed by walls or other cabinets. Tops of wall cabinets and utility cabinets are defined as "concealed."

1.4 SUBMITTALS

- A. Product Data: For the following:
 - 1. Cabinets.
 - 2. Plastic-laminate countertops.
 - 3. Cabinet hardware.

- B. Shop Drawings: For cabinets and countertops. Include plans, elevations, details, and attachments to other work. Show materials, finishes, filler panels, hardware, edge and backsplash profiles, cutouts for plumbing fixtures, and methods of joining countertops.
- C. Samples for Initial Selection: Manufacturer's color charts consisting of units or sections of units showing the full range of colors, textures, and patterns available for each type of material exposed to view.
- D. Product Certificates: Signed by manufacturers of casework certifying that products furnished comply with requirements.

1.5 QUALITY ASSURANCE

- A. Source Limitations for Cabinets: Obtain cabinets through one source from a single manufacturer.
- B. Quality Standards: Unless otherwise indicated, comply with the following standards:
 - 1. Cabinets: KCMA A161.1.
 - a. KCMA Certification: Provide cabinets with KCMA's "Certified Cabinet" seal affixed in a semiexposed location of each unit and showing compliance with the above standard.

1.6 PROJECT CONDITIONS

- A. Environmental Limitations: Do not deliver or install kitchen casework until building is enclosed, wet-work is complete, and HVAC system is operating and will maintain temperature and relative humidity at occupancy levels during the remainder of the construction period.
- B. Established Dimensions: Where kitchen casework is indicated to fit to other construction, establish dimensions for areas where casework is to fit. Coordinate construction to ensure that actual dimensions correspond to established dimensions. Provide fillers and scribes to allow for trimming and fitting.
- C. Field Measurements: Where kitchen casework is indicated to fit to existing construction, verify dimensions of existing construction by field measurements before fabrication and indicate measurements on Shop Drawings. Provide fillers and scribes if necessary.
- D. Field Measurements for Countertops: Verify dimensions of countertops by field measurements after base cabinets are installed but before countertop fabrication is complete. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

1.7 COORDINATION

- A. Coordinate layout and installation of blocking and reinforcement in partitions for support of kitchen casework.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 1. Cabinets: Similar to “Glencoe Square” by Merillat Industries LLC.
 - 2. Plastic Laminate for Countertops:
 - a. Formica Corp.
 - b. Laminart.
 - c. Nevamar Corp.
 - d. Westinghouse Electric Corp.; Specialty Products Div.
 - f. Wilson: Ralph Wilson Plastics Co.

2.2 COLORS, TEXTURES, AND PATTERNS

- A. Colors, Textures, and Patterns: As selected by Architect from manufacturer's full range for these characteristics.

2.3 CABINET MATERIALS

- A. Exposed Materials: Comply with the following:
 - 1. Plastic Laminate: High-pressure decorative laminate complying with NEMA LD 3, Grade VGS.
 - a. Where edges of solid-color plastic-laminate sheets will be visible after fabrication, provide through-color plastic laminate.
- B. Semiexposed Materials: Unless otherwise indicated, provide the following:
 - 1. Plastic Laminate: High-pressure decorative laminate complying with NEMA LD 3, Grade VGS.

2.4 COUNTERTOP MATERIALS

- A. Plastic Laminate: High-pressure decorative laminate complying with NEMA LD 3.
 - 1. Grade: HGS.
 - 2. Grade: HGP.
 - 3. Provide through-color plastic laminate.
 - 4. Grade for Backer Sheet: BKL.

2.5 CASEWORK HARDWARE

- A. General: Manufacturer's standard units complying with BHMA A156.9, of type, material, size, and finish as selected from manufacturer's standard choices.
- B. Hinges: Concealed European-style hinges.
- C. Drawer Guides: Epoxy-coated-metal, self-closing drawer guides; designed to prevent rebound when drawers are closed; with nylon-tired, ball-bearing rollers; and complying with BHMA A156.9, Type B05091.

2.6 CABINET CONSTRUCTION

- A. Face Style: Flush overlay; door and drawer faces cover cabinet body members or face frames with only enough space between faces for operating clearance.
- B. Face Frames: Frameless.
- C. Door and Drawer Fronts: 1/2-inch-thick particleboard with plastic-laminate faces, backs, and edges. Provide same grade, pattern, color, and texture of plastic laminate for backs and edges as for faces.
- D. Exposed Cabinet Ends: Plastic-laminate-faced particleboard.
- E. Cabinet Tops and Bottoms: 5/8-inch-thick particleboard or 1/2-inch-thick plywood, fully supported by and secured in rabbets in end panels, front frame, and back rail.
- F. Back, Top, and Bottom Rails: 3/4-by-2-1/2-inch solid wood, interlocking with end panels and rabbeted to receive top and bottom panels. Back rails secured under pressure with glue and with mechanical fasteners.
- G. Wall-Hung Unit Back Panels: 3/16-inch-thick plywood fastened to rear edge of end panels and to top and bottom rails.
- H. Base Unit Back Panels: 3/16-inch-thick plywood fastened to rear edge of end panels and to top and bottom rails.

- I. Front Frame Drawer Rails: 3/4-by-1-1/4-inch solid wood mortised and fastened into face frame.
- J. Drawers: Fabricate with exposed fronts fastened to subfront with mounting screws from interior of body.
- K. Shelves: 3/4-inch-thick laminate clad particleboard or 5/8-inch-thick laminate clad plywood.
- L. Joinery: Rabbet backs flush into end panels and secure with concealed mechanical fasteners. Connect tops and bottoms of wall cabinets and bottoms and stretchers of base cabinets to ends and dividers with mechanical fasteners. Rabbet tops, bottoms, and backs into end panels.
- M. Factory Finishing: To greatest extent possible, finish casework at factory. Defer only final touchup until after installation.

2.7 PLASTIC-LAMINATE COUNTERTOPS

- A. Configuration: Provide post-formed countertops at kitchen casework locations. Provide square edge countertops at work surface locations.
- B. Plastic-Laminate Substrate: Particleboard not less than 3/4 inch thick.
 - 1. For countertops at sinks and lavatories, use phenolic-resin particleboard or exterior-grade plywood.
 - 2. Build up countertop thickness to 1-1/2 inches at front, back, and ends with additional layers of particleboard laminated to top.
- C. Backer Sheet: Provide plastic-laminate backer sheet on underside of countertop substrate.

PART 3 – EXECUTION

3.1 INSTALLATION

- A. Install casework with no variations in flushness of adjoining surfaces; use concealed shims. Where casework abuts other finished work, scribe and cut for accurate fit. Provide filler strips, scribe strips, and moldings in finish to match casework face.
- B. Install casework without distortion so doors and drawers fit openings and are aligned. Complete installation of hardware and accessories as indicated.
- C. Install casework and countertop level and plumb to a tolerance of 1/8 inch in 8 feet.
- D. Fasten cabinets to adjacent units and to backing.

- E. Fasten plastic-laminate countertops by screwing through corner blocks of base units into underside of countertop. Form seams using splines to align adjacent surfaces, and secure with glue and concealed clamping devices designed for this purpose.

3.2 ADJUSTING AND CLEANING

- A. Adjust casework and hardware so doors and drawers are centered in openings and operate smoothly without warp or bind. Lubricate operating hardware as recommended by manufacturer.
- B. Clean casework on exposed and semiexposed surfaces. Touch up factory-applied finishes to restore damaged or soiled areas.

END OF SECTION 123216

SECTION 220517
SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Sleeves.
 - 2. Stack-sleeve fittings.
 - 3. Sleeve-seal systems.
 - 4. Sleeve-seal fittings.
 - 5. Grout.

1.3 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 SLEEVES

- A. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.
- B. Galvanized-Steel Wall Pipes: ASTM A 53/A 53M, Schedule 40, with plain ends and welded steel collar; zinc coated.
- C. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.

2.2 STACK-SLEEVE FITTINGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Jay R. Smith Mfg. Co.
 - 2. Zurn Industries, LLC.

- B. Description: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring, bolts, and nuts for membrane flashing.
 - 1. Underdeck Clamp: Clamping ring with setscrews.

2.3 SLEEVE-SEAL SYSTEMS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Advance Products & Systems, Inc.
 - 2. CALPICO, Inc.
 - 3. Metraflex Company.
- B. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
 - 1. Sealing Elements: EPDM-rubber or NBR interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 - 2. Pressure Plates: Stainless steel.
 - 3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements.

2.4 GROUT

- A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- B. Characteristics: Nonshrink; recommended for interior and exterior applications.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

- A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
- B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.
- C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
 - 1. Cut sleeves to length for mounting flush with both surfaces.

- a. Exception: Extend sleeves installed in floors 2 inches above finished floor level.
- 2. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.
- D. Install sleeves for pipes passing through interior partitions.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - 2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
 - 3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Section 079200 "Joint Sealants."
- E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section 078413 "Penetration Firestopping."

3.2 STACK-SLEEVE-FITTING INSTALLATION

- A. Install stack-sleeve fittings in new slabs as slabs are constructed.
 - 1. Install fittings that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
 - 2. Secure flashing between clamping flanges for pipes penetrating floors with membrane waterproofing. Comply with requirements for flashing specified in Section 076200 "Sheet Metal Flashing and Trim."
 - 3. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level.
 - 4. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
 - 5. Using grout, seal the space around outside of stack-sleeve fittings.
- B. Fire-Barrier Penetrations: Maintain indicated fire rating of floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section 078413 "Penetration Firestopping."

3.3 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.
- B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.4 SLEEVE-SEAL-FITTING INSTALLATION

- A. Install sleeve-seal fittings in new walls and slabs as they are constructed.
- B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.
- C. Secure nailing flanges to concrete forms.
- D. Using grout, seal the space around outside of sleeve-seal fittings.

END OF SECTION 220517

SECTION 220518
ESCUTCHEONS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Escutcheons.
 - 2. Floor plates.

1.3 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 ESCUTCHEONS

- A. One-Piece, Cast-Brass Type: With polished, chrome-plated and/or rough-brass finish and setscrew fastener.
- B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with chrome-plated finish and spring-clip fasteners.
- C. One-Piece, Stamped-Steel Type: With chrome-plated finish and spring-clip fasteners.

2.2 FLOOR PLATES

- A. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.

- B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of insulated piping and with OD that completely covers opening.
 - 1. Escutcheons for New Piping:
 - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
 - b. Chrome-Plated Piping: One-piece, cast-brass with polished, chrome-plated finish.
 - c. Insulated Piping: One-piece, stamped-steel type.
 - d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass with polished, chrome-plated finish.
 - e. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass with polished, chrome-plated finish.
 - f. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass with rough-brass finish.
 - g. Bare Piping in Equipment Rooms: One-piece, cast-brass with rough-brass finish.

3.2 FIELD QUALITY CONTROL

- A. Replace broken and damaged escutcheons and floor plates using new materials.

END OF SECTION 220518

SECTION 220519
THERMOMETERS AND GAGES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Liquid-in-glass thermometers.
2. Thermowells.
3. Dial-type pressure gages.
4. Gage attachments.
5. Test plugs.
6. Test-plug kits.
7. Sight flow indicators.

B. Related Sections:

1. Section 221116 "Domestic Water Piping" for water meters inside the building.

1.3 ACTION SUBMITTALS

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

1.4 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of meter and gage, from manufacturer.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For meters and gages to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 LIQUID-IN-GLASS THERMOMETERS

- A. Metal-Case, Compact-Style, Liquid-in-Glass Thermometers:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Trerice, H. O. Co.
2. Standards: ASME B40.200. NSF-61
3. Case: Cast aluminum; 6-inch nominal size.
4. Case Form: Straight unless otherwise indicated.
5. Tube: Glass with magnifying lens and blue or red organic liquid.
6. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F.
7. Window: Glass or plastic.
8. Stem: Brass and of length to suit installation.
 - a. Design for Thermowell Installation: Bare stem.
9. Connector: 3/4 inch, with ASME B1.1 screw threads.
10. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

2.2 THERMOWELLS

A. Thermowells:

1. Standards: ASME B40.200, NSF-61(if in direct contact with potable water).
2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
3. Material for Use with Copper Tubing: CNR or CUNI.
4. Type: Stepped shank unless straight or tapered shank is indicated.
5. External Threads: NPS 1/2, NPS 3/4, or NPS 1, ASME B1.20.1 pipe threads.
6. Internal Threads: 1/2, 3/4, and 1 inch, with ASME B1.1 screw threads.
7. Bore: Diameter required to match thermometer bulb or stem.
8. Insertion Length: Length required to match thermometer bulb or stem.
9. Lagging Extension: Include on thermowells for insulated piping and tubing.
10. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.
11. Scale:
 - a. Domestic Cold-Water Piping: 0 to 100 deg F
 - b. Domestic Hot-Water Piping: 30 to 240 deg F.

B. Heat-Transfer Medium: Mixture of graphite and glycerin.

2.3 PRESSURE GAGES

A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Ametek U.S. Gauge.

- b. Ashcroft Inc.
 - c. Watts; a Watts Water Technologies company.
2. Standards: ASME B40.100, NSF-61
 3. Case: Sealed type; liquid filled, cast aluminum or drawn steel; 4-1/2-inch nominal diameter.
 4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
 5. Pressure Connection: Brass, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
 6. Movement: Mechanical, with link to pressure element and connection to pointer.
 7. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi.
 8. Pointer: Dark-colored metal.
 9. Window: Glass or plastic.
 10. Ring: Metal.
 11. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.
 12. Scale Range: 0 to 100 psi

2.4 GAGE ATTACHMENTS

- A. Snubbers: NSF-61, ASME B40.100, brass; with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and porous-metal-type surge-dampening device. Include extension for use on insulated piping.
- B. Valves: Brass or stainless-steel needle, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install thermowells with socket extending to center of pipe and in vertical position in piping tees.
- B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.
- C. Install thermowells with extension on insulated piping.
- D. Fill thermowells with heat-transfer medium.
- E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.
- F. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.
- G. Install remote-mounted pressure gages on panel.
- H. Install valve and snubber in piping for each pressure gage for fluids.
- I. Install thermometers in the following locations:

1. Inlet and outlet of each water heater.
2. Where shown on drawings

J. Install pressure gages in the following locations:

1. Building water service entrance into building.
2. Inlet and outlet of each pressure-reducing valve.
3. Suction and discharge of each domestic water pump.
4. Where shown on drawings

3.2 CONNECTIONS

- A. Install thermometers and gages adjacent to machines and equipment to allow service and maintenance of thermometers, gages, machines, and equipment.

3.3 ADJUSTING

- A. Adjust faces of meters and gages to proper angle for best visibility.

END OF SECTION 220519

SECTION 220523.12
BALL VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Brass ball valves.
 - 2. Bronze ball valves.

1.3 DEFINITIONS

- A. CWP: Cold working pressure.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of valve.
 - 1. Certification that products comply with NSF 61 and NSF 372.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
 - 1. Protect internal parts against rust and corrosion.
 - 2. Protect threads, flange faces, and soldered ends.
 - 3. Set ball valves open to minimize exposure of functional surfaces.
- B. Use the following precautions during storage:
 - 1. Maintain valve end protection.
 - 2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.
- C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use operating handles or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

- A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
- B. ASME Compliance:
 - 1. ASME B1.20.1 for threads for threaded end valves.
 - 2. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
 - 3. ASME B16.18 for solder-joint connections.
 - 4. ASME B31.9 for building services piping valves.
- C. NSF Compliance: NSF 61 and NSF 372 for valve materials for potable-water service.
- D. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.
- E. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- F. Valve Sizes: Same as upstream piping unless otherwise indicated.
- G. Valve Actuator Types:
 - 1. Handlever: For quarter-turn
- H. Valves in Insulated Piping:
 - 1. Include 2-inch stem extensions.
 - 2. Extended operating handles of nonthermal-conductive material and protective sleeves that allow operation of valves without breaking vapor seals or disturbing insulation.
 - 3. Memory stops that are fully adjustable after insulation is applied.

2.2 BRASS BALL VALVES

- A. Two-Piece, Brass Ball Valves with Full Port and Brass Trim:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Apollo Valves; Conbraco Industries, Inc.
 - b. NIBCO INC.
 - c. Watts; a Watts Water Technologies company.
 - 2. Description:
 - a. Standard: MSS SP-110.
 - b. CWP Rating: 600 psig.

- c. Body Design: Two piece.
- d. Body Material: Forged brass.
- e. Ends: Threaded or soldered.
- f. Seats: PTFE.
- g. Stem: Brass.
- h. Ball: Chrome-plated brass.
- i. Port: Full.

2.3 BRONZE BALL VALVES

A. Two-Piece, Bronze Ball Valves with Full Port, and Bronze or Brass Trim:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Apollo Valves; Conbraco Industries, Inc.
 - b. NIBCO INC.
 - c. Watts; a Watts Water Technologies company.
2. Description:
 - a. Standard: MSS SP-110.
 - b. CWP Rating: 600 psig.
 - c. Body Design: Two piece.
 - d. Body Material: Bronze.
 - e. Ends: Threaded or soldered.
 - f. Seats: PTFE.
 - g. Stem: Bronze or brass.
 - h. Ball: Chrome-plated brass.
 - i. Port: Full.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- C. Examine threads on valve and mating pipe for form and cleanliness.
- D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- E. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Locate valves for easy access and provide separate support where necessary.
- C. Install valves in horizontal piping with stem at or above center of pipe.
- D. Install valves in position to allow full stem movement.
- E. Install valve tags. Comply with requirements in Section 220553 "Identification for Plumbing Piping and Equipment" for valve tags and schedules.

3.3 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. If valves with specified CWP ratings are unavailable, the same types of valves with higher CWP ratings may be substituted.
- B. Select valves with the following end connections:
 - 1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
 - 2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.

3.4 DOMESTIC HOT- AND COLD-WATER VALVE SCHEDULE

- A. Pipe NPS 2 and Smaller:
 - 1. Bronze and Brass Valves: Shall be provided with solder-joint ends. Threaded ends shall be provided where equipment or connecting fixtures warrant threaded piping.
- B. Pipe NPS 2-1/2 and Larger:
 - 1. Bronze and Brass Valves, NPS 2-1/2 to NPS 4: May be provided with threaded ends instead of flanged ends.

END OF SECTION 220523.12

SECTION 220523.14
CHECK VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Bronze swing check valves.

1.3 DEFINITIONS

- A. CWP: Cold working pressure.
- B. EPDM: Ethylene propylene-diene terpolymer rubber.
- C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of valve.
 - 1. Certification that products comply with NSF 61 and NSF 372.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
 - 1. Protect internal parts against rust and corrosion.
 - 2. Protect threads, flange faces, grooves, and weld ends.
 - 3. Set check valves in either closed or open position.
- B. Use the following precautions during storage:
 - 1. Maintain valve end protection.
 - 2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

- A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
- B. ASME Compliance:
 - 1. ASME B1.20.1 for threads for threaded end valves.
 - 2. ASME B16.1 for flanges on iron valves.
 - 3. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
 - 4. ASME B16.18 for solder joint.
 - 5. ASME B31.9 for building services piping valves.
- C. AWWA Compliance: Comply with AWWA C606 for grooved-end connections.
- D. NSF Compliance: NSF 61 and NSF 372 for valve materials for potable-water service.
- E. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.
- F. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- G. Valve Sizes: Same as upstream piping unless otherwise indicated.
- H. Valve Bypass and Drain Connections: MSS SP-45.

2.2 BRONZE SWING CHECK VALVES

- A. Class 150, Bronze Swing Check Valves with Bronze Disc:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Apollo Valves; Conbraco Industries, Inc.
 - b. Milwaukee Valve Company.
 - c. NIBCO INC.
 - 2. Description:
 - a. Standard: MSS SP-80, Type 3.
 - b. CWP Rating: 300 psig.
 - c. Body Design: Horizontal flow.
 - d. Body Material: ASTM B 62, bronze.
 - e. Ends: Threaded or soldered. See valve schedule articles.
 - f. Disc: Bronze.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- C. Examine threads on valve and mating pipe for form and cleanliness.
- D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- E. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Locate valves for easy access and provide separate support where necessary.
- C. Install valves in horizontal piping with stem at or above center of pipe.
- D. Install valves in position to allow full stem movement.
- E. Install check valves for proper direction of flow and as follows:
 - 1. Swing Check Valves: In horizontal position with hinge pin level.
- F. Install valve tags. Comply with requirements in Section 220553 "Identification for Plumbing Piping and Equipment" for valve tags and schedules.

3.3 ADJUSTING

- A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. If valves with specified CWP ratings are unavailable, the same types of valves with higher CWP ratings may be substituted.
- B. End Connections:

1. For Copper Tubing, NPS 2 and Smaller: Threaded or soldered.
2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged or threaded.

3.5 DOMESTIC HOT- AND COLD-WATER VALVE SCHEDULE

- A. Pipe NPS 2 and Smaller: Bronze swing check valves, Class 150, bronze disc with soldered or threaded end connections.
- B. Pipe NPS 2-1/2 and Larger: Bronze swing check valves, Class 150, bronze disc with threaded or flanged end connections.

END OF SECTION 220523.14

SECTION 220529
HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

- 1. Metal pipe hangers and supports.
- 2. Trapeze pipe hangers.
- 3. Thermal-hanger shield inserts.
- 4. Fastener systems.
- 5. Equipment supports.

- B. Related Sections:

- 1. Section 055000 "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.

1.3 DEFINITIONS

- A. MSS: Manufacturers Standardization Society of The Valve and Fittings Industry Inc.

1.4 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

- B. Structural Performance: Hangers and supports for plumbing piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

- 1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
- 2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
- 3. Design seismic-restraint hangers and supports for piping and equipment and obtain approval from authorities having jurisdiction.

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following; include Product Data for components:
 - 1. Trapeze pipe hangers.
 - 2. Metal framing systems.
 - 3. Fiberglass strut systems.
 - 4. Pipe stands.
 - 5. Equipment supports.
- C. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 - 1. Detail fabrication and assembly of trapeze hangers.
 - 2. Design Calculations: Calculate requirements for designing trapeze hangers.

1.6 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

1.7 QUALITY ASSURANCE

- A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

- A. Carbon-Steel Pipe Hangers and Supports:
 - 1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
 - 2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.
 - 3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
 - 4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
 - 5. Hanger Rods: Continuous-thread rod, nuts, and washer made of galvanized carbon steel or stainless steel.

2.2 TRAPEZE PIPE HANGERS

- A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.3 THERMAL-HANGER SHIELD INSERTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Carpenter & Paterson, Inc.
 - 2. National Pipe Hanger Corporation.
 - 3. Pipe Shields Inc.
- B. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength and vapor barrier.
- C. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength.
- D. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- E. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- F. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.4 FASTENER SYSTEMS

- A. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated or stainless-steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.5 EQUIPMENT SUPPORTS

- A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.6 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.
- B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.

1. Properties: Nonstaining, noncorrosive, and nongaseous.
2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

- A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.
- B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
 2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel per AWS D1.1/D1.1M.
- C. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- D. Fastener System Installation:
 1. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- E. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- F. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- G. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- H. Install lateral bracing with pipe hangers and supports to prevent swaying.
- I. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- J. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- K. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.

L. Insulated Piping:

1. Attach clamps and spacers to piping.
 - a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
 - b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
 - c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
4. Shield Dimensions for Pipe: Not less than the following:
 - a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
 - b. NPS 4: 12 inches long and 0.06 inch thick.
5. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.2 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
- B. Grouting: Place grout under supports for equipment and make bearing surface smooth.
- C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.3 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.4 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.5 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.
- B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Section 099123 "Painting."
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.6 HANGER AND SUPPORT SCHEDULE

- A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.
- B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.
- C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use carbon-steel pipe hangers and supports, and metal trapeze pipe hangers for general service applications.
- F. Use thermal-hanger shield inserts for insulated piping and tubing.
- G. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
 2. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.
 3. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
 4. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8.
 5. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
 6. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
 7. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
 8. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8.
 9. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3.
 10. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
 11. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.
- H. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.
- I. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
 2. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
 3. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
 4. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.
- J. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
 2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
 3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
 4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.

5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
 6. C-Clamps (MSS Type 23): For structural shapes.
 7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
 8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
 9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.
 10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
 11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
 12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
 - a. Light (MSS Type 31): 750 lb.
 - b. Medium (MSS Type 32): 1500 lb.
 - c. Heavy (MSS Type 33): 3000 lb.
 13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
 14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
 15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.
- K. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
 2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
 3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
- L. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
 2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
 3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
 4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
- M. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
- N. Use mechanical-expansion anchors instead of building attachments where required in concrete construction.

- O. Use pipe positioning systems in pipe spaces behind plumbing fixtures to support supply and waste piping for plumbing fixtures.

END OF SECTION 220529

SECTION 220553
IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Equipment labels.
 - 2. Warning signs and labels.
 - 3. Pipe labels.
 - 4. Stencils.
 - 5. Valve tags.
 - 6. Warning tags.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Samples: For color, letter style, and graphic representation required for each identification material and device.
- C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
- D. Valve numbering scheme.
- E. Valve Schedules: For each piping system to include in maintenance manuals.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

- A. Metal Labels for Equipment:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Brady Corporation.

- b. Brimar Industries, Inc.
 - c. Craftmark Pipe Markers.
 - d. Seton Identification Products.
2. Material and Thickness: aluminum, 0.032-inch or anodized aluminum, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
 3. Letter Color: Black.
 4. Background Color: White.
 5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
 6. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
 7. Fasteners: Stainless-steel rivets or self-tapping screws.
 8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- B. Label Content: Include equipment's Drawing designation or unique equipment number, Drawing numbers where equipment is indicated (plans, details, and schedules), and the Specification Section number and title where equipment is specified.
- C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch bond paper. Tabulate equipment identification number, and identify Drawing numbers where equipment is indicated (plans, details, and schedules) and the Specification Section number and title where equipment is specified. Equipment schedule shall be included in operation and maintenance data.

2.2 WARNING SIGNS AND LABELS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Brady Corporation.
 2. Carlton Industries, LP.
 3. Craftmark Pipe Markers.
- B. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
- C. Letter Color: Red.
- D. Background Color: White.
- E. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
- F. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
- G. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater

viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.

- H. Fasteners: Stainless-steel rivets or self-tapping screws.
- I. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- J. Label Content: Include caution and warning information plus emergency notification instructions.

2.3 PIPE LABELS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Actioncraft Products, Inc.; a division of Industrial Test Equipment Co., Inc.
 - 2. Brady Corporation.
 - 3. Carlton Industries, LP.
 - 4. Craftmark Pipe Markers.
- B. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.
- C. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to partially cover circumference of pipe and to attach to pipe without fasteners or adhesive.
- D. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- E. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings; also include pipe size and an arrow indicating flow direction.
 - 1. Flow-Direction Arrows: Integral with piping-system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
 - 2. Lettering Size: Size letters according to ASME A13.1 for piping.

2.4 VALVE TAGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Actioncraft Products, Inc.; a division of Industrial Test Equipment Co., Inc.
 - 2. Brady Corporation.
 - 3. Carlton Industries, LP.
 - 4. Craftmark Pipe Markers.
- B. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.

1. Tag Material: Brass, 0.032-inch or anodized aluminum, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
 2. Fasteners: Brass wire-link chain or beaded chain.
- C. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
1. Valve-tag schedule shall be included in operation and maintenance data.

2.5 WARNING TAGS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Brady Corporation.
 2. Carlton Industries, LP.
 3. Craftmark Pipe Markers.
- B. Description: Preprinted or partially preprinted accident-prevention tags of plasticized card stock with matte finish suitable for writing.
1. Size: 3 by 5-1/4 inches minimum.
 2. Fasteners: Reinforced grommet and wire or string.
 3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
 4. Color: Safety yellow background with black lettering.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 GENERAL INSTALLATION REQUIREMENTS

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.

3.3 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.

3.4 PIPE LABEL INSTALLATION

- A. Piping Color Coding: Painting of piping is specified in Section 099123 "Painting."
- B. Pipe Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 - 1. Near each valve and control device.
 - 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
 - 3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
 - 4. At access doors, manholes, and similar access points that permit view of concealed piping.
 - 5. Near major equipment items and other points of origination and termination.
 - 6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
 - 7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.
- C. Directional Flow Arrows: Arrows shall be used to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.
- D. Pipe Label Color Schedule:
 - 1. Domestic Water Piping
 - a. Background: Safety green.
 - b. Letter Colors: White.
 - 2. Sanitary Waste Piping:
 - a. Background Color: Safety white.
 - b. Letter Color: Black.

3.5 VALVE-TAG INSTALLATION

- A. Install tags on valves and control devices in piping systems, except check valves, valves within factory-fabricated equipment units, shutoff valves, faucets, convenience and lawn-watering hose connections, and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.
- B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:

1. Valve-Tag Size and Shape:
 - a. Cold Water: 1-1/2 inches, round.
 - b. Hot Water: 1-1/2 inches, round.
2. Valve-Tag Colors:
 - a. Cold Water: Natural.
 - b. Hot Water: Natural.
3. Letter Colors:
 - a. Cold Water: White.
 - b. Hot Water: White.

3.6 WARNING-TAG INSTALLATION

- A. Write required message on, and attach warning tags to, equipment and other items where required.

END OF SECTION 220553

SECTION 220719
PLUMBING PIPING INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes insulating the following plumbing piping services:
 - 1. Domestic cold-water piping.
 - 2. Domestic hot-water piping.
 - 3. Supplies and drains for handicap-accessible lavatories and sinks.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied, if any).

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.
- B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.
- C. Field quality-control reports.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84 by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
- C. Comply with the following applicable standards and other requirements specified for miscellaneous components:
 1. Supply and Drain Protective Shielding Guards: ICC A117.1.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.7 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."
- B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

1.8 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

- A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
 - F. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
 - 1. Block Insulation: ASTM C 552, Type I.
 - 2. Special-Shaped Insulation: ASTM C 552, Type III.
 - 3. Preformed Pipe Insulation without Jacket: Comply with ASTM C 552, Type II, Class 1.
 - 4. Preformed Pipe Insulation with Factory-Applied ASJ: Comply with ASTM C 552, Type II, Class 2.
 - 5. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.
 - G. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.
 - H. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type I. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
 - I. Mineral-Fiber, Preformed Pipe Insulation:
 - 1. Type I, 850 Deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
 - J. Phenolic:
 - 1. Preformed pipe insulation of rigid, expanded, closed-cell structure. Comply with ASTM C 1126, Type III, Grade 1.
 - 2. Block insulation of rigid, expanded, closed-cell structure. Comply with ASTM C 1126, Type II, Grade 1.
 - 3. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.
 - 4. Factory-Applied Jacket: ASJ. Requirements are specified in "Factory-Applied Jackets" Article.
 - K. Polyolefin: Unicellular, polyethylene thermal plastic insulation. Comply with ASTM C 534 or ASTM C 1427, Type I, Grade 1 for tubular materials.
- 2.2 INSULATING CEMENTS
- A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.
 - B. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C 196.
 - C. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449.

2.3 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.
- B. Cellular-Glass Adhesive: Two-component, thermosetting urethane adhesive containing no flammable solvents, with a service temperature range of minus 100 to plus 200 deg F.
 - 1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- C. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.
 - 1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- D. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
 - 1. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- E. Phenolic Adhesive: Solvent-based resin adhesive, with a service temperature range of minus 75 to plus 300 deg F.
 - 1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- F. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
 - 1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- G. PVC Jacket Adhesive: Compatible with PVC jacket.
 - 1. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.4 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
 - 1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.
 - 1. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
 - 2. Service Temperature Range: Minus 20 to plus 180 deg F.

3. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
 4. Color: White.
- C. Vapor-Barrier Mastic: Solvent based; suitable for indoor use on below-ambient services.
1. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 35-mil dry film thickness.
 2. Service Temperature Range: 0 to 180 deg F.
 3. Solids Content: ASTM D 1644, 44 percent by volume and 62 percent by weight.
 4. Color: White.
- D. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below-ambient services.
1. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 30-mil dry film thickness.
 2. Service Temperature Range: Minus 50 to plus 220 deg F.
 3. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.
 4. Color: White.
- E. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.
1. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
 2. Service Temperature Range: Minus 20 to plus 180 deg F.
 3. Solids Content: 60 percent by volume and 66 percent by weight.
 4. Color: White.

2.5 LAGGING ADHESIVES

- A. Description: Comply with MIL-A-3316C, Class I, Grade A, and shall be compatible with insulation materials, jackets, and substrates.
1. For indoor applications, use lagging adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
 2. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over pipe insulation.
 3. Service Temperature Range: 0 to plus 180 deg F.
 4. Color: White.

2.6 SEALANTS

- A. Joint Sealants:
1. Materials shall be compatible with insulation materials, jackets, and substrates.
 2. Permanently flexible, elastomeric sealant.
 3. Service Temperature Range: Minus 100 to plus 300 deg F.
 4. Color: White or gray.
 5. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. FSK and Metal Jacket Flashing Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F.
4. Color: Aluminum.
5. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates.
2. Fire- and water-resistant, flexible, elastomeric sealant.
3. Service Temperature Range: Minus 40 to plus 250 deg F.
4. Color: White.
5. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
6. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.7 FACTORY-APPLIED JACKETS

- A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
 2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
 3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.

2.8 FIELD-APPLIED FABRIC-REINFORCING MESH

- A. Woven Glass-Fiber Fabric: Approximately 2 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in. for covering pipe and pipe fittings.
- B. Woven Polyester Fabric: Approximately 1 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in., in a Leno weave, for pipe.

2.9 FIELD-APPLIED CLOTHS

- A. Woven Glass-Fiber Fabric: Comply with MIL-C-20079H, Type I, plain weave, and presized a minimum of 8 oz./sq. yd..

2.10 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

- B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
1. Adhesive: As recommended by jacket material manufacturer.
 2. Color: White.
 3. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
 - a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.
- C. Metal Jacket:
1. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.
 - a. Factory cut and rolled to size.
 - b. Finish and thickness are indicated in field-applied jacket schedules.
 - c. Moisture Barrier for Indoor Applications: 3-mil-thick, heat-bonded polyethylene and kraft paper.
 - d. Factory-Fabricated Fitting Covers:
 - 1) Same material, finish, and thickness as jacket.
 - 2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
 - 3) Tee covers.
 - 4) Flange and union covers.
 - 5) End caps.
 - 6) Beveled collars.
 - 7) Valve covers.
 - 8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.
 2. Stainless-Steel Jacket: ASTM A 167 or ASTM A 240/A 240M.
 - a. Factory cut and rolled to size.
 - b. Material, finish, and thickness are indicated in field-applied jacket schedules.
 - c. Moisture Barrier for Indoor Applications: 3-mil-thick, heat-bonded polyethylene and kraft paper.
 - d. Factory-Fabricated Fitting Covers:
 - 1) Same material, finish, and thickness as jacket.
 - 2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
 - 3) Tee covers.
 - 4) Flange and union covers.
 - 5) End caps.
 - 6) Beveled collars.
 - 7) Valve covers.

- 8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

2.11 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
 1. Width: 3 inches.
 2. Thickness: 11.5 mils.
 3. Adhesion: 90 ounces force/inch in width.
 4. Elongation: 2 percent.
 5. Tensile Strength: 40 lbf/inch in width.
 6. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

- B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
 1. Width: 3 inches.
 2. Thickness: 6.5 mils.
 3. Adhesion: 90 ounces force/inch in width.
 4. Elongation: 2 percent.
 5. Tensile Strength: 40 lbf/inch in width.
 6. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

- C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.
 1. Width: 2 inches.
 2. Thickness: 6 mils.
 3. Adhesion: 64 ounces force/inch in width.
 4. Elongation: 500 percent.
 5. Tensile Strength: 18 lbf/inch in width.

- D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
 1. Width: 2 inches.
 2. Thickness: 3.7 mils.
 3. Adhesion: 100 ounces force/inch in width.
 4. Elongation: 5 percent.
 5. Tensile Strength: 34 lbf/inch in width.

2.12 SECUREMENTS

- A. Bands:
 1. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316; 0.015 inch thick, 1/2 inch wide with wing seal.

2. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide with wing seal.
- B. Staples: Outward-clinching insulation staples, nominal 3/4-inch-wide, stainless steel or Monel.
- C. Wire: 0.062-inch soft-annealed, stainless steel.

2.13 PROTECTIVE SHIELDING GUARDS

- A. Protective Shielding Pipe Covers,:
 1. Description: Manufactured plastic wraps for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.
- B. Protective Shielding Piping Enclosures,:
 1. Description: Manufactured plastic enclosure for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with ADA requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
 1. Verify that systems to be insulated have been tested and are free of defects.
 2. Verify that surfaces to be insulated are clean and dry.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:
 1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils thick and an epoxy finish 5 mils thick if operating in a temperature range between 140 and 300 deg F. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
 2. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

- C. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
- D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Keep insulation materials dry during application and finishing.
- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- I. Install insulation with least number of joints practical.
- J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 - 1. Install insulation continuously through hangers and around anchor attachments.
 - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
 - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
 - 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- L. Install insulation with factory-applied jackets as follows:
 - 1. Draw jacket tight and smooth.

2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.
 - a. For below-ambient services, apply vapor-barrier mastic over staples.
 4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.
- M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
- P. For above-ambient services, do not install insulation to the following:
1. Vibration-control devices.
 2. Testing agency labels and stamps.
 3. Nameplates and data plates.
 4. Cleanouts.

3.4 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
1. Seal penetrations with flashing sealant.
 2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
 4. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.
- C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.
 2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
 4. Seal jacket to wall flashing with flashing sealant.
- D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
1. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.
- F. Insulation Installation at Floor Penetrations:
1. Pipe: Install insulation continuously through floor penetrations.
 2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.5 GENERAL PIPE INSULATION INSTALLATION

- A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.
- B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
 2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
 3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
 4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
 5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe

insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.

6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
 7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
 8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
 9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.
- C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.
- D. Install removable insulation covers at locations indicated. Installation shall conform to the following:
1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
 2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
 3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
 4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
 5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.6 INSTALLATION OF CELLULAR-GLASS INSULATION

- A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient services, secure laps with outward clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below-ambient services, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as pipe insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of cellular-glass insulation to valve body.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

3.7 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed valve covers manufactured of same material as pipe insulation when available.
2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.8 INSTALLATION OF MINERAL-FIBER INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

3.9 INSTALLATION OF PHENOLIC INSULATION

A. General Installation Requirements:

1. Secure single-layer insulation with stainless-steel bands at 12-inch intervals and tighten bands without deforming insulation materials.
2. Install 2-layer insulation with joints tightly butted and staggered at least 3 inches. Secure inner layer with 0.062-inch wire spaced at 12-inch intervals. Secure outer layer with stainless-steel bands at 12-inch intervals.

B. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient services, secure laps with outward clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets with vapor retarders on below-ambient services, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

C. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of block insulation of same material and thickness as pipe insulation.

D. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed insulation sections of same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.

E. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed insulation sections of same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

3.10 INSTALLATION OF POLYOLEFIN INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Seal split-tube longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of polyolefin sheet insulation of same thickness as pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of polyolefin pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install cut sections of polyolefin pipe and sheet insulation to valve body.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties, and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.11 FIELD-APPLIED JACKET INSTALLATION

A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.

1. Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.
2. Embed glass cloth between two 0.062-inch-thick coats of lagging adhesive.
3. Completely encapsulate insulation with coating, leaving no exposed insulation.

- B. Where FSK jackets are indicated, install as follows:
 - 1. Draw jacket material smooth and tight.
 - 2. Install lap or joint strips with same material as jacket.
 - 3. Secure jacket to insulation with manufacturer's recommended adhesive.
 - 4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch-wide joint strips at end joints.
 - 5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.
- C. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints. Seal with manufacturer's recommended adhesive.
 - 1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.
- D. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

3.12 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Perform tests and inspections.
- C. Tests and Inspections:
 - 1. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.
- D. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.13 PIPING INSULATION SCHEDULE, GENERAL

- A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.
- B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
 - 1. Drainage piping.
 - 2. Underground piping.

3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.14 INDOOR PIPING INSULATION SCHEDULE

A. Domestic Cold Water and Domestic Hot Water:

1. NPS 1 and Smaller: Insulation shall be one of the following:
 - a. Cellular Glass: 1-1/2 inches thick.
 - b. Flexible Elastomeric: 3/4 inch thick.
 - c. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
 - d. Phenolic: 1 inch thick.
 - e. Polyolefin: 1 inch thick.
2. NPS 1-1/4 and Larger: Insulation shall be one of the following:
 - a. Cellular Glass: 1-1/2 inches thick.
 - b. Flexible Elastomeric: 1 inch thick.
 - c. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
 - d. Phenolic: 1 inch thick.
 - e. Polyolefin: 1 inch thick.

B. Exposed Sanitary Drains, Domestic Water, Domestic Hot Water, and Stops for Plumbing Fixtures for People with Disabilities:

1. All Pipe Sizes: Insulation shall be the following:
 - a. Rigid High impact PVC

3.15 INDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is Contractor's option.
- C. Piping, Concealed:
 1. None, if factory jacket is provided else,
 2. Aluminum, Smooth: 0.024 inch thick.
 3. Stainless Steel, Type 304 or Type 316, Smooth 2B Finish: 0.020 inch thick.
- D. Piping, Exposed:
 1. PVC: 30 mils thick.

END OF SECTION 220719

SECTION 221116
DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Aboveground domestic water pipes, tubes, and fittings inside buildings.
 - 2. Encasement for piping.

1.3 ACTION SUBMITTALS

- A. Product Data: For transition fittings and dielectric fittings.

1.4 INFORMATIONAL SUBMITTALS

- A. System purging and disinfecting activities report.
- B. Field quality-control reports.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

- A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.
- B. Potable-water piping and components shall comply with NSF 14 and NSF 61.

2.2 COPPER TUBE AND FITTINGS

- A. Hard Copper Tube: ASTM B 88, Type L water tube, drawn temper.
- B. Fittings in "Cast-Copper, Solder-Joint Fittings" Paragraph below are available in NPS 1/4 to NPS 12.
- C. Cast-Copper, Solder-Joint Fittings: ASME B16.18

- D. Wrought-Copper, Solder-Joint Fittings: ASME B16.22.
- E. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.
- F. Copper Unions:
 - 1. MSS SP-123.
 - 2. Cast-copper-alloy, hexagonal-stock body.
 - 3. Ball-and-socket, metal-to-metal seating surfaces.
 - 4. Solder-joint or threaded ends.

2.3 PIPING JOINING MATERIALS

- A. Pipe-Flange Gasket Materials:
 - 1. AWWA C110/A21.10, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free unless otherwise indicated.
 - 2. Full-face or ring type unless otherwise indicated.
- B. Metal, Pipe-Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
- C. Solder Filler Metals: ASTM B 32, lead-free alloys.
- D. Flux: ASTM B 813, water flushable.

2.4 ENCASEMENT FOR PIPING

- A. Standard: ASTM A 674 or AWWA C105/A21.5.
- B. Form: Sheet or tube.
- C. Color: Black or natural.

2.5 DIELECTRIC FITTINGS

- A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
- B. Dielectric Unions:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Watts; a Watts Water Technologies company.
 - b. Wilkins.
 - c. Zurn Industries, LLC.
 - 2. Standard: ASSE 1079.
 - 3. Pressure Rating: 125 psig minimum at 180 deg F.
 - 4. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Flanges:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Watts; a Watts Water Technologies company.
 - b. Wilkins.
 - c. Zurn Industries, LLC.
2. Standard: ASSE 1079.
3. Factory-fabricated, bolted, companion-flange assembly.
4. Pressure Rating: 125 psig minimum at 180 deg F.
5. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric Nipples:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Elster Perfection Corporation.
 - b. Grinnell Mechanical Products.
 - c. Victaulic Company.
2. Standard: IAPMO PS 66.
3. Electroplated steel nipple complying with ASTM F 1545.
4. Pressure Rating and Temperature: 300 psig at 225 deg F.
5. End Connections: Male threaded or grooved.
6. Lining: Inert and noncorrosive, propylene.

PART 3 - EXECUTION

3.1 EARTHWORK

- A. Comply with requirements in Section 203- Excavation and Embankment for excavating, trenching, and backfilling.

3.2 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of domestic water piping. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.
- B. Install shutoff valve, hose-end drain valve, strainer, pressure gage, and test tee with valve inside the building at each domestic water-service entrance. Comply with requirements for pressure gages in Section 220519 "Meters and Gages for Plumbing Piping" and with requirements for drain valves and strainers in Section 221119 "Domestic Water Piping Specialties."
- C. Install shutoff valve immediately upstream of each dielectric fitting.

- D. Install domestic water piping level with 0.25 percent slope downward toward drain and plumb.
- E. Rough-in domestic water piping for water-meter installation according to utility company's requirements.
- F. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.
- G. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- H. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.
- I. Install piping to permit valve servicing.
- J. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than the system pressure rating used in applications below unless otherwise indicated.
- K. Install piping free of sags and bends.
- L. Install fittings for changes in direction and branch connections.
- M. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.
- N. Install thermometers on inlet and outlet piping from each water heater. Comply with requirements for thermometers in Section 220519 "Meters and Gages for Plumbing Piping."
- O. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- P. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- Q. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

3.3 JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipes, tubes, and fittings before assembly.
- C. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads.

2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.
- D. Soldered Joints for Copper Tubing: Apply ASTM B 813, water-flushable flux to end of tube. Join copper tube and fittings according to ASTM B 828 or CDA's "Copper Tube Handbook."
- E. Flanged Joints: Select appropriate asbestos-free, nonmetallic gasket material in size, type, and thickness suitable for domestic water service. Join flanges with gasket and bolts according to ASME B31.9.
- F. Joints for Dissimilar-Material Piping: Make joints using adapters compatible with materials of both piping systems.

3.4 DIELECTRIC FITTING INSTALLATION

- A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
- B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric couplings or nipples.
- C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges or nipples.

3.5 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements for pipe hanger, support products, and installation in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."
- B. Comply with requirements for pipe hanger, support products, and installation in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."
 1. Vertical Piping: MSS Type 8 or 42, clamps.
 2. Individual, Straight, Horizontal Piping Runs:
 - a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
 - b. Longer Than 100 Feet : MSS Type 43, adjustable roller hangers.
 - c. Longer Than 100 Feet if Indicated: MSS Type 49, spring cushion rolls.
 3. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
 4. Base of Vertical Piping: MSS Type 52, spring hangers.
- C. Support vertical piping and tubing at base and at each floor.
- D. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch.
- E. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
 1. NPS 3/4 and Smaller: 60 inches with 3/8-inch rod.
 2. NPS 1 and NPS 1-1/4: 72 inches with 3/8-inch rod.
 3. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
 4. NPS 2-1/2: 108 inches with 1/2-inch rod.

5. NPS 3 to NPS 5: 10 feet with 1/2-inch rod.

F. Install supports for vertical copper tubing every 10 feet.

G. Support piping and tubing not listed in this article according to MSS SP-69 and manufacturer's written instructions.

3.6 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. When installing piping adjacent to equipment and machines, allow space for service and maintenance.

C. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:

1. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
2. Plumbing Fixtures: Cold- and hot-water-supply piping in sizes indicated, but not smaller than that required by plumbing code.

3.7 IDENTIFICATION

A. Identify system components. Comply with requirements for identification materials and installation in Section 220553 "Identification for Plumbing Piping and Equipment."

B. Label pressure piping with system operating pressure.

3.8 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Piping Inspections:

- a. Do not enclose, insulate, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
- b. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
 - 1) Roughing-in Inspection: Arrange for inspection of piping before concealing or closing in after roughing in and before setting fixtures.
 - 2) Final Inspection: Arrange for authorities having jurisdiction to observe tests specified in "Piping Tests" Subparagraph below and to ensure compliance with requirements.
- c. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
- d. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

2. Piping Tests:

- a. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
- b. Inspect piping for leaks and defects.
- c. Leave new domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
- d. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow it to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
- e. Repair leaks and defects with new materials, and retest piping or portion thereof until satisfactory results are obtained.
- f. Prepare reports for tests and for corrective action required.

B. Domestic water piping will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.9 ADJUSTING

A. Perform the following adjustments before operation:

1. Close drain valves, hydrants, and hose bibbs.
2. Open shutoff valves to fully open position.
3. Open throttling valves to proper setting.
4. Remove plugs used during testing of piping and for temporary sealing of piping during installation.
5. Remove and clean strainer screens. Close drain valves and replace drain plugs.
6. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.10 CLEANING

A. Clean and disinfect potable domestic water piping as follows:

1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:
 - a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
 - b. Fill and isolate system according to either of the following:
 - 1) Fill system or part thereof with water/chlorine solution with at least 50 ppm of chlorine. Isolate with valves and allow to stand for 24 hours.
 - 2) Fill system or part thereof with water/chlorine solution with at least 200 ppm of chlorine. Isolate and allow to stand for three hours.

- c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
 - d. Repeat procedures if biological examination shows contamination.
 - e. Submit water samples in sterile bottles to a third party testing agency to ensure safe drinking water has been achieved.
- B. Prepare and submit reports of purging and disinfecting activities. Include copies of water-sample approvals from authorities having jurisdiction.
- C. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.11 PIPING SCHEDULE

- A. Special fittings with pressure ratings at least equal to piping rating may be used in applications below unless otherwise indicated.
- B. Flanges and unions may be used for aboveground piping joints unless otherwise indicated.
- C. Fitting Option: Extruded-tee connections and brazed joints may be used on aboveground copper tubing.
- D. Aboveground domestic water piping, NPS 2 and smaller, shall be the following:
- 1. Hard copper tube, ASTM B 88, Type L; cast- or wrought-copper, solder-joint fittings; and soldered joints.
- E. Aboveground domestic water piping, NPS 2-1/2 to NPS 4, shall be the following:
- 1. Hard copper tube, ASTM B 88, Type L; cast- or wrought-copper, solder-joint fittings; and soldered joints.

3.12 VALVE SCHEDULE

- A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
- 1. Shutoff Duty: Use ball for piping NPS 2 and smaller. Use butterfly, ball, or gate valves with flanged ends for piping NPS 2-1/2 and larger.
- B. Use check valves to maintain correct direction of domestic water flow to and from equipment.

END OF SECTION 221116

SECTION 221119
DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Vacuum breakers.
2. Backflow preventers.
3. Temperature-actuated, water mixing valves.
4. Strainers.
5. Hoss bibb.
6. Wall hydrants.
7. Drain valves.
8. Water-hammer arresters.

B. Related Requirements:

1. Section 220519 "Thermometers and Gages for Plumbing Piping" for thermometers, pressure gages, and flow meters in domestic water piping.
2. Section 221116 "Domestic Water Piping" for water meters and Disinfection.

1.3 ACTION SUBMITTALS

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

- B. Shop Drawings: For domestic water piping specialties.

1. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For domestic water piping specialties to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PIPING SPECIALTIES

- A. Potable-water piping and components shall comply with NSF 61.

2.2 PERFORMANCE REQUIREMENTS

- A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig unless otherwise indicated.

2.3 VACUUM BREAKERS

- A. Pipe-Applied, Atmospheric-Type Vacuum Breakers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Apollo Valves; Conbraco Industries, Inc.
 - b. Watts; a Watts Water Technologies company.
 - c. Zurn Industries, LLC.
2. Standard: ASSE 1001.
3. Size: NPS 1/4 to NPS 3, as required to match connected piping.
4. Body: Bronze.
5. Inlet and Outlet Connections: Threaded.
6. Finish: Rough bronze.

- B. Hose-Connection Vacuum Breakers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Apollo Valves; Conbraco Industries, Inc.
 - b. Watts; a Watts Water Technologies company.
 - c. Zurn Industries, LLC.
2. Standard: ASSE 1011.
3. Body: Bronze, nonremovable, with manual drain.
4. Outlet Connection: Garden-hose threaded complying with ASME B1.20.7.
5. Finish: Rough bronze.

2.4 BACKFLOW PREVENTERS

- A. Reduced-Pressure-Principle Backflow Preventers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Apollo Valves; Conbraco Industries, Inc.
 - b. Watts; a Watts Water Technologies company.
 - c. Zurn Industries, LLC.
2. Standard: ASSE 1013.
3. Operation: Continuous-pressure applications.
4. Pressure Loss: 12 psig maximum, through middle third of flow range.
5. Size: See Drawings.
6. Pressure Loss at Design Flow Rate: 10 psig for sizes NPS 2 and smaller.
7. Body: Bronze for NPS 2 and smaller; cast iron with interior lining that complies with AWWA C550 or that is FDA approved
8. End Connections: Threaded for NPS 2 and smaller.
9. Configuration: Designed for horizontal, straight-through flow.
10. Accessories:
 - a. Valves NPS 2 and Smaller: Ball type with threaded ends on inlet and outlet.
 - b. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.

B. Backflow-Preventer Test Kits:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Apollo Valves; Conbraco Industries, Inc.
 - b. Watts; a Watts Water Technologies company.
 - c. Zurn Industries, LLC.
2. Description: Factory calibrated, with gages, fittings, hoses, and carrying case with test-procedure instructions.

2.5 TEMPERATURE-ACTUATED, WATER MIXING VALVES

A. Water-Temperature Limiting Devices:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Apollo Valves; Conbraco Industries, Inc.
 - b. Watts; a Watts Water Technologies company.
 - c. Zurn Industries, LLC.
2. Standard: ASSE 1017.
3. Pressure Rating: 125 psig.
4. Type: Thermostatically controlled, water mixing valve.
5. Material: Bronze body with corrosion-resistant interior components.
6. Connections: Threaded union inlets and outlet.

7. Accessories: Check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.
8. Tempered-Water Setting: 110 deg F.
9. Valve Finish: Rough bronze.

2.6 STRAINERS FOR DOMESTIC WATER PIPING

A. Y-Pattern Strainers:

1. Pressure Rating: 125 psig minimum unless otherwise indicated.
2. Body: Bronze for NPS 2 and smaller; cast iron with interior lining that complies with AWWA C550 or that is FDA approved, epoxy coated.
3. End Connections: Threaded for NPS 2 and smaller.
4. Screen: Stainless steel with round perforations unless otherwise indicated.
5. Perforation Size:
 - a. Strainers NPS 2 and Smaller: 0.020 inch.
 - b. Strainers NPS 2-1/2 to NPS 4: 0.045 inch
6. Drain: Factory-installed, hose-end drain valve.

2.7 HOSE BIBBS

A. Hose Bibbs:

1. Standard: ASME A112.18.1 for sediment faucets.
2. Body Material: Bronze.
3. Seat: Bronze, replaceable.
4. Supply Connections: NPS 1/2 or NPS 3/4 threaded or solder-joint inlet.
5. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.
6. Pressure Rating: 125 psig.
7. Vacuum Breaker: Integral nonremovable, drainable, hose-connection vacuum breaker complying with ASSE 1011.
8. Finish for Equipment Rooms: Rough bronze, or chrome or nickel plated.
9. Finish for Service Areas: Rough bronze, or chrome or nickel plated.
10. Finish for Finished Rooms: Chrome or nickel plated.
11. Operation for Equipment Rooms: Wheel handle or operating key.
12. Operation for Service Areas: Wheel handle.
13. Operation for Finished Rooms: Operating key.
14. Include operating key with each operating-key hose bibb.
15. Include integral wall flange with each chrome- or nickel-plated hose bibb.

2.8 WALL HYDRANTS

A. Nonfreeze Wall Hydrants:

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

- a. Jay R. Smith Mfg. Co.
 - b. Watts; a Watts Water Technologies company.
 - c. Zurn Industries, LLC.
2. Standard: ASME A112.21.3M for concealed-outlet, self-draining wall hydrants.
 3. Pressure Rating: 125 psig.
 4. Operation: Loose key.
 5. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
 6. Inlet: NPS 3/4 or NPS 1.
 7. Outlet: Concealed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
 8. Box: Deep, flush mounted with cover.
 9. Box and Cover Finish: Chrome plated.
 10. Outlet: Exposed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
 11. Nozzle and Wall-Plate Finish: Polished nickel bronze.
 12. Operating Keys(s): Two with each wall hydrant.

B. Vacuum Breaker Wall Hydrants:

1. Standard: ASSE 1019, Type A or Type B.
2. Type: Freeze-resistant, automatic draining with integral air-inlet valve.
3. Classification: Type A, for automatic draining with hose removed or Type B, for automatic draining with hose removed or with hose attached and nozzle closed.
4. Pressure Rating: 125 psig.
5. Operation: wheel handle.
6. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
7. Inlet: NPS 1/2 or NPS 3/4.
8. Outlet: Exposed with garden-hose thread complying with ASME B1.20.7.

2.9 DRAIN VALVES

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

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

B. Stop-and-Waste Drain Valves:

1. Standard: MSS SP-110 for ball valves.

2. Pressure Rating: 200-psig minimum CWP or Class 125.
3. Size: NPS 3/4.
4. Body: Copper alloy or ASTM B 62 bronze.
5. Drain: NPS 1/8 side outlet with cap.

2.10 WATER-HAMMER ARRESTERS

A. Water-Hammer Arresters:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Jay R. Smith Mfg. Co.
 - b. Watts; a Watts Water Technologies company.
 - c. Zurn Industries, LLC.
2. Standard: ASSE 1010 or PDI-WH 201.
3. Type: Copper tube with piston.
4. Size: ASSE 1010, Sizes AA and A through F, or PDI-WH 201, Sizes A through F.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.
 1. Locate backflow preventers in same room as connected equipment or system.
 2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe-to-floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are unacceptable for this application.
 3. Do not install bypass piping around backflow preventers.
- B. Install temperature-actuated, water mixing valves with check stops or shutoff valves on inlets and with shutoff valve on outlet.
 1. Install cabinet-type units recessed in or surface mounted on wall as specified.
- C. Install Y-pattern strainers for water on supply side of each backflow preventor.
- D. Install water-hammer arresters in water piping according to PDI-WH 201.
- E. Install drain piping and discharge onto floor drain.

3.2 CONNECTIONS

- A. Comply with requirements for ground equipment in Section 260526 "Grounding and Bonding for Electrical Systems."

3.3 LABELING AND IDENTIFYING

- A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:
 - 1. Pressure vacuum breakers.
 - 2. Reduced-pressure-principle backflow preventers.
 - 3. Thermostatic, water mixing valves.
- B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.4 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Test each reduced-pressure-principle backflow preventer assembly according to authorities having jurisdiction and the device's reference standard.
- B. Domestic water piping specialties will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

3.5 ADJUSTING

- A. Set field-adjustable temperature set points of temperature-actuated, water mixing valves.

END OF SECTION 221119

SECTION 221316
SANITARY WASTE AND VENT PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Pipe, tube, and fittings.
 - 2. Specialty pipe fittings.
 - 3. Encasement for underground metal piping.

1.3 PERFORMANCE REQUIREMENTS

- A. Components and installation shall be capable of withstanding the following minimum working pressure unless otherwise indicated:
 - 1. Soil, Waste, and Vent Piping: 10-foot head of water.
- B. Seismic Performance: Soil, waste, and vent piping and support and installation shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For solvent drainage system. Include plans, elevations, sections, and details.

1.5 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Certificates: For waste and vent piping, 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. Detailed description of piping anchorage devices on which the certification is based and their installation requirements.
- B. Field quality-control reports.

1.6 QUALITY ASSURANCE

- A. Piping materials shall bear label, stamp, or other markings of specified testing agency.
- B. Comply with NSF/ANSI 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-dwv" for plastic drain, waste, and vent piping and "NSF-sewer" for plastic sewer piping.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

- A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.2 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: ASTM A 74, Service and Extra Heavy class(es).
- B. Gaskets: ASTM C 564, rubber.

2.3 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

- A. Pipe and Fittings: ASTM A 888 or CISPI 301.
- B. CISPI, Hubless-Piping Couplings:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Charlotte Pipe and Foundry Company.
 - b. Fernco Inc.
 - c. Tyler Pipe; a subsidiary of McWane Inc.
 - 2. Standards: ASTM C 1277 and CISPI 310.
 - 3. Description: Stainless-steel corrugated shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.
- C. Heavy-Duty, Hubless-Piping Couplings:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Charlotte Pipe and Foundry Company.
 - b. MIFAB, Inc.
 - c. Tyler Pipe; a subsidiary of McWane Inc.
 - 2. Standards: ASTM C 1277 and ASTM C 1540.

3. Description: Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

D. Cast-Iron, Hubless-Piping Couplings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Charlotte Pipe and Foundry Company.
 - b. MG Piping Products Company.
2. Standard: ASTM C 1277.
3. Description: Two-piece ASTM A 48/A 48M, cast-iron housing; stainless-steel bolts and nuts; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.4 COPPER TUBE AND FITTINGS

- A. Copper DWV Tube: ASTM B 306, drainage tube, drawn temper.
- B. Copper Drainage Fittings: ASME B16.23, cast copper or ASME B16.29, wrought copper, solder-joint fittings.
- C. Hard Copper Tube: ASTM B 88, Type L, water tube, drawn temper.
- D. Soft Copper Tube: ASTM B 88, Type L, water tube, annealed temper.
- E. Copper Pressure Fittings:
 1. Copper Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
 2. Copper Unions: MSS SP-123, copper-alloy, hexagonal-stock body with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.
- F. Copper Flanges: ASME B16.24, Class 150, cast copper with solder-joint end.
 1. Flange Gasket Materials: ASME B16.21, full-face, flat, nonmetallic, asbestos-free, 1/8-inch maximum thickness unless thickness or specific material is indicated.
 2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel unless otherwise indicated.
- G. Solder: ASTM B 32, lead free with ASTM B 813, water-flushable flux.

2.5 SPECIALTY PIPE FITTINGS

- A. Transition Couplings:
 1. General Requirements: Fitting or device for joining piping with small differences in OD's or of different materials. Include end connections same size as and compatible with pipes to be joined.
 2. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.

3. Unshielded, Nonpressure Transition Couplings:
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Dallas Specialty & Mfg. Co.
 - 2) Fernco Inc.
 - 3) Mission Rubber Company, LLC; a division of MCP Industries.
 - b. Standard: ASTM C 1173.
 - c. Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.
 - d. Sleeve Materials:
 - 1) For Cast-Iron Soil Pipes: ASTM C 564, rubber.
 - 2) For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.
 4. Shielded, Nonpressure Transition Couplings:
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Cascade Waterworks Mfg. Co.
 - 2) Mission Rubber Company, LLC; a division of MCP Industries.
 - b. Standard: ASTM C 1460.
 - c. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
 5. Pressure Transition Couplings:
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Cascade Waterworks Mfg. Co.
 - 2) Dresser, Inc.
 - 3) Jay R. Smith Mfg. Co.
 - b. Standard: AWWA C219.
 - c. Description: Metal, sleeve-type same size as, with pressure rating at least equal to, and ends compatible with, pipes to be joined.
 - d. Center-Sleeve Material: Manufacturer's standard.
 - e. Gasket Material: Natural or synthetic rubber.
 - f. Metal Component Finish: Corrosion-resistant coating or material.
- B. Dielectric Fittings:

1. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
2. Dielectric Unions:
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) A.Y. McDonald Mfg. Co.
 - 2) Watts; a Watts Water Technologies company.
 - 3) Zurn Industries, LLC.
 - b. Description:
 - 1) Standard: ASSE 1079.
 - 2) Pressure Rating: 150 psig.
 - 3) End Connections: Solder-joint copper alloy and threaded ferrous.
3. Dielectric Flanges:
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Capitol Manufacturing Company.
 - 2) Watts; a Watts Water Technologies company.
 - 3) Zurn Industries, LLC.
 - b. Description:
 - 1) Standard: ASSE 1079.
 - 2) Factory-fabricated, bolted, companion-flange assembly.
 - 3) Pressure Rating: 150 psig.
 - 4) End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.
4. Dielectric-Flange Insulating Kits:
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Advance Products & Systems, Inc.
 - 2) Calpico, Inc.
 - 3) Central Plastics Company.
 - b. Description:
 - 1) Nonconducting materials for field assembly of companion flanges.
 - 2) Pressure Rating: 150 psig.
 - 3) Gasket: Neoprene or phenolic.
 - 4) Bolt Sleeves: Phenolic or polyethylene.
 - 5) Washers: Phenolic with steel backing washers.

5. Dielectric Nipples:

- a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Elster Perfection Corporation.
 - 2) Grinnell Mechanical Products.
 - 3) Victaulic Company.
- b. Description:
 - 1) Standard: IAPMO PS 66
 - 2) Electroplated steel nipple.
 - 3) Pressure Rating: 300 psig at 225 deg F.
 - 4) End Connections: Male threaded or grooved.
 - 5) Lining: Inert and noncorrosive, propylene.

2.6 ENCASEMENT FOR UNDERGROUND METAL PIPING

- A. Standard: ASTM A 674 or AWWA C105/A 21.5.
- B. Material: Linear low-density polyethylene film of 0.008-inch or high-density, cross-laminated polyethylene film of 0.004-inch minimum thickness.
- C. Form: Sheet or tube.
- D. Color: Black or natural.

PART 3 - EXECUTION

3.1 EARTH MOVING

- A. Comply with requirements in Section 203- Excavation and Embankment for excavating, trenching, and backfilling.

3.2 PIPING INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.
- B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

- D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- E. Install piping to permit valve servicing.
- F. Install piping at indicated slopes.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Install piping to allow application of insulation.
- J. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if two fixtures are installed back to back or side by side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.
- K. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.
- L. Install soil and waste drainage and vent piping at the following minimum slopes unless otherwise indicated:
 - 1. Building Sanitary Drain: 2 percent downward in direction of flow for piping NPS 3 and smaller;
 - 2. Horizontal Sanitary Drainage Piping: 2 percent downward in direction of flow.
 - 3. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.
- M. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."
 - 1. Install encasement on underground piping according to ASTM A 674 or AWWA C105/A 21.5.
- N. Install steel piping according to applicable plumbing code.
- O. Install stainless-steel piping according to ASME A112.3.1 and applicable plumbing code.
- P. Install aboveground copper tubing according to CDA's "Copper Tube Handbook."
- Q. Plumbing Specialties:
 - 1. Install backwater valves in sanitary waster gravity-flow piping. Comply with requirements for backwater valves specified in Section 221319 "Sanitary Waste Piping Specialties."

2. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary drainage gravity-flow piping. Comply with requirements for cleanouts specified in Section 221319 "Sanitary Waste Piping Specialties."
 3. Install drains in sanitary drainage gravity-flow piping. Comply with requirements for drains specified in Section 221319 "Sanitary Waste Piping Specialties."
- R. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.
- S. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- T. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- U. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

3.3 JOINT CONSTRUCTION

- A. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
- B. Join hubless, cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.
- C. Join copper tube and fittings with soldered joints according to ASTM B 828. Use ASTM B 813, water-flushable, lead-free flux and ASTM B 32, lead-free-alloy solder.

3.4 SPECIALTY PIPE FITTING INSTALLATION

- A. Transition Couplings:
1. Install transition couplings at joints of piping with small differences in OD's.
 2. In Drainage Piping: Shielded, nonpressure transition couplings.
 3. In Aboveground Force Main Piping: Fitting-type transition couplings.
 4. In Underground Force Main Piping:
 - a. NPS 1-1/2 and Smaller: Fitting-type transition couplings.
 - b. NPS 2 and Larger: Pressure transition couplings.
- B. Dielectric Fittings:
1. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
 2. Dielectric Fittings for NPS 2 and Smaller: Use dielectric unions.
 3. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges.
 4. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

3.5 VALVE INSTALLATION

- A. General valve installation requirements are specified in Section 220523.12 "Ball Valves for Plumbing Piping,"
- B. Shutoff Valves:
 - 1. Install shutoff valve on each sewage pump discharge.
 - 2. Install full-port ball valve for piping NPS 2 and smaller.
- C. Check Valves: Install swing check valve, between pump and shutoff valve, on each sewage pump discharge.

3.6 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements for pipe hanger and support devices and installation specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."
- B. Support horizontal piping and tubing within 12 inches of each fitting, valve, and coupling.
- C. Support vertical piping and tubing at base and at each floor.
- D. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch minimum rods.
- E. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.
 - 2. NPS 3: 60 inches with 1/2-inch rod.
 - 3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.
 - 4. NPS 6 and NPS 8: 60 inches with 3/4-inch rod.
 - 5. Spacing for 10-foot lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches.
- F. Install supports for vertical cast-iron soil piping every 15 feet.
- G. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
 - 1. NPS 1-1/4: 72 inches with 3/8-inch rod.
 - 2. NPS 1-1/2 and NPS 2: 96 inches with 3/8-inch rod.
 - 3. NPS 2-1/2: 108 inches with 1/2-inch rod.
 - 4. NPS 3 and NPS 5: 10 feet with 1/2-inch rod.
 - 5. NPS 6: 10 feet with 5/8-inch rod.
 - 6. NPS 8: 10 feet with 3/4-inch rod.
- H. Install supports for vertical copper tubing every 10 feet.
- I. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.7 CONNECTIONS

- A. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.
- C. Connect drainage and vent piping to the following:
 - 1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.
 - 2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
 - 3. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.
 - 4. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.
 - 5. Install horizontal backwater valves with cleanout cover flush with floor.
 - 6. Comply with requirements for cleanouts and drains specified in Section 221319 "Sanitary Waste Piping Specialties."
 - 7. Equipment: Connect drainage piping as indicated. Provide shutoff valve if indicated and union for each connection. Use flanges instead of unions for connections NPS 2-1/2 and larger.
- D. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.
- E. Make connections according to the following unless otherwise indicated:
 - 1. Install unions, in piping NPS 2 and smaller, adjacent to each valve and at final connection to each piece of equipment.

3.8 IDENTIFICATION

- A. Identify exposed sanitary waste and vent piping. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.9 FIELD QUALITY CONTROL

- A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.
 - 1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
 - 2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
- B. Re-inspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

- C. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.
- D. Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
 - 1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
 - 2. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 - 3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping except outside leaders on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.
 - 4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg. Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.
 - 5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
 - 6. Prepare reports for tests and required corrective action.
- E. Test force-main piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:
 - 1. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.
 - 2. Cap and subject piping to static-water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
 - 3. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.
 - 4. Prepare reports for tests and required corrective action.

3.10 CLEANING AND PROTECTION

- A. Clean interior of piping. Remove dirt and debris as work progresses.
- B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.
- C. Place plugs in ends of uncompleted piping at end of day and when work stops.

3.11 PIPING SCHEDULE

- A. Unions may be used on aboveground pressure piping unless otherwise indicated.
- B. Aboveground, soil and waste piping NPS 4 and smaller shall be any of the following:
 - 1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
 - 2. Hubless, cast-iron soil pipe and fittings; heavy-duty hubless-piping couplings; and coupled joints.
 - 3. Copper DWV tube, copper drainage fittings, and soldered joints.
 - 4. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.
- C. Aboveground, soil and waste piping NPS 5 and larger shall be any of the following:
 - 1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
 - 2. Hubless, cast-iron soil pipe and fittings; CISPI hubless-piping couplings; and coupled joints.
 - 3. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.
- D. Aboveground, vent piping NPS 4 and smaller shall be any of the following:
 - 1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
 - 2. Hubless, cast-iron soil pipe and fittings; CISPI hubless-piping couplings; and coupled joints.
 - 3. Copper DWV tube, copper drainage fittings, and soldered joints.
 - 4. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.
- E. Underground, soil, waste, and vent piping NPS 4 and smaller shall be any of the following:
 - 1. Extra Heavy class, cast-iron soil piping; gaskets; and gasketed joints.
 - 2. Dissimilar Pipe-Material Couplings: Shielded, nonpressure transition couplings.
- F. Aboveground sanitary-sewage force mains NPS 1-1/2 and NPS 2 shall be any of the following:
 - 1. Hard copper tube, Type L; copper pressure fittings; and soldered joints.

END OF SECTION 221316

SECTION 221319
SANITARY WASTE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

- 1. Cleanouts.
- 2. Floor drains.
- 3. Through-penetration firestop assemblies.
- 4. Miscellaneous sanitary drainage piping specialties.

B. Related Requirements:

- 1. Section 221316 "Sanitary Waste and Vent Piping" for sanitary waste and vent piping inside the building.

1.3 DEFINITIONS

- A. ABS: Acrylonitrile-butadiene-styrene plastic.
- B. FOG: Fats, oils, and greases.
- C. FRP: Fiberglass-reinforced plastic.
- D. HDPE: High-density polyethylene plastic.
- E. PE: Polyethylene plastic.
- F. PP: Polypropylene plastic.
- G. PVC: Polyvinyl chloride plastic.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and accessories.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For drainage piping specialties to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic sanitary piping specialty components.

1.7 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Section 033000 "Cast-in-Place Concrete."
- B. Coordinate size and location of roof penetrations.

PART 2 - PRODUCTS

2.1 CLEANOUTS

- A. Exposed Metal Cleanouts:
 - 1. ASME A112.36.2M, Cast-Iron Cleanouts
 - 2. Standard: ASME A112.36.2M for cast iron for cleanout test tee.
 - 3. Size: Same as connected drainage piping
 - 4. Body Material: Hub-and-spigot, cast-iron soil pipe T-branch Hubless, cast-iron soil pipe test tee as required to match connected piping.
 - 5. Closure: Countersunk or raised-head, brass plug.
 - 6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
 - 7. Closure: Stainless-steel plug with seal.
- B. Metal Floor Cleanouts:
 - 1. ASME A112.36.2M, Cast-Iron Cleanouts:
 - 2. Size: Same as connected branch.
 - 3. Type: Adjustable housing.
 - 4. Body or Ferrule: Cast iron.
 - 5. Clamping Device: Required.

6. Outlet Connection: Threaded.
7. Closure: Brass plug with straight threads and gasket.
8. Adjustable Housing Material: Cast iron with threads.
9. Frame and Cover Material and Finish: Polished bronze.
10. Frame and Cover Shape: Round.
11. Top Loading Classification: Heavy Duty.
12. Riser: ASTM A 74, Extra-Heavy class, cast-iron drainage pipe fitting and riser to cleanout.

C. Cast-Iron Wall Cleanouts:

1. Standard: ASME A112.36.2M. Include wall access.
2. Size: Same as connected drainage piping.
3. Body: Hubless, cast-iron soil pipe test tee as required to match connected piping.
4. Closure: Countersunk, brass plug.
5. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
6. Wall Access: Round, cover plate with screw.
7. Wall Access: Square, wall-installation frame and cover.

2.2 FLOOR DRAINS

A. Cast-Iron Floor Drains:

1. Standard: ASME A112.6.3.
2. Pattern: Floor and/or funnel floor drain.
3. Body Material: Gray iron.
4. Seepage Flange: Not required.
5. Anchor Flange: Required.
6. Clamping Device: Not required.
7. Outlet: Bottom.
8. Coating on Interior and Exposed Exterior Surfaces: Not required.
9. Sediment Bucket: Required
10. Top or Strainer Material: Nickel bronze.
11. Top of Body and Strainer Finish: Nickel bronze.
12. Top Shape: Round.
13. Top Loading Classification: Heavy Duty.
14. Funnel: provide where indicated on drawings.
15. Inlet Fitting: Gray iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
16. Trap Material: Cast iron.
17. Trap Pattern: Deep-seal P-trap.
18. Trap Features: Trap-seal primer valve drain connection.

2.3 THROUGH-PENETRATION FIRESTOP ASSEMBLIES

A. Through-Penetration Firestop Assemblies:

1. Standard: UL 1479 assembly of sleeve and stack fitting with firestopping plug.
2. Size: Same as connected soil, waste, or vent stack.

3. Sleeve: Molded PVC plastic, of length to match slab thickness and with integral nailing flange on one end for installation in cast-in-place concrete slabs.
4. Stack Fitting: ASTM A 48/A 48M, gray-iron, hubless-pattern, wye branch with neoprene O-ring at base and gray-iron plug in thermal-release harness. Include PVC protective cap for plug.
5. Special Coating: Corrosion resistant on interior of fittings.

2.4 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

A. Deep-Seal Traps:

1. Description: Cast-iron or bronze casting, with inlet and outlet matching connected piping and cleanout trap-seal primer valve connection.
2. Size: Same as connected waste piping.
 - a. NPS 2: 4-inch-minimum water seal.
 - b. NPS 2-1/2 and Larger: 5-inch-minimum water seal.

B. Floor-Drain, Trap-Seal Primer Fittings:

1. Description: Cast iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
2. Size: Same as floor drain outlet with NPS 1/2 side inlet.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
 1. Size same as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.
 2. Locate at each change in direction of piping greater than 45 degrees.
 3. Locate at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.
 4. Locate at base of each vertical soil and waste stack.
- B. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.
- C. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.
- D. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
 1. Position floor drains for easy access and maintenance.

2. Set floor drains below elevation of surrounding finished floor to allow floor drainage. Set with grates depressed according to the following drainage area radii:
 - a. Radius, 30 Inches or Less: Equivalent to 1 percent slope, but not less than 1/4-inch total depression.
 - b. Radius, 30 to 60 Inches: Equivalent to 1 percent slope.
 - c. Radius, 60 Inches or Larger: Equivalent to 1 percent slope, but not greater than 1-inch total depression.
3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.
4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.

E. Install deep-seal traps on floor drains and other waste outlets, if indicated.

F. Install floor-drain, trap-seal primer fittings on inlet to floor drains that require trap-seal primer connection.

1. Exception: Fitting may be omitted if trap has trap-seal primer connection.
2. Size: Same as floor drain inlet.

G. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.

H. Install wood-blocking reinforcement for wall-mounting-type specialties.

I. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

3.2 CONNECTIONS

A. Comply with requirements in Section 221316 "Sanitary Waste and Vent Piping" for piping installation requirements. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment to allow service and maintenance.

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

B. Tests and Inspections:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.4 PROTECTION

- A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.
- B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 221319

SECTION 221429
SUMP PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Submersible sump pumps.
 - 2. Wet-pit-volute sump pumps.
 - 3. Sump-pump basins and basin covers.
 - 4. Packaged drainage-pump units.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Wiring Diagrams: For power, signal, and control wiring.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For pumps and controls, to include in operation and maintenance manuals.

1.5 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. UL Compliance: Comply with UL 778 for motor-operated water pumps.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Retain shipping flange protective covers and protective coatings during storage.
- B. Protect bearings and couplings against damage.
- C. Comply with pump manufacturer's written rigging instructions for handling.

PART 2 - PRODUCTS

2.1 PACKAGED DRAINAGE-PUMP UNITS

A. Packaged Submersible Drainage-Pump Units:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Bell & Gossett; a Xylem brand.
 - b. Liberty Pumps.
 - c. Little Giant Pump Co.
2. Description: Factory-assembled and -tested, automatic-operation, basin-mounted, sump-pump unit.
3. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller centrifugal pump as defined in HI 1.1-1.2 and HI 1.3.
4. Casing: Metal.
5. Impeller: Brass.
6. Pump Seal: Mechanical.
7. Motor: Hermetically sealed, capacitor-start type, with built-in overload protection.
8. Power Cord: Three-conductor, waterproof cable of length required but not less than 72 inches, with grounding plug and cable-sealing assembly for connection at pump.
9. Pump Discharge Piping: Factory or field fabricated, galvanized, ASTM A 53/A 53M, Schedule 40, steel pipe with ASME B16.4, Class 125, gray iron threaded fittings.
10. Control: Motor-mounted float switch.
11. Basin: Plastic.

B. Capacity and Characteristics:

1. See Drawings
2. Basin: Not Required.
3. Basin:
 - a. Capacity: 5 gal minimum.
 - b. Inlet Connection: NPS 1-1/2 minimum.

2.2 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors.

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

B. Motors for submersible pumps shall be hermetically sealed.

PART 3 - EXECUTION

3.1 EARTHWORK

- A. Excavation and filling are specified in Section 203- Excavation and Embankment.

3.2 EXAMINATION

- A. Examine roughing-in for plumbing piping to verify actual locations of storm drainage piping connections before sump pump installation.

3.3 INSTALLATION

- A. Pump Installation Standards: Comply with HI 1.4 for installation of sump pumps.

3.4 CONNECTIONS

- A. Comply with requirements for piping specified in Section 221316 "Sanitary Waste and Vent Piping" and Section 221319 "Sanitary Waste Piping Specialties." Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to equipment to allow service and maintenance.

3.5 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- B. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- C. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection.
 - 2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Pumps and controls will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports.

3.6 STARTUP SERVICE

A. Perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.

3.7 ADJUSTING

A. Adjust pumps to function smoothly and lubricate as recommended by manufacturer.

B. Adjust control set points.

3.8 DEMONSTRATION

A. Train owner's maintenance personnel to adjust, operate, and maintain controls and pumps.

END OF SECTION 221429

SECTION 223300
ELECTRIC, DOMESTIC-WATER HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Commercial, light-duty, storage, electric, domestic-water heaters.
 - 2. Domestic-water heater accessories.

1.3 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Commercial domestic-water heaters shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
 - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

1.4 ACTION SUBMITTALS

- A. Product Data: For each type and size of domestic-water heater indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings:
 - 1. Wiring Diagrams: For power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Certificates: For commercial domestic-water heaters, 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.

- B. Product Certificates: For each type of commercial, electric, domestic-water heater, from manufacturer.
- C. Domestic-Water Heater Labeling: Certified and labeled by testing agency acceptable to authorities having jurisdiction.
- D. Source quality-control reports.
- E. Field quality-control reports.
- F. Warranty: Sample of special warranty.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For electric, domestic-water heaters to include in emergency, operation, and maintenance manuals.

1.7 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1.
- C. ASME Compliance: Where ASME-code construction is indicated, fabricate and label commercial, domestic-water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
- D. NSF Compliance: Fabricate and label equipment components that will be in contact with potable water to comply with NSF 61, "Drinking Water System Components - Health Effects."

1.8 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.

1.9 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of electric, domestic-water heaters that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

- a. Structural failures including storage tank and supports.
- b. Faulty operation of controls.

- c. Deterioration of metals, metal finishes, and other materials beyond normal use.
- 2. Warranty Periods: From date of Substantial Completion.
 - a. Commercial, Light-Duty, Storage, Electric, Domestic-Water Heaters:
 - 1) Storage Tank: Three years.
 - 2) Controls and Other Components: Two years.

PART 2 - PRODUCTS

2.1 COMMERCIAL, ELECTRIC, DOMESTIC-WATER HEATERS

A. Commercial, Light-Duty, Storage, Electric, Domestic-Water Heaters:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. A. O. Smith Corporation.
 - b. Bradford White Corporation.
 - c. State Industries.
- 2. Standard: UL 174.
- 3. Storage-Tank Construction: Steel, vertical arrangement.
 - a. Tappings: ASME B1.20.1 pipe thread.
 - b. Pressure Rating: 150 psig.
 - c. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending lining material into tappings.
- 4. Factory-Installed Storage-Tank Appurtenances:
 - a. Anode Rod: Replaceable magnesium.
 - b. Dip Tube: Required unless cold-water inlet is near bottom of tank.
 - c. Drain Valve: ASSE 1005.
 - d. Insulation: Comply with ASHRAE/IESNA 90.1.
 - e. Jacket: Steel with enameled finish.
 - f. Heat-Trap Fittings: Inlet type in cold-water inlet and outlet type in hot-water outlet.
 - g. Heating Elements: Two; electric, screw-in immersion type; wired for simultaneous operation unless otherwise indicated. Limited to 12 kW total.
 - h. Temperature Control: Adjustable thermostat.
 - i. Safety Control: High-temperature-limit cutoff device or system.
 - j. Relief Valve: ASME rated and stamped for combination temperature-and-pressure relief valves. Include relieving capacity at least as great as heat input, and include pressure setting less than domestic-water heater working-pressure rating. Select relief valve with sensing element that extends into storage tank.
- 5. Special Requirements: NSF 5 construction with legs for off-floor installation.

- B. Capacity and Characteristics:
 - a. See design drawings for capacity.
- 2. Electrical Characteristics:
 - a. See design drawings for electrical data.

2.2 DOMESTIC-WATER HEATER ACCESSORIES

- A. Drain Pans: Corrosion-resistant metal with raised edge. Comply with ANSI/CSA LC 3. Include dimensions not less than base of domestic-water heater, and include drain outlet not less than NPS 3/4 with ASME B1.20.1 pipe threads or with ASME B1.20.7 garden-hose threads.
- B. Piping-Type Heat Traps: Field-fabricated piping arrangement according to ASHRAE/IESNA 90.1.
- C. Heat-Trap Fittings: ASHRAE 90.2.
- D. Manifold Kits: Domestic-water heater manufacturer's factory-fabricated inlet and outlet piping for field installation, for multiple domestic-water heater installation. Include ball-, butterfly-, or gate-type shutoff valves to isolate each domestic-water heater and calibrated balancing valves to provide balanced flow through each domestic-water heater.
 - 1. Comply with requirements for ball-, butterfly-, or gate-type shutoff valves specified in Section 220523.12 "Ball Valves for Plumbing Piping."
 - 2. Comply with requirements for balancing valves specified in Section 221119 "Domestic Water Piping Specialties."
- E. Pressure-Reducing Valves: ASSE 1003 for water. Set at 25-psig-maximum outlet pressure unless otherwise indicated.
- F. Combination Temperature-and-Pressure Relief Valves: ASME rated and stamped. Include relieving capacity at least as great as heat input, and include pressure setting less than domestic-water heater working-pressure rating. Select relief valves with sensing element that extends into storage tank.
- G. Pressure Relief Valves: ASME rated and stamped. Include pressure setting less than domestic-water heater working-pressure rating.
- H. Vacuum Relief Valves: ANSI Z21.22/CSA 4.4.
- I. Shock Absorbers: ASSE 1010 or PDI-WH 201, Size A water hammer arrester.
- J. Domestic-Water Heater Stands: Manufacturer's factory-fabricated steel stand for floor mounting, capable of supporting domestic-water heater and water. Include dimension that will support bottom of domestic-water heater a minimum of 18 inches above the floor.
- K. Domestic-Water Heater Mounting Brackets: Manufacturer's factory-fabricated steel bracket for wall mounting, capable of supporting domestic-water heater and water.

2.3 SOURCE QUALITY CONTROL

- A. Factory Tests: Test and inspect domestic-water heaters specified to be ASME-code construction, according to ASME Boiler and Pressure Vessel Code.
- B. Hydrostatically test commercial domestic-water heaters to minimum of one and one-half times pressure rating before shipment.
- C. Electric, domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Section 014000 "Quality Requirements" for retesting and reinspecting requirements and Section 017300 "Execution" for requirements for correcting the Work.
- D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 DOMESTIC-WATER HEATER INSTALLATION

- A. Commercial, Electric, Domestic-Water Heater Mounting: Install commercial, electric, domestic-water heaters on concrete base.
 - 1. Exception: Omit concrete bases for commercial, electric, domestic-water heaters if installation on stand, bracket, suspended platform, or directly on floor is indicated.
 - 2. Maintain manufacturer's recommended clearances.
 - 3. Arrange units so controls and devices that require servicing are accessible.
 - 4. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
 - 5. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
 - 6. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 7. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - 8. Anchor domestic-water heaters to substrate.
- B. Install electric, domestic-water heaters level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.
 - 1. Install shutoff valves on domestic-water-supply piping to domestic-water heaters and on domestic-hot-water outlet piping. Comply with requirements for shutoff valves specified in Section 220523.12 "Ball Valves for Plumbing Piping."
- C. Install combination temperature-and-pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.

- D. Install combination temperature-and-pressure relief valves in water piping for electric, domestic-water heaters without storage. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.
- E. Install water-heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for electric, domestic-water heaters that do not have tank drains. Comply with requirements for hose-end drain valves specified in Section 221119 "Domestic Water Piping Specialties."
- F. Install thermometers on outlet piping of electric, domestic-water heaters. Comply with requirements for thermometers specified in Section 220519 "Thermometers and Gages for Plumbing Piping."
- G. Install thermometers on inlet and outlet piping of residential, solar, electric, domestic-water heaters. Comply with requirements for thermometers specified in Section 220519 "Thermometers and Gages for Plumbing Piping."
- H. Assemble and install inlet and outlet piping manifold kits for multiple electric, domestic-water heaters. Fabricate, modify, or arrange manifolds for balanced water flow through each electric, domestic-water heater. Include shutoff valve and thermometer in each domestic-water heater inlet and outlet, and throttling valve in each electric, domestic-water heater outlet. Comply with requirements for valves specified in Section 220523.12 "Ball Valves for Plumbing Piping," and comply with requirements for thermometers specified in Section 220519 "Thermometers and Gages for Plumbing Piping."
- I. Install pressure-reducing valve with integral bypass relief valve in electric, domestic-water booster-heater inlet piping and water hammer arrester in booster-heater outlet piping. Set pressure-reducing valve for outlet pressure of 25 psig. Comply with requirements for pressure-reducing valves and water hammer arresters specified in Section 221119 "Domestic Water Piping Specialties."
- J. Install piping-type heat traps on inlet and outlet piping of electric, domestic-water heater storage tanks without integral or fitting-type heat traps.
- K. Fill electric, domestic-water heaters with water.
- L. Charge domestic-water compression tanks with air.

3.2 CONNECTIONS

- A. Comply with requirements for piping specified in Section 221116 "Domestic Water Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where installing piping adjacent to electric, domestic-water heaters, allow space for service and maintenance of water heaters. Arrange piping for easy removal of domestic-water heaters.

3.3 IDENTIFICATION

- A. Identify system components. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.4 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
 - 2. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
 - 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation.
 - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- B. Electric, domestic-water heaters will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

3.5 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain commercial, electric, domestic-water heaters.

END OF SECTION 223300

SECTION 224213.13
COMMERCIAL WATER CLOSETS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Water closets.
 - 2. Toilet seats.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for water closets.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: Include diagrams for power, signal, and control wiring.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data

PART 2 - PRODUCTS

2.1 FLOOR-MOUNTED, REAR - OUTLET WATER CLOSETS

- A. Water Closets: Floor mounted, rear outlet, tank type.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Standard America.
 - b. Kohler Co.
 - c. TOTO USA, INC.

2. Bowl:
 - a. Standards: ASME A112.19.2/CSA B45.1 and ASME A112.19.5.
 - b. Material: Vitreous china.
 - c. Type: Siphon jet.
 - d. Style: Tank
 - e. Height: Handicapped/elderly, complying with ICC/ANSI A117.1.
 - f. Rim Contour: Elongated.
 - g. Water Consumption: 1.28 gal. per flush.
 - h. Color: White.
3. Bowl-to-Drain Connecting Fitting: ASME A112.4.3.
4. Flush Valve: None

2.2 TOILET SEATS

A. Toilet Seats:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Standard America.
 - b. Kohler Co.
 - c. TOTO USA, INC.
2. Standard: IAPMO/ANSI Z124.5.
3. Material: Plastic.
4. Type: Commercial (Heavy duty).
5. Shape: Elongated rim, open front.
6. Hinge: Check.
7. Hinge Material: Noncorroding metal.
8. Seat Cover: Not required.
9. Color: White.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before water-closet installation.
- B. Examine walls and floors for suitable conditions where water closets will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Water-Closet Installation:

1. Install level and plumb according to roughing-in drawings.
 2. Install floor-mounted water closets on bowl-to-drain connecting fitting attachments to piping or building substrate.
- B. Install toilet seats on water closets.
- C. Wall Flange and Escutcheon Installation:
1. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations and within cabinets and millwork.
 2. Install deep-pattern escutcheons if required to conceal protruding fittings.
 3. Comply with escutcheon requirements specified in Section 220518 "Escutcheons for Plumbing Piping."
- D. Joint Sealing:
1. Seal joints between water closets and walls and floors using sanitary-type, one-part, mildew-resistant silicone sealant.
 2. Match sealant color to water-closet color.
 3. Comply with sealant requirements specified in Section 079200 "Joint Sealants."

3.3 CONNECTIONS

- A. Connect water closets with water supplies and soil, waste, and vent piping. Use size fittings required to match water closets.
- B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."
- C. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."
- D. Where installing piping adjacent to water closets, allow space for service and maintenance.

3.4 ADJUSTING

- A. Operate and adjust water closets and controls. Replace damaged and malfunctioning water closets, fittings, and controls.

3.5 CLEANING AND PROTECTION

- A. Clean water closets and fittings with manufacturers' recommended cleaning methods and materials.
- B. Install protective covering for installed water closets and fittings.
- C. Do not allow use of water closets for temporary facilities unless approved in writing by Owner.

END OF SECTION 224213.13

SECTION 224216.13
COMMERCIAL LAVATORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:

- 1. Lavatories.
- 2. Faucets.

1.3 ACTION SUBMITTALS

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

- 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for lavatories.
- 2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

- B. Shop Drawings

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Counter cutout templates for mounting of counter-mounted lavatories.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For lavatories and faucets to include in operation and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

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

- 1. Faucet Washers and O-Rings: Equal to 10 percent of amount of each type and size installed.

2. Faucet Cartridges and O-Rings: Equal to 5 percent of amount of each type and size installed.

PART 2 - PRODUCTS

2.1 VITREOUS-CHINA, WALL-MOUNTED LAVATORIES

- A. Lavatory: Wheelchair, vitreous china, wall mounted.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Standard America.
 - b. Kohler Co.
 - c. Sloan Valve Company.
 2. Fixture:
 - a. Standard: ASME A112.19.2/CSA B45.1.
 - b. Type: Slab or wheelchair.
 - c. Nominal Size: Rectangular, 27 by 20 inches.
 - d. Faucet-Hole Punching: Three holes, 2-inch centers.
 - e. Faucet-Hole Location: Top.
 - f. Color: White.
 - g. Mounting: For concealed-arm carrier.
 3. Support: ASME A112.6.1M, Type II, concealed-arm lavatory carrier with rectangular, steel uprights.

2.2 SOLID-BRASS, MANUALLY OPERATED FAUCETS

- A. NSF Standard: Comply with NSF/ANSI 61, "Drinking Water System Components - Health Effects," for faucet materials that will be in contact with potable water.
- B. Lavatory Faucets: Manual-type, single-control mixing or two-handle mixing, commercial, solid-brass valve.
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. American Standard America.
 - b. Kohler Co.
 - c. Moen Incorporated.
 2. Standard: ASME A112.18.1/CSA B125.1.
 3. General: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and fixture receptor.
 4. Body Type: Centerset.
 5. Body Material: Commercial, solid brass.

6. Finish: Polished chrome plate.
7. Maximum Flow Rate: 0.5 gpm.
8. Maximum Flow: 0.25 gal. per metering cycle.
9. Mounting Type: Deck, concealed.
10. Valve Handle(s): Single lever.
11. Spout: Rigid type.
12. Spout Outlet: Aerator.
13. Operation: Compression, manual.
14. Drain: Not part of faucet.

2.3 SUPPLY FITTINGS

- A. NSF Standard: Comply with NSF/ANSI 61, "Drinking Water System Components - Health Effects," for supply-fitting materials that will be in contact with potable water.
- B. Standard: ASME A112.18.1/CSA B125.1.
- C. Supply Piping: Chrome-plated-brass pipe or chrome-plated copper tube matching water-supply piping size. Include chrome-plated-brass or stainless-steel wall flange.
- D. Supply Stops: Chrome-plated-brass, one-quarter-turn, ball-type or compression valve with inlet connection matching supply piping.
- E. Operation: Wheel handle.
- F. Risers:
 1. NPS 1/2.
 2. ASME A112.18.6, braided- or corrugated-stainless-steel, flexible hose riser.

2.4 WASTE FITTINGS

- A. Standard: ASME A112.18.2/CSA B125.2.
- B. Drain: Grid type with NPS 1-1/4 offset and straight tailpiece.
- C. Trap:
 1. Size: NPS 1-1/4.
 2. Material: Chrome-plated, two-piece, cast-brass trap and swivel elbow with 0.032-inch-thick brass tube to wall; and chrome-plated, brass or steel wall flange.
 3. Material: Stainless-steel, two-piece trap and swivel elbow with 0.012-inch-thick stainless-steel tube to wall; and stainless-steel wall flange.
 4. Provide with trap primer overflow connection for the trap primer for the floor drain.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before lavatory installation.
- B. Examine counters and walls for suitable conditions where lavatories will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install lavatories level and plumb according to roughing-in drawings.
- B. Install supports, affixed to building substrate, for wall-mounted lavatories.
- C. Install accessible wall-mounted lavatories at handicapped/elderly mounting height for people with disabilities or the elderly, according to ICC/ANSI A117.1.
- D. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 220518 "Escutcheons for Plumbing Piping."
- E. Seal joints between lavatories, counters, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 079200 "Joint Sealants."
- F. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible lavatories. Comply with requirements in Section 220719 "Plumbing Piping Insulation."

3.3 CONNECTIONS

- A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
- B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."
- C. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."

3.4 ADJUSTING

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

3.5 CLEANING AND PROTECTION

- A. After completing installation of lavatories, inspect and repair damaged finishes.
- B. Clean lavatories, faucets, and other fittings with manufacturers' recommended cleaning methods and materials.
- C. Provide protective covering for installed lavatories and fittings.
- D. Do not allow use of lavatories for temporary facilities unless approved in writing by Owner.

END OF SECTION 224216.13

SECTION 224216.16
COMMERCIAL SINKS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Service basins
 - 2. Sink faucets.
 - 3. Supply fittings.
 - 4. Waste fittings.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for sinks.
 - 2. Include rated capacities, operating characteristics and furnished specialties and accessories.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Counter cutout templates for mounting of counter-mounted lavatories.

1.5 CLOSEOUT SUBMITTALS

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

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Faucet Washers and O-Rings: Equal to 10 percent of amount of each type and size installed.
 - 2. Faucet Cartridges and O-Rings: Equal to 5 percent of amount of each type and size installed.

PART 2 - PRODUCTS

2.1 SERVICE BASINS

- A. Service Basins: Terrazzo, floor mounted.
 - 1. Fixture:
 - a. Standard: IAPMO PS 99.
 - b. Shape: Square.
 - c. Nominal Size: 24 by 24 inches.
 - d. Height: 6 inches.
 - e. Tiling Flange: Not required.
 - f. Rim Guard: Stainless steel, On all top surfaces.
 - g. Wall Guard: Stainless Steel, all around
 - h. Color: White
 - i. Drain: Grid with NPS 3 outlet.
 - 2. Mounting: On floor and flush to wall.

2.2 SUPPLY FITTINGS

- A. NSF Standard: Comply with NSF/ANSI 61, "Drinking Water System Components - Health Effects," for supply-fitting materials that will be in contact with potable water.
- B. Standard: ASME A112.18.1/CSA B125.1.
- C. Supply Piping: Chrome-plated brass pipe or chrome-plated copper tube matching water-supply piping size. Include chrome-plated brass or stainless-steel wall flange.
- D. Supply Stops: Chrome-plated brass, one-quarter-turn, ball-type or compression valve with inlet connection matching supply piping.
- E. Operation: Wheel handle.
- F. Risers:
 - 1. NPS 1/2
 - 2. ASME A112.18.6, braided or corrugated stainless-steel flexible hose.

2.3 WASTE FITTINGS

- A. Standard: ASME A112.18.2/CSA B125.2.
- B. Drain: Grid type with NPS 1-1/2 offset and straight tailpiece.
- C. Trap:
 - 1. Size: NPS 1-1/2.

2. Material: Chrome-plated, two-piece, cast-brass trap and swivel elbow with 0.032-inch-thick brass tube to wall; and chrome-plated brass or steel wall flange.
3. Material: Stainless-steel, two-piece trap and swivel elbow with 0.012-inch-thick stainless-steel tube to wall; and stainless-steel wall flange.

2.4 GROUT

- A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.
- B. Characteristics: Nonshrink; recommended for interior and exterior applications.
- C. Design Mix: 5000-psi, 28-day compressive strength.
- D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before sink installation.
- B. Examine walls, floors, and counters for suitable conditions where sinks will be installed.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install sinks level and plumb according to roughing-in drawings.
- B. Install supports, affixed to building substrate, for wall-hung sinks.
- C. Install accessible wall-mounted sinks at handicapped/elderly mounting height according to ICC/ANSI A117.1.
- D. Set floor-mounted sinks in leveling bed of cement grout.
- E. Install water-supply piping with stop on each supply to each sink faucet.
 1. Exception: Use ball or gate valves if supply stops are not specified with sink. Comply with valve requirements specified in Section 220523.12 "Ball Valves for Plumbing Piping."
 2. Install stops in locations where they can be easily reached for operation.
- F. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 220518 "Escutcheons for Plumbing Piping."

- G. Seal joints between sinks and counters, floors, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Section 079200 "Joint Sealants."
- H. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible sinks. Comply with requirements in Section 220719 "Plumbing Piping Insulation."

3.3 CONNECTIONS

- A. Connect sinks with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.
- B. Comply with water piping requirements specified in Section 221116 "Domestic Water Piping."
- C. Comply with soil and waste piping requirements specified in Section 221316 "Sanitary Waste and Vent Piping."

3.4 ADJUSTING

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

3.5 CLEANING AND PROTECTION

- A. After completing installation of sinks, inspect and repair damaged finishes.
- B. Clean sinks, faucets, and other fittings with manufacturers' recommended cleaning methods and materials.
- C. Provide protective covering for installed sinks and fittings.
- D. Do not allow use of sinks for temporary facilities unless approved in writing by Owner.

END OF SECTION 224216.16

SECTION 230513
COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on alternating-current power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.2 COORDINATION

- A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:
 - 1. Motor controllers.
 - 2. Torque, speed, and horsepower requirements of the load.
 - 3. Ratings and characteristics of supply circuit and required control sequence.
 - 4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

- A. Comply with NEMA MG 1 unless otherwise indicated.

2.2 MOTOR CHARACTERISTICS

- A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.
- B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.3 POLYPHASE MOTORS

- A. Description: NEMA MG 1, Design B, medium induction motor.
- B. Efficiency: Premium efficient, as defined in NEMA MG 1.
- C. Service Factor: 1.15.

- D. Multispeed Motors: Variable torque.
 - 1. For motors with 2:1 speed ratio, consequent pole, single winding.
 - 2. For motors with other than 2:1 speed ratio, separate winding for each speed.
- E. Rotor: Random-wound, squirrel cage.
- F. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.
- G. Temperature Rise: Match insulation rating.
- H. Insulation: **Class F as a minimum**
- I. Code Letter Designation:
 - 1. Motors **15** HP and Larger: NEMA starting Code F or Code G.
 - 2. Motors Smaller Than **15** HP: Manufacturer's standard starting characteristic.
- J. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.4 ADDITIONAL REQUIREMENTS FOR POLYPHASE MOTORS

- A. Motors Used with Reduced-Voltage and Multispeed Controllers: Match wiring connection requirements for controller with required motor leads. Provide terminals in motor terminal box, suited to control method.
- B. Motors Used with Variable-Frequency Controllers:
 - 1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width-modulated inverters.
 - 2. Premium-Efficient Motors: Class B temperature rise; Class F insulation.
 - 3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.
 - 4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

2.5 SINGLE-PHASE MOTORS

- A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:
 - 1. Permanent-split capacitor.
 - 2. Split phase.
 - 3. Capacitor start, inductor run.
 - 4. Capacitor start, capacitor run.
- B. Multispeed Motors: Variable-torque, permanent-split-capacitor type.

- C. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.
- D. Motors 1/20 HP and Smaller: Shaded-pole type.
- E. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

PART 3 - EXECUTION (Not Applicable)

END OF SECTION 230513

SECTION 230516
EXPANSION FITTINGS AND LOOPS FOR HVAC PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Metal, compensator packless expansion joints.
 - 2. Rubber union connector packless expansion joints.
 - 3. Flexible-hose packless expansion joints.
 - 4. Alignment guides and anchors.
 - 5. Pipe loops and swing connections.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Delegated-Design Submittal: For each anchor and alignment guide, including analysis data, signed and sealed by the qualified professional engineer responsible for their preparation.
 - 1. Design Calculations: Calculate requirements for thermal expansion of piping systems and for selecting and designing expansion joints, loops, and swing connections.
 - 2. Anchor Details: Detail fabrication of each anchor indicated. Show dimensions and methods of assembly and attachment to building structure.
 - 3. Alignment Guide Details: Detail field assembly and attachment to building structure.
 - 4. Schedule: Indicate type, manufacturer's number, size, material, pressure rating, end connections, and location for each expansion joint.

1.3 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance data.

1.5 QUALITY ASSURANCE

- A. Pipe and Pressure-Vessel Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Compatibility: Products shall be suitable for piping service fluids, materials, working pressures, and temperatures.
- B. Capability: Products to absorb 200 percent of maximum axial movement between anchors.

2.2 PACKED EXPANSION JOINTS

2.3 PACKLESS EXPANSION JOINTS

A. Metal, Compensator Packless Expansion Joints

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Flex-Hose Co., Inc.
 - b. Flex-Weld, Inc.
 - c. Mason Industries, Inc.
 - d. Metraflex Company (The).
- 2. Minimum Pressure Rating: 150 psig, unless otherwise indicated.
- 3. Description: Totally enclosed, externally pressurized, multi-ply bellows isolated from fluid flow by an internal pipe sleeve and external housing.
- 4. Joint Axial Movement: 2 inches of compression and 1/2 inch of extension.
- 5. Configuration for Copper Tubing: Multi-ply, phosphor-bronze bellows with copper pipe ends.
 - a. End Connections for Copper Tubing NPS 2 and Smaller: Solder joint or threaded.
 - b. End Connections for Copper Tubing NPS 2-1/2 to NPS 4: Threaded.

B. Rubber Union Connector Expansion Joints ;

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Flex-Hose Co., Inc.
 - b. Flexicraft Industries.
 - c. Mason Industries, Inc.
- 2. Material: Twin reinforced-rubber spheres with external restraining cables.
- 3. Minimum Pressure Rating: 150 psig at 170 deg F , unless otherwise indicated.
- 4. End Connections for NPS 2 and Smaller: Threaded.

C. Flexible-Hose Packless Expansion Joints

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Flex-Hose Co., Inc.
 - b. Flexicraft Industries.
 - c. Mason Industries, Inc.
 - d. Metraflex Company (The).
2. Description: Manufactured assembly with inlet and outlet elbow fittings and two flexible-metal-hose legs joined by long-radius, 180-degree return bend or center section of flexible hose.
3. Flexible Hose: Corrugated-metal inner hoses and braided outer sheaths.
4. Expansion Joints for Copper Tubing NPS 2 and Smaller: Copper-alloy fittings with solder-joint end connections.
 - a. Bronze hoses and single-braid bronze sheaths with 450 psig at 70 deg F and 340 psig at 450 deg F ratings.
5. Expansion Joints for Copper Tubing NPS 2-1/2 to NPS 4: Copper-alloy fittings with end connections.
 - a. Stainless-steel hoses and single-braid, stainless-steel sheaths with 300 psig at 70 deg F and 225 psig at 450 deg F ratings.
6. Expansion Joints for Steel Piping NPS 2-1/2 to NPS 6 : Carbon-steel fittings with Flanged end connections.
 - a. Stainless-steel hoses and single-braid, stainless-steel sheaths with 200 psig at 70 deg F and 145 psig at 600 deg F) ratings.

2.4 ALIGNMENT GUIDES AND ANCHORS

A. Alignment Guides :

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Flex-Hose Co., Inc.
 - b. Mason Industries, Inc.
 - c. Metraflex Company (The).
 - d. U.S. Bellows, Inc.
2. Description: Steel, factory-fabricated alignment guide, with bolted two-section outer cylinder and base for attaching to structure; with two-section guiding slider for bolting to pipe.

B. Anchor Materials:

1. Steel Shapes and Plates: ASTM A36/A36M.
2. Bolts and Nuts: ASME B18.10 or ASTM A183, steel hex head.
3. Washers: ASTM F844, steel, plain, flat washers.

4. Mechanical Fasteners: Insert-wedge-type stud with expansion plug anchor for use in hardened portland cement concrete, with tension and shear capacities appropriate for application.
 - a. Stud: Threaded, zinc-coated carbon steel.
 - b. Expansion Plug: Zinc-coated steel.
 - c. Washer and Nut: Zinc-coated steel.

5. Chemical Fasteners: Insert-type stud, bonding-system anchor for use with hardened portland cement concrete, with tension and shear capacities appropriate for application.
 - a. Bonding Material: ASTM C881/C881M, Type IV, Grade 3, two-component epoxy resin suitable for surface temperature of hardened concrete where fastener is to be installed.
 - b. Stud: ASTM A307, zinc-coated carbon steel with continuous thread on stud, unless otherwise indicated.
 - c. Washer and Nut: Zinc-coated steel.

PART 3 - EXECUTION

3.1 EXPANSION JOINT INSTALLATION

- A. Install expansion joints of sizes matching sizes of piping in which they are installed.
- B. Install packed-type expansion joints with packing suitable for fluid service.
- C. Install metal-bellows expansion joints according to EJMA's "Standards of the Expansion Joint Manufacturers Association, Inc."

3.2 PIPE LOOP AND SWING CONNECTION INSTALLATION

- A. Install pipe loops cold-sprung in tension or compression as required to partly absorb tension or compression produced during anticipated change in temperature.
- B. Connect risers and branch connections to mains with at least five pipe fittings, including tee in main.
- C. Connect risers and branch connections to terminal units with at least four pipe fittings, including tee in riser.
- D. Connect mains and branch connections to terminal units with at least four pipe fittings, including tee in main.

3.3 ALIGNMENT-GUIDE AND ANCHOR INSTALLATION

- A. Install alignment guides to guide expansion and to avoid end-loading and torsional stress.

- B. Install two guide(s) on each side of pipe expansion fittings and loops. Install guides nearest to expansion joint not more than four pipe diameters from expansion joint.
- C. Attach guides to pipe, and secure guides to building structure.
- D. Install anchors at locations to prevent stresses from exceeding those permitted by ASME B31.9 and to prevent transfer of loading and stresses to connected equipment.
- E. Anchor Attachments:
 - 1. Anchor Attachment to Steel Pipe: Attach by welding. Comply with ASME B31.9 and ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
 - 2. Anchor Attachment to Copper Tubing: Attach with pipe hangers. Use MSS SP-69, Type 24; U bolts bolted to anchor.
- F. Fabricate and install steel anchors by welding steel shapes, plates, and bars. Comply with ASME B31.9 and AWS D1.1/D1.1M.
 - 1. Anchor Attachment to Steel Structural Members: Attach by welding.
 - 2. Anchor Attachment to Concrete Structural Members: Attach by fasteners. Follow fastener manufacturer's written instructions.
- G. Use grout to form flat bearing surfaces for guides and anchors attached to concrete.

END OF SECTION 230516

SECTION 230517
SLEEVES AND SLEEVE SEALS FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Sleeves.
 - 2. Sleeve-seal systems.

1.3 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 SLEEVES

- A. Cast-Iron Wall Pipes: Cast or fabricated of cast or ductile iron and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.
- B. Galvanized-Steel Wall Pipes: ASTM A 53/A 53M, Schedule 40, with plain ends and welded steel collar; zinc coated.
- C. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, with plain ends.
- D. Galvanized-Steel-Sheet Sleeves: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

2.2 SLEEVE-SEAL SYSTEMS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Advance Products & Systems, Inc.
 - 2. CALPICO, Inc.
 - 3. Metraflex Company (The).

- B. Description: Modular sealing-element unit, designed for field assembly, for filling annular space between piping and sleeve.
 - 1. Sealing Elements: EPDM-rubber interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
 - 2. Pressure Plates: Carbon steel.
 - 3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION

- A. Install sleeves for piping passing through penetrations in floors, partitions, roofs, and walls.
- B. For sleeves that will have sleeve-seal system installed, select sleeves of size large enough to provide 1-inch annular clear space between piping and concrete slabs and walls.
- C. Install sleeves in concrete floors, concrete roof slabs, and concrete walls as new slabs and walls are constructed.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level.
 - 2. Using grout, seal the space outside of sleeves in slabs and walls without sleeve-seal system.
- D. Install sleeves for pipes passing through interior partitions.
 - 1. Cut sleeves to length for mounting flush with both surfaces.
 - 2. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation.
 - 3. Seal annular space between sleeve and piping or piping insulation; use joint sealants appropriate for size, depth, and location of joint. Comply with requirements for sealants specified in Section 079200 "Joint Sealants."
- E. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements for firestopping specified in Section 078413 "Penetration Firestopping."

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

- A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at service piping entries into building.
- B. Select type, size, and number of sealing elements required for piping material and size and for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve-seal system components, and install in annular space between piping and

sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a watertight seal.

3.3 SLEEVE AND SLEEVE-SEAL SCHEDULE

A. Use sleeves and sleeve seals for the following piping-penetration applications:

1. Exterior Concrete Walls above Grade:
 - a. Piping Smaller Than NPS 6: Galvanized-steel wall sleeves.
2. Exterior Concrete Walls below Grade:
 - a. Piping Smaller Than NPS 6: Galvanized-steel wall sleeves with sleeve-seal system or Galvanized-steel-pipe sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
3. Concrete Slabs-on-Grade:
 - a. Piping Smaller Than NPS 6: Galvanized-steel wall sleeves with sleeve-seal system or Galvanized-steel-pipe sleeves with sleeve-seal system.
 - 1) Select sleeve size to allow for 1-inch annular clear space between piping and sleeve for installing sleeve-seal system.
4. Concrete Slabs above Grade:
 - a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves or Stack-sleeve fittings.
5. Interior Partitions:
 - a. Piping Smaller Than NPS 6: Galvanized-steel-pipe sleeves.

END OF SECTION 230517

SECTION 230518
ESCUTCHEONS FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Escutcheons.
 - 2. Floor plates.

1.3 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 ESCUTCHEONS

- A. One-Piece, Cast-Brass Type: With polished, chrome-plated in finished spaces only and rough-brass finish and setscrew fastener.
- B. Split-Casting Brass Type: With polished, chrome-plated in finished spaces only and rough-brass finish and with concealed hinge and setscrew.

2.2 FLOOR PLATES

- A. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.
- B. Split-Casting Floor Plates: Cast brass with concealed hinge.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install escutcheons for piping penetrations of walls, ceilings, and finished floors.

- B. Install escutcheons with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
 - 1. Escutcheons for New Piping:
 - a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
 - b. Chrome-Plated Piping: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
 - c. Insulated Piping: One-piece, stamped-steel type, split-plate, stamped-steel type with concealed hinge or split-plate, stamped-steel type with exposed-rivet hinge.
 - d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass or split-casting brass type with polished, chrome-plated finish.
 - e. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished, chrome-plated finish.
 - f. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, stamped-steel type.
 - g. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass or split-casting brass type with rough-brass finish.
- C. Install floor plates for piping penetrations of equipment-room floors.
- D. Install floor plates with ID to closely fit around pipe, tube, and insulation of piping and with OD that completely covers opening.
 - 1. New Piping: One-piece, floor-plate type.
 - 2. Existing Piping: Split-casting, floor-plate type.

3.2 FIELD QUALITY CONTROL

- A. Replace broken and damaged escutcheons and floor plates using new materials.

END OF SECTION 230518

SECTION 230519
METERS AND GAGES FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Bimetallic-actuated thermometers.
 - 2. Filled-system thermometers.
 - 3. Thermowells.
 - 4. Dial-type pressure gages.
 - 5. Gage attachments.
 - 6. Test plugs.
 - 7. Test-plug kits.
 - 8. Sight flow indicators.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Wiring Diagrams: For power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of meter and gage, from manufacturer.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For meters and gages to include in operation and maintenance manuals.

PART 2 - PRODUCTS

2.1 BIMETALLIC-ACTUATED THERMOMETERS

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

2. Nanmac Corporation.
 3. Watts; a Watts Water Technologies company.
- B. Standard: ASME B40.200.
- C. Case: sealed type(s); stainless steel with 3-inch nominal diameter.
- D. Dial: Nonreflective aluminum with permanently etched scale markings and scales in deg F.
- E. Connector Type(s): Union joint, adjustable angle, with unified-inch screw threads.
- F. Connector Size: ASME B1.1 screw threads.
- G. Stem: 0.25 or 0.375 inch in diameter; stainless steel.
- H. Window: Plain glass or plastic.
- I. Ring: Stainless steel.
- J. Element: Bimetal coil.
- K. Pointer: Dark-colored metal.
- L. Accuracy: Plus or minus 1.5 percent of scale range.

2.2 FILLED-SYSTEM THERMOMETERS

- A. Direct-Mounted, Metal-Case, Vapor-Actuated Thermometers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Ashcroft Inc.
 - b. Terrice, H. O. Co.
 - c. Weiss Instruments, Inc.
 2. Standard: ASME B40.200.
 3. Case: Sealed type, cast aluminum or drawn steel; 5-inch nominal diameter.
 4. Element: Bourdon tube or other type of pressure element.
 5. Movement: Mechanical, dampening type, with link to pressure element and connection to pointer.
 6. Dial: Nonreflective aluminum with permanently etched scale markings graduated in deg F.
 7. Pointer: Dark-colored metal.
 8. Window: Glass or plastic.
 9. Ring: Metal.
 10. Connector Type(s): Union joint, adjustable, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device; with ASME B1.1 screw threads.
 11. Thermal System: Liquid-filled bulb in copper-plated steel, aluminum, or brass stem and of length to suit installation.
 - a. Design for Air-Duct Installation: With ventilated shroud.

- b. Design for Thermowell Installation: Bare stem.

- 12. Accuracy: Plus or minus 1 percent of scale range.

2.3 DUCT-THERMOMETER MOUNTING BRACKETS

- A. Description: Flanged bracket with screw holes, for attachment to air duct and made to hold thermometer stem.

2.4 THERMOWELLS

- A. Thermowells:

- 1. Standard: ASME B40.200.
- 2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.
- 3. Material for Use with Copper Tubing: CNR or CUNI.
- 4. Material for Use with Steel Piping: CRES.
- 5. Type: Stepped shank unless straight or tapered shank is indicated.
- 6. External Threads: NPS 1/2, NPS 3/4, or NPS 1, ASME B1.20.1 pipe threads.
- 7. Internal Threads: 1/2, 3/4, and 1 inch, with ASME B1.1 screw threads.
- 8. Bore: Diameter required to match thermometer bulb or stem.
- 9. Insertion Length: Length required to match thermometer bulb or stem.
- 10. Lagging Extension: Include on thermowells for insulated piping and tubing.
- 11. Bushings: For converting size of thermowell's internal screw thread to size of thermometer connection.

- B. Heat-Transfer Medium: Mixture of graphite and glycerin.

2.5 PRESSURE GAGES

- A. Direct-Mounted, Metal-Case, Dial-Type Pressure Gages:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Ametek U.S. Gauge.
 - b. Watts; a Watts Water Technologies company.
 - c. Weiss Instruments, Inc.
- 2. Standard: ASME B40.100.
- 3. Case: Sealed type(s); cast aluminum or drawn steel; 4-1/2-inch nominal diameter.
- 4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.
- 5. Pressure Connection: Brass, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and bottom-outlet type unless back-outlet type is indicated.
- 6. Movement: Mechanical, with link to pressure element and connection to pointer.
- 7. Dial: Nonreflective aluminum with permanently etched scale markings graduated in psi.
- 8. Pointer: Dark-colored metal.
- 9. Window: Glass or plastic.
- 10. Ring: Metal.
- 11. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

2.6 GAGE ATTACHMENTS

- A. Snubbers: ASME B40.100, brass; with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads and porous-metal-type surge-dampening device. Include extension for use on insulated piping.
- B. Siphons: Loop-shaped section of brass or stainless-steel pipe with NPS 1/4 or NPS 1/2 pipe threads.
- C. Valves: Brass ball, with NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe threads.

2.7 TEST PLUGS

- A. Description: Test-station fitting made for insertion into piping tee fitting.
- B. Body: Brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.
- C. Thread Size: NPS 1/4 or NPS 1/2, ASME B1.20.1 pipe thread.
- D. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F.
- E. Core Inserts: Chlorosulfonated polyethylene synthetic and EPDM self-sealing rubber.

2.8 TEST-PLUG KITS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Flow Design, Inc.
 - 2. Trerice, H. O. Co.
 - 3. Weiss Instruments, Inc.
- B. Furnish one test-plug kit(s) containing two thermometer(s), one pressure gage and adapter, and carrying case. Thermometer sensing elements, pressure gage, and adapter probes shall be of diameter to fit test plugs and of length to project into piping.
- C. High-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch-diameter dial and tapered-end sensing element. Dial range shall be at least 0 to 220 deg F.
- D. Pressure Gage: Small, Bourdon-tube insertion type with 2- to 3-inch-diameter dial and probe. Dial range shall be at least 0 to 200 psig.
- E. Carrying Case: Metal or plastic, with formed instrument padding.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install thermowells with socket extending into pipe fluid per manufacturers recommended installation instructions and in vertical position in piping tees.
- B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.
- C. Install thermowells with extension on insulated piping.
- D. Fill thermowells with heat-transfer medium.
- E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.
- F. Install duct-thermometer mounting brackets in walls of ducts. Attach to duct with screws.
- G. Install direct-mounted pressure gages in piping tees with pressure gage located on pipe at the most readable position.
- H. Install valve and snubber in piping for each pressure gage for fluids.
- I. Install test plugs in piping tees.
- J. Install flow indicators in piping systems in accessible positions for easy viewing.
- K. Assemble and install connections, tubing, and accessories between flow-measuring elements and flowmeters according to manufacturer's written instructions.
- L. Install differential-pressure-type flowmeter elements, with at least minimum straight lengths of pipe, upstream and downstream from element according to manufacturer's written instructions.
- M. Install permanent indicators on walls or brackets in accessible and readable positions.
- N. Install connection fittings in accessible locations for attachment to portable indicators.
- O. Install thermometers in the following locations:
 - 1. Inlet and outlet of each hydronic zone.
 - 2. Inlet and outlet of each hydronic boiler.
 - 3. Two inlets and two outlets of each chiller.
 - 4. Inlet and outlet of each hydronic coil in air-handling units.
 - 5. Two inlets and two outlets of each hydronic heat exchanger.
 - 6. Inlet and outlet of each thermal-storage tank.
 - 7. Outside-, return-, supply-, and mixed-air ducts.
 - 8. Where indicated on contract drawings.
- P. Install pressure gages in the following locations:
 - 1. Discharge of each pressure-reducing valve.
 - 2. Inlet and outlet of each chiller chilled-water and condenser-water connection.

3. Suction and discharge of each pump.
4. Where indicated on contract documents.

3.2 CONNECTIONS

- A. Install meters and gages adjacent to machines and equipment to allow service and maintenance of meters, gages, machines, and equipment.
- B. Connect flowmeter-system elements to meters.
- C. Connect flowmeter transmitters to meters.
- D. Connect thermal-energy meter transmitters to meters.

3.3 ADJUSTING

- A. After installation, calibrate meters according to manufacturer's written instructions.
- B. Adjust faces of meters and gages to proper angle for best visibility.

3.4 THERMOMETER SCHEDULE

- A. Thermometers at inlet and outlet of each hydronic zone shall be one of the following:
 1. Sealed, bimetallic-actuated type.
 2. Direct-mounted, metal-case, vapor-actuated type.
 3. Test plug with chlorosulfonated polyethylene synthetic or EPDM self-sealing rubber inserts.
- B. Thermometers at inlet and outlet of each hydronic boiler shall be one of the following:
 1. Sealed, bimetallic-actuated type.
 2. Direct-mounted, metal-case, vapor-actuated type.
 3. Test plug with chlorosulfonated polyethylene synthetic or EPDM self-sealing rubber inserts.
- C. Thermometers at inlet and outlet of each hydronic coil in air-handling units and built-up central systems shall be one of the following:
 1. Sealed, bimetallic-actuated type.
 2. Direct-mounted, metal-case, vapor-actuated type.
 3. Test plug with chlorosulfonated polyethylene synthetic or EPDM self-sealing rubber inserts.
- D. Thermometers at outside-, return-, supply-, and mixed-air ducts shall be one of the following:
 1. Sealed, bimetallic-actuated type.
 2. Direct-mounted, metal-case, vapor-actuated type.
- E. Thermometer stems shall be of length to match thermowell insertion length.

3.5 THERMOMETER SCALE-RANGE SCHEDULE

- A. Scale Range for Heating, Hot-Water Piping: 0 to 250 deg F.
- B. Scale Range for Air Ducts: 0 to 150 deg F.

3.6 PRESSURE-GAGE SCHEDULE

- A. Pressure gages at discharge of each pressure-reducing valve shall be one of the following:
 - 1. Sealed, direct-mounted, metal case.
 - 2. Test plug with chlorosulfonated polyethylene synthetic or EPDM self-sealing rubber inserts.
- B. Pressure gages at suction and discharge of each pump shall be one of the following:
 - 1. Sealed, direct-mounted, metal case.
 - 2. Test plug with chlorosulfonated polyethylene synthetic or EPDM self-sealing rubber inserts.

3.7 PRESSURE-GAGE SCALE-RANGE SCHEDULE

- A. Scale Range for Heating, Hot-Water Piping: 0 to 160 psi.

3.8 FLOWMETER SCHEDULE

- A. Flowmeters for Heating, Hot-Water Piping: Pitot-tube or Turbine type.

3.9 THERMAL-ENERGY METER SCHEDULE

- A. Thermal-Energy Meters for Chilled-Water Piping: Impeller-turbine type.
- B. Thermal-Energy Meters for Heating, Hot-Water Piping: Impeller-turbine type.

END OF SECTION 230519

SECTION 230523.12
BALL VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Brass ball valves.
 - 2. Bronze ball valves.

1.3 DEFINITIONS

- A. CWP: Cold working pressure.

1.4 ACTION SUBMITTALS

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

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
 - 1. Protect internal parts against rust and corrosion.
 - 2. Protect threads, flange faces, and weld ends.
 - 3. Set ball valves open to minimize exposure of functional surfaces.
- B. Use the following precautions during storage:
 - 1. Maintain valve end protection.
 - 2. Store valves indoors and maintain at higher-than-ambient-dew-point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.
- C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use operating handles or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

- A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
- B. ASME Compliance:
 - 1. ASME B1.20.1 for threads for threaded-end valves.
 - 2. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
 - 3. ASME B16.18 for solder-joint connections.
 - 4. ASME B31.9 for building services piping valves.
- C. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.
- D. Refer to HVAC valve schedule articles for applications of valves.
- E. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- F. Valve Sizes: Same as upstream piping unless otherwise indicated.
- G. Valve Actuator Types:
 - 1. Handlever: For quarter-turn valves smaller than NPS 4.
- H. Valves in Insulated Piping:
 - 1. Include 2-inch stem extensions.
 - 2. Extended operating handle of nonthermal-conductive material, and protective sleeves that allow operation of valves without breaking the vapor seals or disturbing insulation.
 - 3. Memory stops that are fully adjustable after insulation is applied.
- I. Valve Bypass and Drain Connections: MSS SP-45.

2.2 BRASS BALL VALVES

- A. Two-Piece Brass Ball Valves with Full Port and Brass Trim:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Apollo Valves; Conbraco Industries, Inc.
 - b. NIBCO INC.
 - c. Watts; a Watts Water Technologies company.
 - 2. Description:

- a. Standard: MSS SP-110.
- b. SWP Rating: 150 psig.
- c. CWP Rating: 600 psig.
- d. Body Design: Two piece.
- e. Body Material: Forged brass.
- f. Ends: Threaded.
- g. Seats: PTFE.
- h. Stem: Brass.
- i. Ball: Chrome-plated brass.
- j. Port: Full.

2.3 BRONZE BALL VALVES

A. Two-Piece Bronze Ball Valves with Full Port and Bronze or Brass Trim:

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Apollo Valves; Conbraco Industries, Inc.
 - b. NIBCO INC.
 - c. Watts; a Watts Water Technologies company.
- 2. Description:
 - a. Standard: MSS SP-110.
 - b. SWP Rating: 150 psig.
 - c. CWP Rating: 600 psig.
 - d. Body Design: Two piece.
 - e. Body Material: Bronze.
 - f. Ends: Threaded.
 - g. Seats: PTFE.
 - h. Stem: Bronze.
 - i. Ball: Chrome-plated brass.
 - j. Port: Full.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- C. Examine threads on valve and mating pipe for form and cleanliness.

- D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- E. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Locate valves for easy access and provide separate support where necessary.
- C. Install valves in horizontal piping with stem at or above center of pipe.
- D. Install valves in position to allow full stem movement.
- E. Install valve tags. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for valve tags and schedules.

3.3 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. If valves with specified SWP classes or CWP ratings are unavailable, the same types of valves with higher SWP classes or CWP ratings may be substituted.
- B. Select valves with the following end connections:
 - 1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
 - 2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules below.

3.4 HEATING-WATER VALVE SCHEDULE

- A. Pipe NPS 3 and Smaller: Two piece, full port, brass or bronze with brass or bronze trim.
 - 1. Valves may be provided with solder-joint ends instead of threaded ends.

END OF SECTION 230523.12

SECTION 230523.14
CHECK VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Bronze lift check valves.
 - 2. Bronze swing check valves.

1.3 DEFINITIONS

- A. CWP: Cold working pressure.
- B. EPDM: Ethylene propylene copolymer rubber.
- C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.

1.4 ACTION SUBMITTALS

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

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
 - 1. Protect internal parts against rust and corrosion.
 - 2. Protect threads, flange faces, grooves, and weld ends.
 - 3. Block check valves in either closed or open position.
- B. Use the following precautions during storage:
 - 1. Maintain valve end protection.
 - 2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.
- C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

- A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.
- B. ASME Compliance:
 - 1. ASME B1.20.1 for threads for threaded-end valves.
 - 2. ASME B16.18 for solder joint.
 - 3. ASME B31.9 for building services piping valves.
- C. Bronze valves shall be made with dezincification-resistant materials. Bronze valves made with copper alloy (brass) containing more than 15 percent zinc are not permitted.
- D. Valve Pressure-Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.
- E. Valve Sizes: Same as upstream piping unless otherwise indicated.
- F. Valve Bypass and Drain Connections: MSS SP-45.

2.2 BRONZE LIFT CHECK VALVES

- A. Class 125 Lift Check Valves with Bronze Disc:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Crane; Crane Energy Flow Solutions.
 - b. Jenkins Valves; Crane Energy Flow Solutions.
 - c. Stockham; Crane Energy Flow Solutions.
 - 2. Description:
 - a. Standard: MSS SP-80, Type 1.
 - b. CWP Rating: 200 psig.
 - c. Body Design: Vertical flow.
 - d. Body Material: ASTM B 61 or ASTM B 62, bronze.
 - e. Ends: Threaded.
 - f. Disc: Bronze.

2.3 BRONZE SWING CHECK VALVES

- A. Class 125, Bronze Swing Check Valves with Bronze Disc:
 - 1. Description:

- a. Standard: MSS SP-80, Type 3.
- b. CWP Rating: 200 psig.
- c. Body Design: Horizontal flow.
- d. Body Material: ASTM B 62, bronze.
- e. Ends: Threaded.
- f. Disc: Bronze.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.
- B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.
- C. Examine threads on valve and mating pipe for form and cleanliness.
- D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.
- E. Do not attempt to repair defective valves; replace with new valves.

3.2 VALVE INSTALLATION

- A. Install valves with unions or flanges at each piece of equipment arranged to allow service, maintenance, and equipment removal without system shutdown.
- B. Locate valves for easy access and provide separate support where necessary.
- C. Install valves in horizontal piping with stem at or above center of pipe.
- D. Install valves in position to allow full stem movement.
- E. Install check valves for proper direction of flow and as follows:
 - 1. Swing Check Valves: In horizontal position with hinge pin level.
 - 2. Lift Check Valves: With stem upright and plumb.
- F. Install valve tags. Comply with requirements for valve tags and schedules in Section 230553 "Identification for HVAC Piping and Equipment."

3.3 ADJUSTING

- A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

- A. If valve applications are not indicated, use the following:
 - 1. Pump-Discharge Check Valves:
 - a. NPS 3 and Smaller: Bronze swing check valves with bronze disc.
- B. If valves with specified SWP classes or CWP ratings are unavailable, the same types of valves with higher SWP classes or CWP ratings may be substituted.
- C. Select valves, except wafer types, with the following end connections:
 - 1. For Copper Tubing, NPS 2 and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules.
 - 2. For Copper Tubing, NPS 2-1/2 to NPS 4: Flanged ends except where threaded valve-end option is indicated in valve schedules.

3.5 HEATING-WATER VALVE SCHEDULE

- A. Pipe NPS 3 and Smaller:
 - 1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
 - 2. Bronze Swing Check Valves: Class 125 or Class 150, bronze disc.

END OF SECTION 230523.14

SECTION 230529
HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.01 GENERAL PROVISIONS

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

1.02 SUMMARY

- A. Section Includes:

- 1. Metal pipe hangers and supports.
- 2. Trapeze pipe hangers.
- 3. Metal framing systems.
- 4. Thermal-hanger shield inserts.
- 5. Fastener systems.

- B. Related Sections:

- 1. Section 230516 "Expansion Fittings and Loops for HVAC Piping" for pipe guides and anchors.
- 2. Section 230548 "Vibration and Seismic Controls for HVAC"
- 3. Section 233113 "Metal Ducts" for duct hangers and supports.

1.03 DEFINITIONS

- A. MSS: Manufacturers Standardization Society of The Valve and Fittings Industry Inc.

1.04 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

- B. Structural Performance: Hangers and supports for HVAC piping and equipment shall withstand the effects of gravity loads and stresses within limits and under conditions indicated according to ASCE/SEI 7.

- 1. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.
- 2. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
- 3. Design seismic-restraint hangers and supports for piping and equipment and obtain approval from authorities having jurisdiction.

1.05 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: Signed and sealed by a qualified professional engineer in the Commonwealth of Massachusetts. Show fabrication and installation details and include calculations for the following; include Product Data for components:
 - 1. Trapeze pipe hangers.
 - 2. Metal framing systems.
 - 3. Pipe stands.
 - 4. Equipment supports.
- C. Delegated-Design Submittal: For trapeze hangers indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 - 1. Detail fabrication and assembly of trapeze hangers.
 - 2. Design Calculations: Calculate requirements for designing trapeze hangers.

1.06 INFORMATIONAL SUBMITTALS

- A. Welding certificates.

1.07 QUALITY ASSURANCE

- A. Structural Steel Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

PART 2 - PRODUCTS

2.01 METAL PIPE HANGERS AND SUPPORTS

- A. Carbon-Steel Pipe Hangers and Supports:
 - 1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
 - 2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.
 - 3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
 - 4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
 - 5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
- B. Copper Pipe Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of copper-coated steel.

2.02 TRAPEZE PIPE HANGERS

- A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural carbon-steel shapes with MSS SP-58 carbon-steel hanger rods, nuts, saddles, and U-bolts.

2.03 METAL FRAMING SYSTEMS

A. MFMA Manufacturer Metal Framing Systems:

1. Manufacturer: Subject to compliance with requirements, provide product by one of the following or equal:
 - a. Allied Tube & Conduit.
 - b. Flex-Strut Inc.
 - c. Unistrut; an Atkore International company.
2. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.
3. Standard: MFMA-4.
4. Channels: Continuous slotted steel channel with inturned lips.
5. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
6. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
7. Metallic Coating: Hot-dipped galvanized.

B. Non-MFMA Manufacturer Metal Framing Systems:

1. Manufacturer: Subject to compliance with requirements, provide product by one of the following or equal:
 - a. Anvil International.
 - b. Empire Industries, Inc.
 - c. Haydon Corporation.
 - d. NIBCO INC.
2. Description: Shop- or field-fabricated pipe-support assembly made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.
3. Standard: Comply with MFMA-4.
4. Channels: Continuous slotted steel channel with inturned lips.
5. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
6. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.
7. Coating: Zinc.

2.04 THERMAL-HANGER SHIELD INSERTS

1. Manufacturer: Subject to compliance with requirements, provide product by one of the following or equal:
 2. Carpenter & Paterson, Inc.
 3. National Pipe Hanger Corporation.
 4. PHS Industries, Inc.
 5. Pipe Shields Inc.
- B. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength and vapor barrier.
- C. Insulation-Insert Material for Hot Piping: ASTM C 552, Type II cellular glass with 100-psig or ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength.
- D. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.
- E. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.
- F. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

2.05 FASTENER SYSTEMS

- A. Contractor shall verify suitability of fastener for each application. The following paragraphs are generally suited for lightweight concrete or concrete slabs less than 4 inches thick. Consult with Fastener manufacturer for each application. Manufacturer installation instructions and guidelines shall be strictly adhered to.
- B. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened Portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
- C. Mechanical-Expansion Anchors: Insert-wedge-type, stainless- steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

2.06 EQUIPMENT SUPPORTS

- A. Description: Welded, shop- or field-fabricated equipment support made from structural carbon-steel shapes.

2.07 MISCELLANEOUS MATERIALS

- A. Structural Steel: ASTM A 36/A 36M, carbon-steel plates, shapes, and bars; black and galvanized.

- B. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink and nonmetallic grout; suitable for interior and exterior applications.
 - 1. Properties: Nonstaining, noncorrosive, and nongaseous.
 - 2. Design Mix: 5000-psi, 28-day compressive strength.

PART 3 - EXECUTION

3.01 HANGER AND SUPPORT INSTALLATION

- A. Metal Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.
- B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.
 - 1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.
 - 2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.
- C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.
- D. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.
- E. Fastener System Installation:
 - 1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches thick in concrete after concrete is placed and completely cured. Use operators that are licensed by powder-actuated tool manufacturer. Install fasteners according to powder-actuated tool manufacturer's operating manual.
 - 2. Install mechanical-expansion anchors in concrete after concrete is placed and completely cured. Install fasteners according to manufacturer's written instructions.
- F. Install hangers and supports complete with necessary attachments, inserts, bolts, rods, nuts, washers, and other accessories.
- G. Equipment Support Installation: Fabricate from welded-structural-steel shapes.
- H. Install hangers and supports to allow controlled thermal and seismic movement of piping systems, to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends, and similar units.
- I. Install lateral bracing with pipe hangers and supports to prevent swaying.

- J. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.
- K. Load Distribution: Install hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.
- L. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and to not exceed maximum pipe deflections allowed by ASME B31.9 for building services piping.
- M. Insulated Piping:
 - 1. Attach clamps and spacers to piping.
 - a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
 - b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
 - c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
 - 2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 - 3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
 - a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.
 - 4. Shield Dimensions for Pipe: Not less than the following:
 - a. NPS 1/4 to NPS 3-1/2: 12 inches long and 0.048 inch thick.
 - b. NPS 4: 12 inches long and 0.06 inch thick.
 - c. NPS 5 and NPS 6: 18 inches long and 0.06 inch thick.
 - 5. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.02 EQUIPMENT SUPPORTS

- A. Fabricate structural-steel stands to suspend equipment from structure overhead or to support equipment above floor.
- B. Grouting: Place grout under supports for equipment and make bearing surface smooth.

- C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.03 METAL FABRICATIONS

- A. Cut, drill, and fit miscellaneous metal fabrications for trapeze pipe hangers and equipment supports.
- B. Fit exposed connections together to form hairline joints. Field weld connections that cannot be shop welded because of shipping size limitations.
- C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
 - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
 - 2. Obtain fusion without undercut or overlap.
 - 3. Remove welding flux immediately.
 - 4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.04 ADJUSTING

- A. Hanger Adjustments: Adjust hangers to distribute loads equally on attachments and to achieve indicated slope of pipe.
- B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches.

3.05 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.
- B. Touchup: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Section 099600 "High-Performance Coatings."
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

3.06 HANGER AND SUPPORT SCHEDULE

- A. Specific hanger and support requirements are in Sections specifying piping systems and equipment.

- B. Comply with MSS SP-69 for pipe-hanger selections and applications that are not specified in piping system Sections.
- C. Use hangers and supports with galvanized metallic coatings for piping and equipment that will not have field-applied finish.
- D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.
- E. Use carbon-steel pipe hangers and supports metal trapeze pipe hangers and metal framing systems and attachments for general service applications.
- F. Use stainless-steel pipe hangers and stainless-steel or corrosion-resistant attachments for hostile environment applications.
- G. Use copper-plated pipe hangers and copper or stainless-steel attachments for copper piping and tubing.
- H. Use padded hangers for piping that is subject to scratching.
- I. Use thermal-hanger shield inserts for insulated piping and tubing.
- J. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
 - 1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated, stationary pipes NPS 1/2 to NPS 30.
 - 2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of up to 1050 deg F, pipes NPS 4 to NPS 24, requiring up to 4 inches of insulation.
 - 3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes NPS 3/4 to NPS 36, requiring clamp flexibility and up to 4 inches of insulation.
 - 4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.
 - 5. Pipe Hangers (MSS Type 5): For suspension of pipes NPS 1/2 to NPS 4, to allow off-center closure for hanger installation before pipe erection.
 - 6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 8.
 - 7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
 - 8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
 - 9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.
 - 10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8.
 - 11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3.
 - 12. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.
 - 13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.

14. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
 15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36, with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
 16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
 17. Single-Pipe Rolls (MSS Type 41): For suspension of pipes NPS 1 to NPS 30, from two rods if longitudinal movement caused by expansion and contraction might occur.
 18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24, from single rod if horizontal movement caused by expansion and contraction might occur.
- K. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24.
 2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 if longer ends are required for riser clamps.
- L. Hanger-Rod Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel Turnbuckles (MSS Type 13): For adjustment up to 6 inches for heavy loads.
 2. Steel Clevises (MSS Type 14): For 120 to 450 deg F piping installations.
 3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.
 4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
 5. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F piping installations.
- M. Building Attachments: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.
 2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joint construction, to attach to top flange of structural shape.
 3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
 4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
 5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
 6. C-Clamps (MSS Type 23): For structural shapes.
 7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.
 8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.
 9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.

10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.
 11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.
 12. Welded-Steel Brackets: For support of pipes from below or for suspending from above by using clip and rod. Use one of the following for indicated loads:
 - a. Light (MSS Type 31): 750 lb.
 - b. Medium (MSS Type 32): 1500 lb.
 - c. Heavy (MSS Type 33): 3000 lb.
 13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.
 14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.
 15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.
- N. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Steel-Pipe-Covering Protection Saddles (MSS Type 39): To fill interior voids with insulation that matches adjoining insulation.
 2. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.
 3. Thermal-Hanger Shield Inserts: For supporting insulated pipe.
- O. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
 2. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.
 3. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.
 4. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
 5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.
 6. Variable-Spring Base Supports (MSS Type 52): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from base support.
 7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.
 8. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:
 - a. Horizontal (MSS Type 54): Mounted horizontally.
 - b. Vertical (MSS Type 55): Mounted vertically.
 - c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

- P. Comply with MSS SP-69 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.
- Q. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.
- R. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

PART 4 - COMPENSATION

4.01 MEASUREMENT

- A. The Work of this Section shall be measured on a Lump Sum Basis as part of Section 230000 – HEATING, VENTILATING AND AIR CONDITIONING. No separate measurement or payment will be made for the Work of this Section.
- B. Payment for the work of this Section shall be as described in the SUPPLEMENTAL INSTRUCTIONS TO BIDDERS.

END OF SECTION 230529

SECTION 230548
VIBRATION AND SEISMIC CONTROLS FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Elastomeric isolation pads.
2. Elastomeric isolation mounts.
3. Restrained elastomeric isolation mounts.
4. Open-spring isolators.
5. Housed-spring isolators.
6. Restrained-spring isolators.
7. Housed-restrained-spring isolators.
8. Elastomeric hangers.
9. Spring hangers.
10. Restraint cables.
11. Seismic-restraint accessories.
12. Mechanical anchor bolts.
13. Adhesive anchor bolts.

B. Related Requirements:

1. Section 220548 "Vibration and Seismic Controls for Plumbing" for devices for plumbing equipment and systems.

1.3 DEFINITIONS

- A. IBC: International Building Code.
- B. ICC-ES: ICC-Evaluation Service.
- C. OSHPD: Office of Statewide Health Planning & Development (for the State of California).

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.

2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of vibration isolation device and seismic-restraint component required.
 - a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an evaluation service member of ICC-ES OSHPD an agency acceptable to authorities having jurisdiction.
 - b. Annotate to indicate application of each product submitted and compliance with requirements.
 3. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.
- B. Shop Drawings:
1. Detail fabrication and assembly of equipment bases. Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
 2. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
- C. Delegated-Design Submittal: For each vibration isolation and seismic-restraint device.
1. Include design calculations and details for selecting vibration isolators, seismic restraints, and vibration isolation bases complying with performance requirements, design criteria, and analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
 2. Design Calculations: Calculate static and dynamic loading due to equipment weight, operation, and seismic forces required to select vibration isolators and seismic restraints and for designing vibration isolation bases.
 - a. Coordinate design calculations with wind load calculations required for equipment mounted outdoors. Comply with requirements in other Sections for equipment mounted outdoors.
 3. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, spring deflection changes, and seismic loads. Include certification that riser system was examined for excessive stress and that none exists.
 4. Seismic-Restraint Details:
 - a. Design Analysis: To support selection and arrangement of seismic restraints. Include calculations of combined tensile and shear loads.
 - b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.
 - c. Coordinate seismic-restraint and vibration isolation details with wind-restraint details required for equipment mounted outdoors. Comply with requirements in other Sections for equipment mounted outdoors.

- d. Preapproval and Evaluation Documentation: By an evaluation service member of ICC-ES OSHPD an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Show coordination of vibration isolation device installation and seismic bracing for HVAC piping and equipment with other systems and equipment in the vicinity, including other supports and restraints, if any.
- B. Qualification Data: For professional engineer and testing agency.
- C. Welding certificates.
- D. Air-Mounting System Performance Certification: Include natural frequency, load, and damping test data performed by an independent agency.
- E. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For air-spring mounts and restrained-air-spring mounts to include in operation and maintenance manuals.

1.7 QUALITY ASSURANCE

- A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7 and that is acceptable to authorities having jurisdiction.
- B. Comply with seismic-restraint requirements in the IBC unless requirements in this Section are more stringent.
- C. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- D. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage preapproval OPA number from OSHPD, preapproval by ICC-ES, or preapproval by another agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are unavailable, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.

PART 2 - PRODUCTS

2.1 ELASTOMERIC ISOLATION PADS

A. Elastomeric Isolation Pads: .

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Mason Industries, Inc.
 - b. Vibration Isolation.
 - c. Vibration Mountings & Controls, Inc.
2. Fabrication: Single or multiple layers of sufficient durometer stiffness for uniform loading over pad area.
3. Size: Factory or field cut to match requirements of supported equipment.
4. Pad Material: Oil and water resistant with elastomeric properties.
5. Surface Pattern: Smooth Ribbed Waffle pattern.
6. Infused nonwoven cotton or synthetic fibers.
7. Load-bearing metal plates adhered to pads.
8. Sandwich-Core Material: Resilient and elastomeric Insert compound.
 - a. Surface Pattern: Smooth Ribbed Waffle pattern.
 - b. Infused nonwoven cotton or synthetic fibers.

2.2 ELASTOMERIC ISOLATION MOUNTS

A. Double-Deflection, Elastomeric Isolation Mounts: .

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Mason Industries, Inc.
 - b. Vibration Isolation.
 - c. Vibration Mountings & Controls, Inc.
2. Mounting Plates:
 - a. Top Plate: Encapsulated steel load transfer top plates, factory drilled and threaded with threaded studs or bolts.
 - b. Baseplate: Encapsulated steel bottom plates with holes provided for anchoring to support structure.
3. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

2.3 RESTRAINED ELASTOMERIC ISOLATION MOUNTS

A. Restrained Elastomeric Isolation Mounts: .

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Mason Industries, Inc.
 - b. Vibration Isolation.
 - c. Vibration Mountings & Controls, Inc.
2. Description: All-directional isolator with seismic restraints containing two separate and opposing elastomeric elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.
 - a. Housing: Cast-ductile iron or welded steel.
 - b. Elastomeric Material: Molded, oil-resistant rubber, neoprene, or other elastomeric material.

2.4 HOUSED-RESTRAINED-SPRING ISOLATORS

A. Freestanding, Steel, Open-Spring Isolators with Vertical-Limit Stop Restraint in Two-Part Telescoping Housing: .

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Mason Industries, Inc.
 - b. Vibration Isolation.
 - c. Vibration Mountings & Controls, Inc.
2. Two-Part Telescoping Housing: A steel top and bottom frame separated by an elastomeric material and enclosing the spring isolators. Housings are equipped with adjustable non-adjustable snubbers to limit vertical movement.
 - a. Drilled base housing for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig.
 - b. Threaded top housing with adjustment bolt and cap screw to fasten and level equipment.
3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2.5 RESTRAINED-AIR-SPRING ISOLATORS

A. Freestanding, Single or Multiple, Compressed-Air Bellows with Vertical-Limit Stop Restraint: .

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

- a. Firestone Industrial Products Company.
 - b. Mason Industries, Inc.
2. Housing: Steel housing with vertical-limit stops to prevent spring extension due to weight being removed.
 - a. Base with holes for bolting to structure with an elastomeric isolator pad attached to the underside. Bases shall limit floor load to 500 psig.
 - b. Top plate with threaded mounting holes elastomeric pad.
 - c. Internal leveling bolt that acts as blocking during installation.
 3. Restraint: Limit stop as required for equipment and authorities having jurisdiction.
 4. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
 5. Minimum Additional Travel: 50 percent of the required deflection at rated load.
 6. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 7. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 8. Bellows Assembly: Upper and lower powder-coated steel sections connected by a replaceable, flexible, nylon-reinforced neoprene bellows or similar elastomeric material.
 9. Maximum Natural Frequency: 3 Hz.
 10. Operating Pressure Range: 25 to 100 psig.
 11. Burst Pressure: At least three times manufacturer's published maximum operating pressure.
 12. Tank valves.

2.6 ELASTOMERIC HANGERS

- A. Elastomeric Mount in a Steel Frame with Upper and Lower Steel Hanger Rods: .
 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Mason Industries, Inc.
 - b. Vibration Eliminator Co., Inc.
 - c. Vibration Mountings & Controls, Inc.
 2. Frame: Steel, fabricated with a connection for an upper threaded hanger rod and an opening on the underside to allow for a maximum of 30 degrees of angular lower hanger-rod misalignment without binding or reducing isolation efficiency.
 3. Dampening Element: Molded, oil-resistant rubber, neoprene, or other elastomeric material with a projecting bushing for the underside opening preventing steel to steel contact.

2.7 SPRING HANGERS

- A. Combination Coil-Spring and Elastomeric-Insert Hanger with Spring and Insert in Compression: .

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Mason Industries, Inc.
 - b. Vibration Isolation.
 - c. Vibration Mountings & Controls, Inc.
2. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
4. Minimum Additional Travel: 50 percent of the required deflection at rated load.
5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
7. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
8. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
9. Self-centering hanger-rod cap to ensure concentricity between hanger rod and support spring coil.

2.8 RESTRAINT CABLES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Mason Industries, Inc.
 2. Vibration & Seismic Technologies, LLC.
 3. Vibration Mountings & Controls, Inc.
- B. Restraint Cables: [ASTM A 603 galvanized] [ASTM A 492 stainless]-steel cables. End connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; with a minimum of two clamping bolts for cable engagement.

2.9 SEISMIC-RESTRAINT ACCESSORIES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Mason Industries, Inc.
 2. TOLCO.
 3. Vibration & Seismic Technologies, LLC.
- B. Hanger-Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections Reinforcing steel angle clamped to hanger rod.

- C. Hinged and Swivel Brace Attachments: Multifunctional steel connectors for attaching hangers to rigid channel bracings and restraint cables.
- D. Bushings for Floor-Mounted Equipment Anchor Bolts: Neoprene bushings designed for rigid equipment mountings, and matched to type and size of anchor bolts and studs.
- E. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices used.
- F. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

2.10 MECHANICAL ANCHOR BOLTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. B-line, an Eaton business.
 - 2. Hilti, Inc.
 - 3. Mason Industries, Inc.
- B. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type in zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

2.11 ADHESIVE ANCHOR BOLTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Hilti, Inc.
 - 2. Kinetics Noise Control, Inc.
 - 3. Mason Industries, Inc.
- B. Adhesive Anchor Bolts: Drilled-in and capsule anchor system containing PVC or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with zinc-coated steel for interior applications and stainless steel for exterior applications. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

2.12 VIBRATION ISOLATION EQUIPMENT BASES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Mason Industries, Inc.
 - 2. Vibration Isolation.
 - 3. Vibration Mountings & Controls, Inc.

- B. Steel Rails: Factory-fabricated, welded, structural-steel rails.
 - 1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide rails.
 - a. Include supports for suction and discharge elbows for pumps.
 - 2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Rails shall have shape to accommodate supported equipment.
 - 3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.
- C. Steel Bases: Factory-fabricated, welded, structural-steel bases and rails.
 - 1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.
 - a. Include supports for suction and discharge elbows for pumps.
 - 2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.
 - 3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and equipment to receive vibration isolation and seismic-control devices for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

- A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an agency acceptable to authorities having jurisdiction.
- B. Hanger-Rod Stiffeners: Install hanger-rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.
- C. Strength of Support and Seismic-Restraint Assemblies: Where not indicated, select sizes of components so strength is adequate to carry present and future static and seismic loads within specified loading limits.

3.3 VIBRATION CONTROL AND SEISMIC-RESTRAINT DEVICE INSTALLATION

- A. Coordinate the location of embedded connection hardware with supported equipment attachment and mounting points and with requirements for concrete reinforcement and formwork specified in Section 033000 "Cast-in-Place Concrete."
- B. Installation of vibration isolators must not cause any change of position of equipment, piping, or ductwork resulting in stresses or misalignment.
- C. Equipment Restraints:
 - 1. Install seismic snubbers on HVAC equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.
 - 2. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
 - 3. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction that provides required submittals for component.
- D. Piping Restraints:
 - 1. Comply with requirements in MSS SP-127.
 - 2. Space lateral supports a maximum of 40 feet o.c., and longitudinal supports a maximum of 80 feet o.c.
 - 3. Brace a change of direction longer than 12 feet.
- E. Install cables so they do not bend across edges of adjacent equipment or building structure.
- F. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction that provides required submittals for component.
- G. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.
- H. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.
- I. Attachment to Structure: If specific attachment is not indicated, anchor bracing to structure at flanges of beams, at upper truss chords of bar joists, or at concrete members.
- J. Drilled-in Anchors:
 - 1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcing or embedded items during coring or drilling. Notify the structural engineer if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
 - 2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.

3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
4. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.
5. Set anchors to manufacturer's recommended torque, using a torque wrench.
6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.4 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

- A. Install flexible connections in piping where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment. Comply with requirements in Section 232113 "Hydronic Piping" for piping flexible connections.

3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Perform tests and inspections.
- C. Tests and Inspections:
 1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.
 2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless postconnection testing has been approved), and with at least seven days' advance notice.
 3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.
 4. Test at least four of each type and size of installed anchors and fasteners selected by Architect.
 5. Test to 90 percent of rated proof load of device.
 6. Measure isolator restraint clearance.
 7. Measure isolator deflection.
 8. Verify snubber minimum clearances.
 9. Test and adjust restrained-air-spring isolator controls and safeties.
- D. Remove and replace malfunctioning units and retest as specified above.
- E. Prepare test and inspection reports.

3.6 ADJUSTING

- A. Adjust isolators after piping system is at operating weight.
- B. Adjust limit stops on restrained-spring isolators to mount equipment at normal operating height. After equipment installation is complete, adjust limit stops so they are out of contact during normal operation.

END OF SECTION 230548

SECTION 230553
IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Equipment labels.
 - 2. Warning signs and labels.
 - 3. Pipe labels.
 - 4. Duct labels.
 - 5. Valve tags.
 - 6. Warning tags.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Samples: For color, letter style, and graphic representation required for each identification material and device.
- C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.
- D. Valve numbering scheme.
- E. Valve Schedules: For each piping system to include in maintenance manuals.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

- A. Metal Labels for Equipment:
 - 1. Material and Thickness: Brass, 0.032-inch aluminum, 0.032-inch or anodized aluminum, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
 - 2. Letter Color: Black.
 - 3. Background Color: White.

4. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
5. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
6. Fasteners: Stainless-steel rivets or self-tapping screws.
7. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

2.2 WARNING SIGNS AND LABELS

- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
- B. Letter Color: Red.
- C. Background Color: White.
- D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
- E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
- F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
- G. Fasteners: Stainless-steel rivets or self-tapping screws.
- H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- I. Label Content: Include caution and warning information plus emergency notification instructions.

2.3 PIPE LABELS

- A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction according to ASME A13.1.
- B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to partially cover circumference of pipe and to attach to pipe without fasteners or adhesive.
- C. Self-Adhesive Pipe Labels: Printed plastic with contact-type, permanent-adhesive backing.
- D. Pipe Label Contents: Include identification of piping service using same designations or abbreviations as used on Drawings; also include pipe size and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
2. Lettering Size: Size letters according to ASME A13.1 for piping.

2.4 DUCT LABELS

- A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.
- B. Letter Color: Black.
- C. Background Color: White.
- D. Maximum Temperature: Able to withstand temperatures up to 160 deg F.
- E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
- F. Minimum Letter Size: 1/4 inch for name of units if viewing distance is less than 24 inches, 1/2 inch for viewing distances up to 72 inches, and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-quarters the size of principal lettering.
- G. Fasteners: Stainless-steel rivets or self-tapping screws.
- H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.
- I. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings; also include duct size and an arrow indicating flow direction.
 1. Flow-Direction Arrows: Integral with duct system service lettering to accommodate both directions or as separate unit on each duct label to indicate flow direction.

2.5 VALVE TAGS

- A. Description: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.
 1. Tag Material: Brass, 0.032-inch aluminum, 0.032-inch or anodized aluminum, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
 2. Fasteners: Brass wire-link chain or beaded chain.
- B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
 1. Valve-tag schedule shall be included in operation and maintenance data.

2.6 WARNING TAGS

- A. Description: Preprinted or partially preprinted accident-prevention tags of plasticized card stock with matte finish suitable for writing.
 - 1. Size: Approximately 4 by 7 inches.
 - 2. Fasteners: Brass grommet and wire.
 - 3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
 - 4. Color: Safety-yellow background with black lettering.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 GENERAL INSTALLATION REQUIREMENTS

- A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- B. Coordinate installation of identifying devices with locations of access panels and doors.
- C. Install identifying devices before installing acoustical ceilings and similar concealment.

3.3 EQUIPMENT LABEL INSTALLATION

- A. Install or permanently fasten labels on each major item of mechanical equipment.
- B. Locate equipment labels where accessible and visible.

3.4 PIPE LABEL INSTALLATION

- A. Piping Color Coding: Painting of piping is specified in Section 099123 "Painting."
- B. Pipe Label Locations: Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
 - 1. Near each valve and control device.
 - 2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
 - 3. Near penetrations and on both sides of through walls, floors, ceilings, and inaccessible enclosures.

4. At access doors, manholes, and similar access points that permit view of concealed piping.
 5. Near major equipment items and other points of origination and termination.
 6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment.
 7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.
- C. Directional Flow Arrows: Arrows shall be used to indicate direction of flow in pipes, including pipes where flow is allowed in both directions.
- D. Pipe Label Color Schedule:
1. Heating Water Piping: White letters on a safety-green background.
 2. Refrigerant Piping: Black letters on a safety-white background.

3.5 DUCT LABEL INSTALLATION

- A. Install self-adhesive duct labels with permanent adhesive on air ducts in the following color codes:
1. Blue: For cold-air supply ducts.
 2. Yellow: For hot-air supply ducts.
 3. Green: For exhaust-, outside-, relief-, return-, and mixed-air ducts.
- B. Stenciled Duct Label Option: Stenciled labels showing service and flow direction may be provided instead of plastic-laminated duct labels, at Installer's option.
- C. Locate labels near points where ducts enter into and exit from concealed spaces and at maximum intervals of 50 feet in each space where ducts are exposed or concealed by removable ceiling system.

3.6 VALVE-TAG INSTALLATION

- A. Install tags on valves and control devices in piping systems, except check valves, valves within factory-fabricated equipment units, shutoff valves, faucets, convenience and lawn-watering hose connections, and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.
- B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:
1. Valve-Tag Size and Shape:
 - a. Refrigerant: 1-1/2 inches, round.
 - b. Hot Water: 1-1/2 inches, round.
 - c. Gas: 1-1/2 inches, round.
 2. Valve-Tag Colors:
 - a. Toxic and Corrosive Fluids: Black letters on a safety-orange background.
 - b. Potable and Other Water: White letters on a safety-green background.

- c. Defined by User: White letters on a safety-purple background, black letters on a safety-white background, white letters on a safety-gray background, and white letters on a safety-black background

3.7 WARNING-TAG INSTALLATION

- A. Write required message on, and attach warning tags to, equipment and other items where required.

END OF SECTION 230553

SECTION 230593
TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Balancing Air Systems:
 - a. Constant-volume air systems.
 - b. Multizone systems.
 - 2. Balancing Hydronic Piping Systems:
 - a. Primary-secondary hydronic systems.

1.3 DEFINITIONS

- A. AABC: Associated Air Balance Council.
- B. NEBB: National Environmental Balancing Bureau.
- C. TAB: Testing, adjusting, and balancing.
- D. TABB: Testing, Adjusting, and Balancing Bureau.
- E. TAB Specialist: An entity engaged to perform TAB Work.

1.4 ACTION SUBMITTALS

1.5 INFORMATIONAL SUBMITTALS

- A. Qualification Data: Within 30 days of Contractor's Notice to Proceed, submit documentation that the TAB contractor and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.
- B. Contract Documents Examination Report: Within 30 days of Contractor's Notice to Proceed, submit the Contract Documents review report as specified in Part 3.

- C. Strategies and Procedures Plan: Within 60 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures as specified in "Preparation" Article.
- D. Certified TAB reports.
- E. Sample report forms.
- F. Instrument calibration reports, to include the following:
 - 1. Instrument type and make.
 - 2. Serial number.
 - 3. Application.
 - 4. Dates of use.
 - 5. Dates of calibration.

1.6 QUALITY ASSURANCE

- A. TAB Contractor Qualifications: Engage a TAB entity certified by AABC, NEBB or TABB.
 - 1. TAB Field Supervisor: Employee of the TAB contractor and certified by AABC, NEBB or TABB.
 - 2. TAB Technician: Employee of the TAB contractor and who is certified by AABC, NEBB or TABB as a TAB technician.
- B. TAB Conference: Meet with Owner, Construction Manager, and Commissioning Authority on approval of the TAB strategies and procedures plan to develop a mutual understanding of the details. Require the participation of the TAB field supervisor and technicians. Provide seven days' advance notice of scheduled meeting time and location.
 - 1. Agenda Items:
 - a. The Contract Documents examination report.
 - b. The TAB plan.
 - c. Coordination and cooperation of trades and subcontractors.
 - d. Coordination of documentation and communication flow.
- C. Certify TAB field data reports and perform the following:
 - 1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
 - 2. Certify that the TAB team complied with the approved TAB plan and the procedures specified and referenced in this Specification.
- D. TAB Report Forms: Use standard TAB contractor's forms approved by Engineer of record and Commissioning Authority.
- E. Instrumentation Type, Quantity, Accuracy, and Calibration: As described in ASHRAE 111, Section 5, "Instrumentation."
- F. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."

- G. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.7.2.3 - "System Balancing."

1.7 PROJECT CONDITIONS

- A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.
- B. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

1.8 COORDINATION

- A. Notice: Provide seven days' advance notice for each test. Include scheduled test dates and times.
- B. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

PART 2 - PRODUCTS (Not Applicable)

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine the Contract Documents to become familiar with Project requirements and to discover conditions in systems' designs that may preclude proper TAB of systems and equipment.
- B. Examine systems for installed balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers. Verify that locations of these balancing devices are accessible.
- C. Examine the approved submittals for HVAC systems and equipment.
- D. Examine design data including HVAC system descriptions, statements of design assumptions for environmental conditions and systems' output, and statements of philosophies and assumptions about HVAC system and equipment controls.
- E. Examine ceiling plenums and underfloor air plenums used for supply, return, or relief air to verify that they meet the leakage class of connected ducts as specified in Section 233113 "Metal Ducts" and are properly separated from adjacent areas. Verify that penetrations in plenum walls are sealed and fire-stopped if required.
- F. Examine equipment performance data including fan and pump curves.

1. Relate performance data to Project conditions and requirements, including system effects that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.
 2. Calculate system-effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from the conditions used to rate equipment performance. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," or in SMACNA's "HVAC Systems - Duct Design." Compare results with the design data and installed conditions.
- G. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.
- H. Examine test reports specified in individual system and equipment Sections.
- I. Examine HVAC equipment and filters and verify that bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.
- J. Examine strainers. Verify that startup screens are replaced by permanent screens with indicated perforations.
- K. Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.
- L. Examine heat-transfer coils for correct piping connections and for clean and straight fins.
- M. Examine system pumps to ensure absence of entrained air in the suction piping.
- N. Examine operating safety interlocks and controls on HVAC equipment.
- O. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.2 PREPARATION

- A. Prepare a TAB plan that includes strategies and step-by-step procedures.
- B. Complete system-readiness checks and prepare reports. Verify the following:
1. Permanent electrical-power wiring is complete.
 2. Hydronic systems are filled, clean, and free of air.
 3. Automatic temperature-control systems are operational.
 4. Equipment and duct access doors are securely closed.
 5. Balance, smoke, and fire dampers are open.
 6. Isolating and balancing valves are open and control valves are operational.
 7. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.
 8. Windows and doors can be closed so indicated conditions for system operations can be met.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

- A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Total System Balance", ASHRAE 111, NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems" and SMACNA's "HVAC Systems - Testing, Adjusting, and Balancing" and in this Section.
 - 1. Comply with requirements in ASHRAE 62.1, Section 7.2.2 - "Air Balancing."
- B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.
 - 1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.
 - 2. After testing and balancing, install test ports and duct access doors that comply with requirements in Section 233300 "Air Duct Accessories."
 - 3. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Section 230713 "Duct Insulation," and Section 230719 "HVAC Piping Insulation."
- C. Mark equipment and balancing devices, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, with paint or other suitable, permanent identification material to show final settings.
- D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.4 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

- A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.
- B. Prepare schematic diagrams of systems' "as-built" duct layouts.
- C. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.
- D. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.
- E. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.
- F. Verify that motor starters are equipped with properly sized thermal protection.
- G. Check dampers for proper position to achieve desired airflow path.
- H. Check for airflow blockages.
- I. Check condensate drains for proper connections and functioning.
- J. Check for proper sealing of air-handling-unit components.

- K. Verify that air duct system is sealed as specified in Section 233113 "Metal Ducts."

3.5 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

- A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
 - 1. Measure total airflow.
 - a. Where sufficient space in ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow.
 - 2. Measure fan static pressures as follows to determine actual static pressure:
 - a. Measure outlet static pressure as far downstream from the fan as practical and upstream from restrictions in ducts such as elbows and transitions.
 - b. Measure static pressure directly at the fan outlet or through the flexible connection.
 - c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from the flexible connection, and downstream from duct restrictions.
 - d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.
 - 3. Measure static pressure across each component that makes up an air-handling unit and -treating equipment.
 - a. Report the cleanliness status of filters and the time static pressures are measured.
 - 4. Measure static pressures entering and leaving other devices, such as sound traps, heat-recovery equipment, and air washers, under final balanced conditions.
 - 5. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.
 - 6. Obtain approval from Engineer of Record for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in HVAC Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.
 - 7. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.
- B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.
 - 1. Measure airflow of submain and branch ducts.

- a. Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.
 2. Measure static pressure at a point downstream from the balancing damper, and adjust volume dampers until the proper static pressure is achieved.
 3. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.
- C. Measure air outlets and inlets without making adjustments.
1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.
- D. Adjust air outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using branch volume dampers rather than extractors and the dampers at air terminals.
1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.
 2. Adjust patterns of adjustable outlets for proper distribution without drafts.

3.6 GENERAL PROCEDURES FOR HYDRONIC SYSTEMS

- A. Prepare test reports with pertinent design data, and number in sequence starting at pump to end of system. Check the sum of branch-circuit flows against the approved pump flow rate. Correct variations that exceed plus or minus 5 percent.
- B. Prepare schematic diagrams of systems' "as-built" piping layouts.
- C. Prepare hydronic systems for testing and balancing according to the following, in addition to the general preparation procedures specified above:
 1. Open all manual valves for maximum flow.
 2. Check liquid level in expansion tank.
 3. Check makeup water-station pressure gage for adequate pressure for highest vent.
 4. Check flow-control valves for specified sequence of operation, and set at indicated flow.
 5. Set differential-pressure control valves at the specified differential pressure. Do not set at fully closed position when pump is positive-displacement type unless several terminal valves are kept open.
 6. Set system controls so automatic valves are wide open to heat exchangers.
 7. Check pump-motor load. If motor is overloaded, throttle main flow-balancing device so motor nameplate rating is not exceeded.
 8. Check air vents for a forceful liquid flow exiting from vents when manually operated.

3.7 PROCEDURES FOR PRIMARY-SECONDARY HYDRONIC SYSTEMS

- A. Balance the primary circuit flow first and then balance the secondary circuits.

3.8 PROCEDURES FOR MOTORS

A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:

1. Manufacturer's name, model number, and serial number.
2. Motor horsepower rating.
3. Motor rpm.
4. Efficiency rating.
5. Nameplate and measured voltage, each phase.
6. Nameplate and measured amperage, each phase.
7. Starter thermal-protection-element rating.

B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass of the controller to prove proper operation. Record observations including name of controller manufacturer, model number, serial number, and nameplate data.

3.9 PROCEDURES FOR BOILERS

A. Hydronic Boilers: Measure and record entering- and leaving-water temperatures and water flow.

3.10 PROCEDURES FOR HEAT-TRANSFER COILS

A. Measure, adjust, and record the following data for each water coil:

1. Entering- and leaving-water temperature.
2. Water flow rate.
3. Water pressure drop.
4. Dry-bulb temperature of entering and leaving air.
5. Wet-bulb temperature of entering and leaving air for cooling coils.
6. Airflow.
7. Air pressure drop.

B. Measure, adjust, and record the following data for each electric heating coil:

1. Nameplate data.
2. Airflow.
3. Entering- and leaving-air temperature at full load.
4. Voltage and amperage input of each phase at full load and at each incremental stage.
5. Calculated kilowatt at full load.
6. Fuse or circuit-breaker rating for overload protection.

C. Measure, adjust, and record the following data for each refrigerant coil:

1. Dry-bulb temperature of entering and leaving air.
2. Wet-bulb temperature of entering and leaving air.
3. Airflow.
4. Air pressure drop.
5. Refrigerant suction pressure and temperature.

3.11 TOLERANCES

- A. Set HVAC system's air flow rates and water flow rates within the following tolerances:
 - 1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 5 percent.
 - 2. Air Outlets and Inlets: Plus or minus 5 percent.
 - 3. Heating-Water Flow Rate: Plus or minus 5 percent.

3.12 REPORTING

- A. Initial Construction-Phase Report: Based on examination of the Contract Documents as specified in "Examination" Article, prepare a report on the adequacy of design for systems' balancing devices. Recommend changes and additions to systems' balancing devices to facilitate proper performance measuring and balancing. Recommend changes and additions to HVAC systems and general construction to allow access for performance measuring and balancing devices.
- B. Status Reports: Prepare monthly progress reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.13 FINAL REPORT

- A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.
 - 1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
 - 2. Include a list of instruments used for procedures, along with proof of calibration.
- B. Final Report Contents: In addition to certified field-report data, include the following:
 - 1. Pump curves.
 - 2. Fan curves.
 - 3. Manufacturers' test data.
 - 4. Field test reports prepared by system and equipment installers.
 - 5. Other information relative to equipment performance; do not include Shop Drawings and product data.
- C. General Report Data: In addition to form titles and entries, include the following data:
 - 1. Title page.
 - 2. Name and address of the TAB contractor.
 - 3. Project name.
 - 4. Project location.
 - 5. Architect's name and address.
 - 6. Engineer's name and address.
 - 7. Contractor's name and address.

8. Report date.
 9. Signature of TAB supervisor who certifies the report.
 10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
 11. Summary of contents including the following:
 - a. Indicated versus final performance.
 - b. Notable characteristics of systems.
 - c. Description of system operation sequence if it varies from the Contract Documents.
 12. Nomenclature sheets for each item of equipment.
 13. Data for terminal units, including manufacturer's name, type, size, and fittings.
 14. Notes to explain why certain final data in the body of reports vary from indicated values.
 15. Test conditions for fans and pump performance forms including the following:
 - a. Settings for outdoor-, return-, and exhaust-air dampers.
 - b. Conditions of filters.
 - c. Cooling coil, wet- and dry-bulb conditions.
 - d. Face and bypass damper settings at coils.
 - e. Fan drive settings including settings and percentage of maximum pitch diameter.
 - f. Inlet vane settings for variable-air-volume systems.
 - g. Settings for supply-air, static-pressure controller.
 - h. Other system operating conditions that affect performance.
- D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:
1. Quantities of outdoor, supply, return, and exhaust airflows.
 2. Water and steam flow rates.
 3. Duct, outlet, and inlet sizes.
 4. Pipe and valve sizes and locations.
 5. Terminal units.
 6. Balancing stations.
 7. Position of balancing devices.
- E. Air-Handling-Unit Test Reports: For air-handling units with coils, include the following:
1. Unit Data:
 - a. Unit identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and unit size.
 - e. Manufacturer's serial number.
 - f. Unit arrangement and class.
 - g. Discharge arrangement.
 - h. Sheave make, size in inches, and bore.
 - i. Center-to-center dimensions of sheave, and amount of adjustments in inches.
 - j. Number, make, and size of belts.
 - k. Number, type, and size of filters.

2. Motor Data:
 - a. Motor make, and frame type and size.
 - b. Horsepower and rpm.
 - c. Volts, phase, and hertz.
 - d. Full-load amperage and service factor.
 - e. Sheave make, size in inches, and bore.
 - f. Center-to-center dimensions of sheave, and amount of adjustments in inches.

3. Test Data (Indicated and Actual Values):
 - a. Total air flow rate in cfm.
 - b. Total system static pressure in inches wg.
 - c. Fan rpm.
 - d. Discharge static pressure in inches wg.
 - e. Filter static-pressure differential in inches wg.
 - f. Preheat-coil static-pressure differential in inches wg.
 - g. Cooling-coil static-pressure differential in inches wg.
 - h. Heating-coil static-pressure differential in inches wg.
 - i. Outdoor airflow in cfm.
 - j. Return airflow in cfm.
 - k. Outdoor-air damper position.
 - l. Return-air damper position.
 - m. Vortex damper position.

F. Apparatus-Coil Test Reports:

1. Coil Data:
 - a. System identification.
 - b. Location.
 - c. Coil type.
 - d. Number of rows.
 - e. Fin spacing in fins per inch o.c.
 - f. Make and model number.
 - g. Face area in sq. ft..
 - h. Tube size in NPS.
 - i. Tube and fin materials.
 - j. Circuiting arrangement.
2. Test Data (Indicated and Actual Values):
 - a. Air flow rate in cfm.
 - b. Average face velocity in fpm.
 - c. Air pressure drop in inches wg.
 - d. Outdoor-air, wet- and dry-bulb temperatures in deg F.
 - e. Return-air, wet- and dry-bulb temperatures in deg F.
 - f. Entering-air, wet- and dry-bulb temperatures in deg F.
 - g. Leaving-air, wet- and dry-bulb temperatures in deg F.
 - h. Water flow rate in gpm.
 - i. Water pressure differential in feet of head or psig.

- j. Entering-water temperature in deg F.
- k. Leaving-water temperature in deg F.
- l. Refrigerant expansion valve and refrigerant types.
- m. Refrigerant suction pressure in psig.
- n. Refrigerant suction temperature in deg F.

G. Gas- Fired Heat Apparatus Test Reports: In addition to manufacturer's factory startup equipment reports, include the following:

- 1. Unit Data:
 - a. System identification.
 - b. Location.
 - c. Make and type.
 - d. Model number and unit size.
 - e. Manufacturer's serial number.
 - f. Fuel type in input data.
 - g. Output capacity in Btu/h.
 - h. Ignition type.
 - i. Burner-control types.
 - j. Motor horsepower and rpm.
 - k. Motor volts, phase, and hertz.
 - l. Motor full-load amperage and service factor.
 - m. Sheave make, size in inches, and bore.
 - n. Center-to-center dimensions of sheave, and amount of adjustments in inches.
- 2. Test Data (Indicated and Actual Values):
 - a. Total air flow rate in cfm.
 - b. Entering-air temperature in deg F.
 - c. Leaving-air temperature in deg F.
 - d. Air temperature differential in deg F.
 - e. Entering-air static pressure in inches wg.
 - f. Leaving-air static pressure in inches wg.
 - g. Air static-pressure differential in inches wg.
 - h. Low-fire fuel input in Btu/h.
 - i. High-fire fuel input in Btu/h.
 - j. Manifold pressure in psig.
 - k. High-temperature-limit setting in deg F.
 - l. Operating set point in Btu/h.
 - m. Motor voltage at each connection.
 - n. Motor amperage for each phase.
 - o. Heating value of fuel in Btu/h.

H. Fan Test Reports: For supply, return, and exhaust fans, include the following:

- 1. Fan Data:
 - a. System identification.
 - b. Location.
 - c. Make and type.

- d. Model number and size.
 - e. Manufacturer's serial number.
 - f. Arrangement and class.
 - g. Sheave make, size in inches, and bore.
 - h. Center-to-center dimensions of sheave, and amount of adjustments in inches.
2. Motor Data:
- a. Motor make, and frame type and size.
 - b. Horsepower and rpm.
 - c. Volts, phase, and hertz.
 - d. Full-load amperage and service factor.
 - e. Sheave make, size in inches, and bore.
 - f. Center-to-center dimensions of sheave, and amount of adjustments in inches.
 - g. Number, make, and size of belts.
3. Test Data (Indicated and Actual Values):
- a. Total airflow rate in cfm.
 - b. Total system static pressure in inches wg.
 - c. Fan rpm.
 - d. Discharge static pressure in inches wg.
 - e. Suction static pressure in inches wg.
- I. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:
1. Report Data:
- a. System and air-handling-unit number.
 - b. Location and zone.
 - c. Traverse air temperature in deg F.
 - d. Duct static pressure in inches wg.
 - e. Duct size in inches.
 - f. Duct area in sq. ft..
 - g. Indicated air flow rate in cfm.
 - h. Indicated velocity in fpm.
 - i. Actual air flow rate in cfm.
 - j. Actual average velocity in fpm.
 - k. Barometric pressure in psig.
- J. Air-Terminal-Device Reports:
1. Unit Data:
- a. System and air-handling unit identification.
 - b. Location and zone.
 - c. Apparatus used for test.
 - d. Area served.
 - e. Make.
 - f. Number from system diagram.

- g. Type and model number.
- h. Size.
- i. Effective area in sq. ft..

2. Test Data (Indicated and Actual Values):

- a. Air flow rate in cfm.
- b. Air velocity in fpm.
- c. Preliminary air flow rate as needed in cfm.
- d. Preliminary velocity as needed in fpm.
- e. Final air flow rate in cfm.
- f. Final velocity in fpm.
- g. Space temperature in deg F.

K. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves and include the following:

1. Unit Data:

- a. Unit identification.
- b. Location.
- c. Service.
- d. Make and size.
- e. Model number and serial number.
- f. Water flow rate in gpm.
- g. Water pressure differential in feet of head or psig.
- h. Required net positive suction head in feet of head or psig.
- i. Pump rpm.
- j. Impeller diameter in inches.
- k. Motor make and frame size.
- l. Motor horsepower and rpm.
- m. Voltage at each connection.
- n. Amperage for each phase.
- o. Full-load amperage and service factor.
- p. Seal type.

2. Test Data (Indicated and Actual Values):

- a. Static head in feet of head or psig.
- b. Pump shutoff pressure in feet of head or psig.
- c. Actual impeller size in inches.
- d. Full-open flow rate in gpm.
- e. Full-open pressure in feet of head or psig.
- f. Final discharge pressure in feet of head or psig.
- g. Final suction pressure in feet of head or psig.
- h. Final total pressure in feet of head or psig.
- i. Final water flow rate in gpm.
- j. Voltage at each connection.
- k. Amperage for each phase.

L. Instrument Calibration Reports:

1. Report Data:
 - a. Instrument type and make.
 - b. Serial number.
 - c. Application.
 - d. Dates of use.
 - e. Dates of calibration.

3.14 INSPECTIONS

A. Initial Inspection:

1. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the final report.
2. Check the following for each system:
 - a. Measure airflow of at least 5 percent of air outlets.
 - b. Measure water flow of at least 5 percent of terminals.
 - c. Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.
 - d. Verify that balancing devices are marked with final balance position.
 - e. Note deviations from the Contract Documents in the final report.

B. Final Inspection:

1. After initial inspection is complete and documentation by random checks verifies that testing and balancing are complete and accurately documented in the final report, request that a final inspection be made by Construction Manager and Commissioning Authority.
2. The TAB contractor's test and balance engineer shall conduct the inspection in the presence of Construction Manager and Commissioning Authority.
3. Construction Manager and Commissioning Authority shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.
4. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."
5. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.

C. TAB Work will be considered defective if it does not pass final inspections. If TAB Work fails, proceed as follows:

1. Recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.

2. If the second final inspection also fails, Owner may contract the services of another TAB contractor to complete TAB Work according to the Contract Documents and deduct the cost of the services from the original TAB contractor's final payment.

D. Prepare test and inspection reports.

3.15 ADDITIONAL TESTS

- A. Within 90 days of completing TAB, perform additional TAB to verify that balanced conditions are being maintained throughout and to correct unusual conditions.
- B. Seasonal Periods: If initial TAB procedures were not performed during near-peak summer and winter conditions, perform additional TAB during near-peak summer and winter conditions.

END OF SECTION 230593

SECTION 230713
DUCT INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes insulating the following duct services:
 - 1. Indoor, concealed supply, return and outdoor air.
 - 2. Indoor, exposed supply, return and outdoor air.
 - 3. Indoor, concealed exhaust between isolation damper and penetration of building exterior.
- B. Related Sections:
 - 1. Section 230719 "HVAC Piping Insulation."
 - 2. Section 233113 "Metal Ducts" for duct liners.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied if any).
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
 - 2. Detail insulation application at elbows, fittings, dampers, specialties and flanges for each type of insulation.
 - 3. Detail application of field-applied jackets.
 - 4. Detail application at linkages of control devices.
- C. Samples: For each type of insulation and jacket indicated. Identify each Sample, describing product and intended use. Sample sizes are as follows:
 - 1. Sheet Form Insulation Materials: 12 inches square.
 - 2. Sheet Jacket Materials: 12 inches square.
 - 3. Manufacturer's Color Charts: For products where color is specified, show the full range of colors available for each type of finish material.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.
- B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.
- C. Field quality-control reports.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
 - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
 - 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.7 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."
- B. Coordinate clearance requirements with duct Installer for duct insulation application. Before preparing ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.
- C. Coordinate installation and testing of heat tracing.

1.8 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

- A. Comply with requirements in "Duct Insulation Schedule, General," "Indoor Duct and Plenum Insulation Schedule," and "Aboveground, Outdoor Duct and Plenum Insulation Schedule" articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- F. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type II for sheet materials.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Aeroflex USA, Inc.
 - b. Armacell LLC.
 - c. K-Flex USA.
- G. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type III with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. CertainTeed Corporation.
 - b. Johns Manville; a Berkshire Hathaway company.
 - c. Owens Corning.

- H. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. For duct and plenum applications, provide insulation with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. CertainTeed Corporation.
 - b. Johns Manville; a Berkshire Hathaway company.
 - c. Owens Corning.

- I. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied ASJ complying with ASTM C 1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C 612, Type IB. Nominal density is 2.5 lb/cu. ft. or more. Thermal conductivity (k-value) at 100 deg F is 0.29 Btu x in./h x sq. ft. x deg F or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. CertainTeed Corporation.
 - b. Johns Manville; a Berkshire Hathaway company.
 - c. Owens Corning.

2.2 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

- B. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Aeroflex USA, Inc.
 - b. Armacell LLC.
 - c. K-Flex USA.

 - 2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

- C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. Eagle Bridges - Marathon Industries.

- c. Foster Brand; H. B. Fuller Construction Products.
- 2. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- D. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. Eagle Bridges - Marathon Industries.
 - c. Foster Brand; H. B. Fuller Construction Products.
 - 2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.3 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
 - 1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. Eagle Bridges - Marathon Industries.
 - c. Knauf Insulation.
 - 2. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
 - 3. Service Temperature Range: Minus 20 to plus 180 deg F.
 - 4. Solids Content: 60 percent by volume and 66 percent by weight.
 - 5. Color: White.

2.4 SEALANTS

- A. FSK and Metal Jacket Flashing Sealants:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. Eagle Bridges - Marathon Industries.
 - c. Foster Brand; H. B. Fuller Construction Products.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: Aluminum.
6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. ASJ Flashing Sealants, and Vinyl Jacket Flashing Sealants:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: White.
6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.5 FACTORY-APPLIED JACKETS

- A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
 2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
 3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
 4. FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C 1136, Type II.
 5. Vinyl Jacket: White vinyl with a permeance of 1.3 perms when tested according to ASTM E 96/E 96M, Procedure A, and complying with NFPA 90A and NFPA 90B.
- B. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
- C. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.
- D. Metal Jacket:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ITW Insulation Systems; Illinois Tool Works, Inc.
 - b. RPR Products, Inc.

2. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.
 - a. Sheet and roll stock ready for shop or field sizing.
 - b. Finish and thickness are indicated in field-applied jacket schedules.
 - c. Moisture Barrier for Indoor Applications: 1-mil-thick, heat-bonded polyethylene and kraft paper.
 - d. Moisture Barrier for Outdoor Applications: 3-mil-thick, heat-bonded polyethylene and kraft paper.

E. Self-Adhesive Outdoor Jacket: 60-mil-thick, laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a rubberized bituminous resin on a crosslaminated polyethylene film covered with white aluminum-foil facing.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Polyguard Products, Inc.

2.6 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Avery Dennison Corporation, Specialty Tapes Division.
 - b. Ideal Tape Co., Inc., an American Biltrite Company.
 - c. Knauf Insulation.
2. Width: 3 inches.
3. Thickness: 11.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Avery Dennison Corporation, Specialty Tapes Division.
 - b. Ideal Tape Co., Inc., an American Biltrite Company.
 - c. Knauf Insulation.
2. Width: 3 inches.

3. Thickness: 6.5 mils.
4. Adhesion: 90 ounces force/inch in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch in width.
7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

C. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Avery Dennison Corporation, Specialty Tapes Division.
 - b. Ideal Tape Co., Inc., an American Biltrite Company.
 - c. Knauf Insulation.
2. Width: 2 inches.
3. Thickness: 3.7 mils.
4. Adhesion: 100 ounces force/inch in width.
5. Elongation: 5 percent.
6. Tensile Strength: 34 lbf/inch in width.

2.7 SECUREMENTS

A. Bands:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ITW Insulation Systems; Illinois Tool Works, Inc.
 - b. RPR Products, Inc.
2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316; 0.015 inch thick, 1/2 inch wide with wing seal or closed seal.
3. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide with wing seal or closed seal.
4. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.

B. Insulation Pins and Hangers:

1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.135-inch-diameter shank, length to suit depth of insulation indicated.
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) AGM Industries, Inc.
 - 2) Gemco.
 - 3) Hardcast, Inc.

2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.135-inch-diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch galvanized carbon-steel washer.
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) AGM Industries, Inc.
 - 2) Gemco.
 - 3) Hardcast, Inc.

3. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) AGM Industries, Inc.
 - 2) Gemco.
 - 3) Midwest Fasteners, Inc.
 - b. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
 - c. Spindle: Aluminum or Stainless steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
 - d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

4. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Gemco.
 - 2) Midwest Fasteners, Inc.
 - b. Baseplate: Perforated, nylon sheet, 0.030 inch thick by 1-1/2 inches in diameter.
 - c. Spindle: Nylon, 0.106-inch-diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches.
 - d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

5. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) AGM Industries, Inc.
 - 2) Gemco.
 - 3) Hardcast, Inc.
 - b. Baseplate: Galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
 - c. Spindle: Aluminum or Stainless steel, fully annealed, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
 - d. Adhesive-backed base with a peel-off protective cover.
 6. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick, aluminum or stainless-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) AGM Industries, Inc.
 - 2) Gemco.
 - 3) Hardcast, Inc.
 - b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.
 7. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
 - a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1) Gemco.
 - 2) Midwest Fasteners, Inc.
- C. Staples: Outward-clinching insulation staples, nominal 3/4-inch-wide, stainless steel or Monel.
- D. Wire: 0.062-inch soft-annealed, stainless steel.
1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. C & F Wire.

2.8 CORNER ANGLES

- A. Aluminum Corner Angles: 0.040 inch thick, minimum 1 by 1 inch, aluminum according to ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14.
- B. Stainless-Steel Corner Angles: 0.024 inch thick, minimum 1 by 1 inch, stainless steel according to ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
 - 1. Verify that systems to be insulated have been tested and are free of defects.
 - 2. Verify that surfaces to be insulated are clean and dry.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of ducts and fittings.
- B. Install insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each item of duct system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Keep insulation materials dry during application and finishing.
- G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- H. Install insulation with least number of joints practical.

- I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 - 1. Install insulation continuously through hangers and around anchor attachments.
 - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
 - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
- J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- K. Install insulation with factory-applied jackets as follows:
 - 1. Draw jacket tight and smooth.
 - 2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
 - 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches o.c.
 - a. For below ambient services, apply vapor-barrier mastic over staples.
 - 4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
 - 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct flanges and fittings.
- L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

3.4 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
 - 1. Seal penetrations with flashing sealant.
 - 2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.

3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
 4. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
1. Seal penetrations with flashing sealant.
 2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
 4. Seal jacket to wall flashing with flashing sealant.
- C. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- D. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.
1. Comply with requirements in Section 078413 "Penetration Firestopping" firestopping and fire-resistive joint sealers.
- E. Insulation Installation at Floor Penetrations:
1. Duct: For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least 2 inches.
 2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."
- 3.5 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION
- A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- 3.6 INSTALLATION OF MINERAL-FIBER INSULATION
- A. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
 2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.

3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
 - a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
 - b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
 - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
 - d. Do not overcompress insulation during installation.
 - e. Impale insulation over pins and attach speed washers.
 - f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
 4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
 - a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
 - b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.
 5. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.
 6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
 7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch-wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.
- B. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces.
 2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
 3. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

- a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
 - b. On duct sides with dimensions larger than 18 inches, space pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
 - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
 - d. Do not overcompress insulation during installation.
 - e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
4. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing 2 inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward-clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
 - a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
 - b. Install vapor stops for ductwork and plenums operating below 50 deg F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two times the insulation thickness, but not less than 3 inches.
 5. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
 6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch-wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

3.7 FIELD-APPLIED JACKET INSTALLATION

- A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.
 1. Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.
 2. Embed glass cloth between two 0.062-inch-thick coats of lagging adhesive.
 3. Completely encapsulate insulation with coating, leaving no exposed insulation.
- B. Where FSK jackets are indicated, install as follows:
 1. Draw jacket material smooth and tight.
 2. Install lap or joint strips with same material as jacket.
 3. Secure jacket to insulation with manufacturer's recommended adhesive.

4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch-wide joint strips at end joints.
 5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.
- C. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

3.8 FINISHES

- A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 099123 "Painting."
1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
 - a. Finish Coat Material: Interior, flat, latex-emulsion size.
- B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.
- C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.
- D. Do not field paint aluminum or stainless-steel jackets.

3.9 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Perform tests and inspections.
- C. Tests and Inspections:
1. Inspect ductwork, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location(s) for each duct system defined in the "Duct Insulation Schedule, General" Article.
- D. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.10 DUCT INSULATION SCHEDULE, GENERAL

- A. Plenums and Ducts Requiring Insulation:
1. Indoor, concealed supply and outdoor air.

2. Indoor, exposed supply and outdoor air.
3. Indoor, concealed return located in unconditioned space.
4. Indoor, exposed return located in unconditioned space.
5. Indoor, concealed exhaust between isolation damper and penetration of building exterior.

B. Items Not Insulated:

1. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
2. Factory-insulated flexible ducts.
3. Factory-insulated plenums and casings.
4. Flexible connectors.
5. Vibration-control devices.
6. Factory-insulated access panels and doors.

3.11 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Concealed, round and flat-oval, supply-air duct insulation shall be one of the following:

1. Flexible Elastomeric: 1 inch thick.
2. Mineral-Fiber Blanket: 1-1/2 inches thick and 1.5-lb/cu. ft. nominal density.
3. Mineral-Fiber Board: 1-1/2 inches thick and 3-lb/cu. ft. nominal density.

B. Concealed, round and flat-oval, return-air duct insulation shall be one of the following:

1. Flexible Elastomeric: 1 inch thick.
2. Mineral-Fiber Blanket: 1-1/2 inches thick and 1.5-lb/cu. ft. nominal density.
3. Mineral-Fiber Board: 1-1/2 inches thick and 3-lb/cu. ft. nominal density.

C. Concealed, round and flat-oval, outdoor-air duct insulation shall be one of the following:

1. Flexible Elastomeric: 1 inch thick.
2. Mineral-Fiber Blanket: 1-1/2 inches thick and 1.5-lb/cu. ft. nominal density.
3. Mineral-Fiber Board: 1-1/2 inches thick and 3-lb/cu. ft. nominal density.

D. Concealed, round and flat-oval, exhaust-air duct insulation shall be one of the following:

1. Flexible Elastomeric: 1 inch thick.
2. Mineral-Fiber Blanket: 1-1/2 inches thick and 1.5-lb/cu. ft. nominal density.
3. Mineral-Fiber Board: 1-1/2 inches thick and 3-lb/cu. ft. nominal density.

E. Concealed, rectangular, supply-air duct insulation shall be one of the following:

1. Flexible Elastomeric: 1 inch thick.
2. Mineral-Fiber Blanket: 1-1/2 inches thick and 1.5-lb/cu. ft. nominal density.
3. Mineral-Fiber Board: 1-1/2 inches thick and 3-lb/cu. ft. nominal density.

F. Concealed, rectangular, return-air duct insulation shall be one of the following:

1. Flexible Elastomeric: 1 inch thick.
2. Mineral-Fiber Blanket: 1-1/2 inches thick and 1.5-lb/cu. ft. nominal density.
3. Mineral-Fiber Board: 1-1/2 inches thick and 3-lb/cu. ft. nominal density.

- G. Concealed, rectangular, outdoor-air duct insulation shall be one of the following:
 - 1. Flexible Elastomeric: 1 inch thick.
 - 2. Mineral-Fiber Blanket: 1-1/2 inches thick and 1.5-lb/cu. ft. nominal density.
 - 3. Mineral-Fiber Board: 1-1/2 inches thick and 3-lb/cu. ft. nominal density.

- H. Concealed, rectangular, exhaust-air duct insulation between isolation damper and penetration of building exterior shall be one of the following:
 - 1. Flexible Elastomeric: 1 inch thick.
 - 2. Mineral-Fiber Blanket: 1-1/2 inches thick and 1.5-lb/cu. ft. nominal density.
 - 3. Mineral-Fiber Board: 1-1/2 inches thick and 3-lb/cu. ft. nominal density.

- I. Concealed, supply-air plenum insulation shall be one of the following:
 - 1. Flexible Elastomeric: 1 inch thick.
 - 2. Mineral-Fiber Blanket: 1-1/2 inches thick and 1.5-lb/cu. ft. nominal density.
 - 3. Mineral-Fiber Board: 1-1/2 inches thick and 3-lb/cu. ft. nominal density.

- J. Concealed, return-air plenum insulation shall be one of the following:
 - 1. Flexible Elastomeric: 1 inch thick.
 - 2. Mineral-Fiber Blanket: 1-1/2 inches thick and 1.5-lb/cu. ft. nominal density.
 - 3. Mineral-Fiber Board: 1-1/2 inches thick and 3-lb/cu. ft. nominal density.

- K. Concealed, outdoor-air plenum insulation shall be one of the following:
 - 1. Flexible Elastomeric: 1 inch thick.
 - 2. Mineral-Fiber Blanket: 1-1/2 inches thick and 1.5-lb/cu. ft. nominal density.
 - 3. Mineral-Fiber Board: 1-1/2 inches thick and 3-lb/cu. ft. nominal density.

- L. Exposed, round and flat-oval, supply-air duct insulation shall be one of the following:
 - 1. Mineral-Fiber Blanket: 2 inches thick and 3-lb/cu. ft. nominal density.
 - 2. Mineral-Fiber Board: 2 inches thick and 6-lb/cu. ft. nominal density.
 - 3. Mineral-Fiber Pipe and Tank: 2 inches thick.

- M. Exposed, round and flat-oval, return-air duct insulation shall be one of the following:
 - 1. Mineral-Fiber Blanket: 2 inches thick and 3-lb/cu. ft. nominal density.
 - 2. Mineral-Fiber Board: 2 inches thick and 6-lb/cu. ft. nominal density.
 - 3. Mineral-Fiber Pipe and Tank: 2 inches thick.

- N. Exposed, round and flat-oval, outdoor-air duct insulation shall be one of the following:
 - 1. Mineral-Fiber Blanket: 2 inches thick and 3-lb/cu. ft. nominal density.
 - 2. Mineral-Fiber Board: 2 inches thick and 6-lb/cu. ft. nominal density.
 - 3. Mineral-Fiber Pipe and Tank: 2 inches thick.

- O. Exposed, rectangular, supply-air duct insulation shall be one of the following:
 - 1. Mineral-Fiber Blanket: 2 inches thick and 3-lb/cu. ft. nominal density.
 - 2. Mineral-Fiber Board: 2 inches thick and 6-lb/cu. ft. nominal density.

- P. Exposed, rectangular, return-air duct insulation shall be one of the following:

1. Mineral-Fiber Blanket: 2 inches thick and 3-lb/cu. ft. nominal density.
2. Mineral-Fiber Board: 2 inches thick and 6-lb/cu. ft. nominal density.

Q. Exposed, rectangular, outdoor-air duct insulation shall be one of the following:

1. Mineral-Fiber Blanket: 2 inches thick and 3-lb/cu. ft. nominal density.
2. Mineral-Fiber Board: 2 inches thick and 6-lb/cu. ft. nominal density.

R. Exposed, supply-air plenum insulation shall be one of the following:

1. Mineral-Fiber Blanket: 2 inches thick and 3-lb/cu. ft. nominal density.
2. Mineral-Fiber Board: 2 inches thick and 6-lb/cu. ft. nominal density.

S. Exposed, outdoor-air plenum insulation shall be one of the following:

1. Mineral-Fiber Blanket: 2 inches thick and 3-lb/cu. ft. nominal density.
2. Mineral-Fiber Board: 2 inches thick and 6-lb/cu. ft. nominal density.

3.12 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Ducts and Plenums, Concealed:

1. Aluminum, Smooth or Corrugated: 0.024 inch thick.

D. Ducts and Plenums, Exposed:

1. Aluminum, Smooth or Corrugated: 0.024 inch thick.

END OF SECTION 230713

SECTION 230719
HVAC PIPING INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes insulating the following HVAC piping systems:
 - 1. Condensate drain piping, indoors.
 - 2. Heating hot-water piping, indoors and outdoors.
 - 3. Refrigerant suction and hot-gas piping, indoors and outdoors.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied if any).
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
 - 2. Detail insulation application at pipe expansion joints for each type of insulation.
 - 3. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
 - 4. Detail removable insulation at piping specialties.
 - 5. Detail application of field-applied jackets.
 - 6. Detail application at linkages of control devices.
- C. Samples: For each type of insulation and jacket indicated. Identify each Sample, describing product and intended use.
 - 1. Preformed Pipe Insulation Materials: 12 inches long by NPS 2.
 - 2. Sheet Form Insulation Materials: 12 inches square.
 - 3. Jacket Materials for Pipe: 12 inches long by NPS 2.
 - 4. Sheet Jacket Materials: 12 inches square.
 - 5. Manufacturer's Color Charts: For products where color is specified, show the full range of colors available for each type of finish material.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer.

- B. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.
- C. Field quality-control reports.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.
 - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
 - 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.7 COORDINATION

- A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."
- B. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.
- C. Coordinate installation and testing of heat tracing.

1.8 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

- A. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and "Outdoor, Underground Piping Insulation Schedule" articles for where insulating materials shall be applied.
- B. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.
- D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- F. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Pittsburgh Corning Corporation.
 - 2. Block Insulation: ASTM C 552, Type I.
 - 3. Special-Shaped Insulation: ASTM C 552, Type III.
 - 4. Board Insulation: ASTM C 552, Type IV.
 - 5. Preformed Pipe Insulation without Jacket: Comply with ASTM C 552, Type II, Class 1.
 - 6. Preformed Pipe Insulation with Factory-Applied ASJ: Comply with ASTM C 552, Type II, Class 2.
 - 7. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.
- G. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Aeroflex USA, Inc.
 - b. Armacell LLC.
 - c. K-Flex USA.

- H. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290,III with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. CertainTeed Corporation.
 - b. Johns Manville; a Berkshire Hathaway company.
 - c. Owens Corning.
- I. Mineral-Fiber, Preformed Pipe Insulation:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Johns Manville; a Berkshire Hathaway company.
 - b. Knauf Insulation.
 - c. Owens Corning.
- J. Mineral-Fiber, Pipe Insulation Wicking System: Preformed pipe insulation complying with ASTM C 547, Type I, Grade A, with absorbent cloth factory-applied to the entire inside surface of preformed pipe insulation and extended through the longitudinal joint to outside surface of insulation under insulation jacket. Factory apply a white, polymer, vapor-retarder jacket with self-sealing adhesive tape seam and evaporation holes running continuously along the longitudinal seam, exposing the absorbent cloth.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Owens Corning.
- K. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied FSK jacket complying with ASTM C 1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C 612, Type IB. Nominal density is 2.5 lb/cu. ft. or more. Thermal conductivity (k-value) at 100 deg F is 0.29 Btu x in./h x sq. ft. x deg F or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. CertainTeed Corporation.
 - b. Johns Manville; a Berkshire Hathaway company.
 - c. Owens Corning.

2.2 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.

- B. Cellular-Glass Adhesive: Two-component, thermosetting urethane adhesive containing no flammable solvents, with a service temperature range of minus 100 to plus 200 deg F.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Foster Brand; H. B. Fuller Construction Products.
 - 2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- C. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Aeroflex USA, Inc.
 - b. Armacell LLC.
 - c. K-Flex USA.
 - 2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- D. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. Eagle Bridges - Marathon Industries.
 - c. Foster Brand; H. B. Fuller Construction Products.
 - 2. For indoor applications, adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- E. Polystyrene Adhesive: Solvent- or water-based, synthetic resin adhesive with a service temperature range of minus 20 to plus 140 deg F.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. Foster Brand; H. B. Fuller Construction Products.
- F. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. Eagle Bridges - Marathon Industries.

- c. Foster Brand; H. B. Fuller Construction Products.
- 2. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.3 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.
 - 1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. Vapor-Barrier Mastic: Water based; suitable for indoor use on below-ambient services.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. Knauf Insulation.
 - c. Vimasco Corporation.
 - 2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
 - 3. Service Temperature Range: Minus 20 to plus 180 deg F.
 - 4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
 - 5. Color: White.
- C. Vapor-Barrier Mastic: Solvent based; suitable for indoor use on below-ambient services.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. Eagle Bridges - Marathon Industries.
 - c. Foster Brand; H. B. Fuller Construction Products.
 - 2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 35-mil dry film thickness.
 - 3. Service Temperature Range: 0 to 180 deg F.
 - 4. Solids Content: ASTM D 1644, 44 percent by volume and 62 percent by weight.
 - 5. Color: White.
- D. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below-ambient services.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. Eagle Bridges - Marathon Industries.
 - c. Foster Brand; H. B. Fuller Construction Products.

2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm at 30-mil dry film thickness.
3. Service Temperature Range: Minus 50 to plus 220 deg F.
4. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.
5. Color: White.

E. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. Eagle Bridges - Marathon Industries.
 - c. Knauf Insulation.
2. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Solids Content: 60 percent by volume and 66 percent by weight.
5. Color: White.

2.4 SEALANTS

A. Joint Sealants:

1. Joint Sealants for Cellular-Glass Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.
 - b. - Marathon Industries; 405.
 - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-45.
 - d. Mon-Eco Industries, Inc.; 44-05.
 - e. Pittsburgh Corning Corporation; Pittseal 444.
2. Joint Sealants for Polystyrene Products: Subject to compliance with requirements, provide one of the following:
 - a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-70.
 - b. - Marathon Industries; 405.
 - c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-45.
 - d. Mon-Eco Industries, Inc.; 44-05.
3. Materials shall be compatible with insulation materials, jackets, and substrates.
4. Permanently flexible, elastomeric sealant.
5. Service Temperature Range: Minus 100 to plus 300 deg F.
6. Color: White or gray.
7. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. FSK and Metal Jacket Flashing Sealants:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
 - b. Eagle Bridges - Marathon Industries.
 - c. Foster Brand; H. B. Fuller Construction Products.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: Aluminum.
6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. ASJ Flashing Sealants, and Vinyl Jacket Flashing Sealants:

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Childers Brand; H. B. Fuller Construction Products.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F.
5. Color: White.
6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.5 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
4. FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C 1136, Type II.
5. Vinyl Jacket: White vinyl with a permeance of 1.3 perms when tested according to ASTM E 96/E 96M, Procedure A, and complying with NFPA 90A and NFPA 90B.
 - a. .

2.6 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
- B. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.
 - 1. Adhesive: As recommended by jacket material manufacturer.
 - 2. Color: White.
 - 3. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
 - a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.
- C. Metal Jacket:
 - 1. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.
 - a. Sheet and roll stock ready for shop or field sizing or Factory cut and rolled to size.
 - b. Finish and thickness are indicated in field-applied jacket schedules.
 - c. Moisture Barrier for Indoor Applications: 3-mil-thick, heat-bonded polyethylene and kraft paper.
 - d. Moisture Barrier for Outdoor Applications: 3-mil-thick, heat-bonded polyethylene and kraft paper.
 - e. Factory-Fabricated Fitting Covers:
 - 1) Same material, finish, and thickness as jacket.
 - 2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
 - 3) Tee covers.
 - 4) Flange and union covers.
 - 5) End caps.
 - 6) Beveled collars.
 - 7) Valve covers.
 - 8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.
- D. Self-Adhesive Outdoor Jacket: 60-mil-thick, laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a rubberized bituminous resin on a crosslaminated polyethylene film covered with white aluminum-foil facing.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. Polyguard Products, Inc.

2.7 TAPES

- A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Avery Dennison Corporation, Specialty Tapes Division.
 - b. Ideal Tape Co., Inc., an American Biltrite Company.
 - c. Venture Tape.
 2. Width: 3 inches.
 3. Thickness: 11.5 mils.
 4. Adhesion: 90 ounces force/inch in width.
 5. Elongation: 2 percent.
 6. Tensile Strength: 40 lbf/inch in width.
 7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.
- B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Avery Dennison Corporation, Specialty Tapes Division.
 - b. Ideal Tape Co., Inc., an American Biltrite Company.
 - c. Venture Tape.
 2. Width: 3 inches.
 3. Thickness: 6.5 mils.
 4. Adhesion: 90 ounces force/inch in width.
 5. Elongation: 2 percent.
 6. Tensile Strength: 40 lbf/inch in width.
 7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.
- C. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Avery Dennison Corporation, Specialty Tapes Division.
 - b. Ideal Tape Co., Inc., an American Biltrite Company.
 - c. Venture Tape.
 2. Width: 2 inches.
 3. Thickness: 3.7 mils.
 4. Adhesion: 100 ounces force/inch in width.
 5. Elongation: 5 percent.
 6. Tensile Strength: 34 lbf/inch in width.

2.8 SECUREMENTS

A. Bands:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. ITW Insulation Systems; Illinois Tool Works, Inc.
 - b. RPR Products, Inc.
2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316; 0.015 inch thick, 1/2 inch wide with wing seal or closed seal.
3. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide with wing seal or closed seal.
4. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.

B. Staples: Outward-clinching insulation staples, nominal 3/4-inch-wide, stainless steel or Monel.

C. Wire: 0.062-inch soft-annealed, stainless steel.

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - a. C & F Wire.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.
 1. Verify that systems to be insulated have been tested and are free of defects.
 2. Verify that surfaces to be insulated are clean and dry.
 3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
- B. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:
 1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils thick and an epoxy finish 5 mils thick if operating in a temperature range between 140 and 300 deg F. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

2. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
- C. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
- D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of pipe system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Keep insulation materials dry during application and finishing.
- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- I. Install insulation with least number of joints practical.
- J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.
 1. Install insulation continuously through hangers and around anchor attachments.
 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.
 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

- L. Install insulation with factory-applied jackets as follows:
 - 1. Draw jacket tight and smooth.
 - 2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
 - 3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches o.c.
 - a. For below-ambient services, apply vapor-barrier mastic over staples.
 - 4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
 - 5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.
- M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
- P. For above-ambient services, do not install insulation to the following:
 - 1. Vibration-control devices.
 - 2. Testing agency labels and stamps.
 - 3. Nameplates and data plates.
 - 4. Manholes.
 - 5. Handholes.
 - 6. Cleanouts.

3.4 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
 - 1. Seal penetrations with flashing sealant.
 - 2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 - 3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
 - 4. Seal jacket to roof flashing with flashing sealant.

- B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.
- C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
 - 1. Seal penetrations with flashing sealant.
 - 2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
 - 3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
 - 4. Seal jacket to wall flashing with flashing sealant.
- D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- E. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.
 - 1. Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.
- F. Insulation Installation at Floor Penetrations:
 - 1. Pipe: Install insulation continuously through floor penetrations.
 - 2. Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.5 GENERAL PIPE INSULATION INSTALLATION

- A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.
- B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
 - 1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
 - 2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
 - 3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
 - 4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe

insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.

5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
 6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
 7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
- C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.
- D. Install removable insulation covers at locations indicated. Installation shall conform to the following:
1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
 2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
 3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
 4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
 5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.6 INSTALLATION OF CELLULAR-GLASS INSULATION

- A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient services, secure laps with outward-clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below-ambient services, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as pipe insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of cellular-glass insulation to valve body.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

3.7 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

A. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of pipe insulation.
2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed valve covers manufactured of same material as pipe insulation when available.
2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.8 INSTALLATION OF MINERAL-FIBER INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward-clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

3.9 INSTALLATION OF POLYSTYRENE INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of insulation with tape or bands and tighten bands without deforming insulation materials. Orient longitudinal joints between half sections in 3- and 9-o'clock positions on the pipe.
2. For insulation with factory-applied jackets with vapor barriers, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive or tape as recommended by insulation material manufacturer and seal with vapor-barrier mastic.
3. All insulation shall be tightly butted and free of voids and gaps at all joints. Vapor barrier must be continuous. Before installing jacket material, install vapor-barrier system.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, and make thickness same as adjacent pipe insulation, not to exceed 1-1/2-inch.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of polystyrene block insulation of same thickness as pipe insulation.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed insulation sections of same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed section of polystyrene insulation to valve body.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

3.10 FIELD-APPLIED JACKET INSTALLATION

- A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.

1. Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.
2. Embed glass cloth between two 0.062-inch-thick coats of lagging adhesive.
3. Completely encapsulate insulation with coating, leaving no exposed insulation.

B. Where FSK jackets are indicated, install as follows:

1. Draw jacket material smooth and tight.
2. Install lap or joint strips with same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.
4. Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch-wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

C. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches o.c. and at end joints.

3.11 FINISHES

- A. Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 099123 "Painting."
- B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.
- C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.
- D. Do not field paint aluminum or stainless-steel jackets.

3.12 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Perform tests and inspections.
- C. Tests and Inspections:
 1. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.
- D. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.13 PIPING INSULATION SCHEDULE, GENERAL

- A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.
- B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
 - 1. Drainage piping located in crawl spaces.
 - 2. Underground piping.
 - 3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.14 INDOOR PIPING INSULATION SCHEDULE

- A. Condensate and Equipment Drain Water below 60 Deg F:
 - 1. All Pipe Sizes: Insulation shall be one of the following:
 - a. Cellular Glass: 1-1/2 inches thick.
 - b. Flexible Elastomeric: 1 inch thick.
 - c. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
- B. Heating-Hot-Water Supply and Return, 200 Deg F and Below:
 - 1. NPS 12 and Smaller: Insulation shall be one of the following:
 - a. Cellular Glass: 1-1/2 inches thick.
 - b. Flexible Elastomeric: 1 inch thick.
 - c. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
- C. Refrigerant Suction and Hot-Gas Piping:
 - 1. All Pipe Sizes: Insulation shall be one of the following:
 - a. Cellular Glass: 1-1/2 inches thick.
 - b. Flexible Elastomeric: 1 inch thick.
- D. Refrigerant Suction and Hot-Gas Flexible Tubing:
 - 1. All Pipe Sizes: Insulation shall be one of the following:
 - a. Flexible Elastomeric: 1 inch thick.

3.15 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

- A. Heating-Hot-Water Supply and Return, 200 Deg F and Below:
 - 1. All Pipe Sizes: Insulation shall be one of] the following:
 - a. Cellular Glass: 3 inches thick.

- b. Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inches thick.

B. Refrigerant Suction and Hot-Gas Piping:

- 1. All Pipe Sizes: Insulation shall be one of the following:

- a. Cellular Glass: 2 inches thick.
- b. Flexible Elastomeric: 2 inches thick.
- c. Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inches thick.

C. Refrigerant Suction and Hot-Gas Flexible Tubing:

- 1. All Pipe Sizes: Insulation shall be one of the following:

- a. Flexible Elastomeric: 2 inches thick.

3.16 INDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is Contractor's option.
- C. Piping, Concealed:
 - 1. Aluminum, Smooth Corrugated: 0.024 inch thick.
- D. Piping, Exposed:
 - 1. Aluminum, Smooth or Corrugated: 0.024 inch thick.

3.17 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is Contractor's option.
- C. Piping, Concealed:
 - 1. Aluminum, Smooth or Corrugated: 0.024 inch thick.
- D. Piping, Exposed:
 - 1. Aluminum, Smooth or Corrugated with Z-Shaped Locking Seam: 0.024 inch thick.

END OF SECTION 230719

SECTION 230923
DIRECT DIGITAL CONTROL (DDC) SYSTEM FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, apply to this Section.
- B. Section Includes:
 - 1. DDC system for monitoring and controlling of HVAC systems.
 - 2. Delivery of selected control devices to equipment and systems manufacturers for factory installation and to HVAC systems installers for field installation.
- C. Related Requirements:
 - 1. Section 235216 - "Condensing Boilers"
 - 2. Section 237313 – "Air Handling Unit"
 - 3. Section 237339 – "Heating and Ventilation Unit"
 - 4. Section 238123 – "Computer-Room Air-Conditioners"
 - 5. Sections 232123 – "Hydronic Pumps"
 - 6. Sections 238126 – "Split-System Air-Conditioners"
 - 7. Section 238239.16 – "Propeller Unit Heaters"

1.2 DEFINITIONS

- A. Algorithm: A logical procedure for solving a recurrent mathematical problem. A prescribed set of well-defined rules or processes for solving a problem in a finite number of steps.
- B. Analog: A continuously varying signal value, such as current, flow, pressure, or temperature.
- C. BACnet Specific Definitions:
 - 1. BACnet: Building Automation Control Network Protocol, ASHRAE 135. A communications protocol allowing devices to communicate data over and services over a network.
 - 2. BACnet MSTP: A token passing protocol. Where, "MS" stands for Master – Slave and the "TP" stands for token passing. This protocol is utilized mainly used for connecting

- field devices to controllers/routers/control applications. BACnet MSTP utilizes RS485/EIA485 as its physical layer.
3. BACnet Interoperability Building Blocks (BIBBs): BIBB defines a small portion of BACnet functionality that is needed to perform a particular task. BIBBs are combined to build the BACnet functional requirements for a device.
 4. BACnet/IP: Defines and allows using a reserved UDP socket to transmit BACnet messages over IP networks. A BACnet/IP network is a collection of one or more IP subnetworks that share the same BACnet network number.
 5. BACnet Testing Laboratories (BTL): Organization responsible for testing products for compliance with ASHRAE 135, operated under direction of BACnet International.
 6. PICS (Protocol Implementation Conformance Statement): Written document that identifies the particular options specified by BACnet that are implemented in a device.
- D. Binary: Two-state signal where a high signal level represents "ON" or "OPEN" condition and a low signal level represents "OFF" or "CLOSED" condition. "Digital" is sometimes used interchangeably with "Binary" to indicate a two-state signal.
- E. Controller: Generic term for any standalone, microprocessor-based, digital controller residing on a network, used for local or global control. Three types of controllers are indicated: Network Controller, Programmable Application Controller, and Application-Specific Controller.
- F. Control System Integrator: An entity that assists in expansion of existing enterprise system and support of additional operator interfaces to I/O being added to existing enterprise system.
- G. COV: Changes of value.
- H. DDC System Provider: Authorized representative of, and trained by, DDC system manufacturer and responsible for execution of DDC system Work indicated.
- I. Distributed Control: Processing of system data is decentralized and control decisions are made at subsystem level. System operational programs and information are provided to remote subsystems and status is reported back. On loss of communication, subsystems shall be capable of operating in a standalone mode using the last best available data.
- J. DOCSIS: Data-OverCable Service Interface Specifications.
- K. E/P: Voltage to pneumatic.
- L. Gateway: Bidirectional protocol translator that connects control systems that use different communication protocols.
- M. HLC: Heavy load conditions.
- N. I/O: System through which information is received and transmitted. I/O refers to analog input (AI), binary input (BI), analog output (AO) and binary output (BO). Analog signals are continuous and represent control influences such as flow, level, moisture, pressure, and temperature. Binary signals convert electronic signals to digital pulses (values) and generally represent two-position operating and alarm status. "Digital," (DI and (DO), is sometimes used interchangeably with "Binary," (BI and (BO), respectively.
- O. I/P: Current to pneumatic.

- P. LAN: Local area network.
- Q. LNS: LonWorks Network Services.
- R. LON Specific Definitions:
1. FTT-10: Echelon Transmitter-Free Topology Transceiver.
 2. LonMark: Association comprising suppliers and installers of LonTalk products. Association provides guidelines for implementing LonTalk protocol to ensure interoperability through a standard or consistent implementation.
 3. LonTalk: An open standard protocol developed by the Echelon Corporation that uses a "Neuron Chip" for communication. LonTalk is a register trademark of Echelon.
 4. LonWorks: Network technology developed by Echelon.
 5. Node: Device that communicates using CEA-709.1-C protocol and that is connected to a CEA-709.1-C network.
 6. Node Address: The logical address of a node on the network, consisting of a Domain number, Subnet number, and Node number. "Node number" portion of an address is a number assigned to device during installation, is unique within a subnet, and is not a factory-set unique Node ID.
 7. Node ID: A unique 48-bit identifier assigned at factory to each CEA-709.1-C device. Sometimes called a "Neuron ID."
 8. Program ID: An identifier (number) stored in a device (usually EEPROM) that identifies node manufacturer, functionality of device (application and sequence), transceiver used, and intended device usage.
 9. Standard Configuration Property Type (SCPT): Pronounced "skip-it." A standard format type maintained by LonMark International for configuration properties.
 10. Standard Network Variable Type (SNVT): Pronounced "snivet." A standard format type maintained by LonMark used to define data information transmitted and received by individual nodes. "SNVT" is used in two ways. It is an acronym for "Standard Network Variable Type" and is often used to indicate a network variable itself (i.e., it can mean "a network variable of a standard network variable type").
 11. Subnet: Consists of a logical grouping of up to 127 nodes, where logical grouping is defined by node addressing. Each subnet is assigned a number, which is unique within a Domain. See "Node Address."
 12. TP/FT-10: Free Topology Twisted Pair network defined by CEA-709.3 and is most common media type for a CEA-709.1-C control network.
 13. TP/XF-1250: High-speed, 1.25-Mbps, twisted-pair, doubly terminated bus network defined by "LonMark Interoperability Guidelines" typically used only to connect multiple TP/FT-10 networks.
 14. User-Defined Configuration Property Type (UCPT): Pronounced "U-Keep-It." A Configuration Property format type that is defined by device manufacturer.
 15. User-Defined Network Variable Type (UNVT): Network variable format defined by device manufacturer. UNVTs create non-standard communications that other vendors' devices may not correctly interpret and may negatively impact system operation. UNVTs are not allowed.
- S. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.
- T. Modbus TCP/IP: An open protocol for exchange of process data.

- U. MS/TP: Master-slave/token-passing, IEE 8802-3. Datalink protocol LAN option that uses twisted-pair wire for low-speed communication.
- V. MTBF: Mean time between failures.
- W. Network Controller: Digital controller, which supports a family of programmable application and application-specific controllers that communicate on peer-to-peer network for transmission of global data.
- X. Network Repeater: Device that receives data packet from one network and rebroadcasts it to another network. No routing information is added to protocol.
- Y. Peer to Peer: Networking architecture that treats all network stations as equal partners.
- Z. POT: Portable operator's terminal.
- AA. PUE: Performance usage effectiveness.
- BB. RAM: Random access memory.
- CC. RF: Radio frequency.
- DD. Router: Device connecting two or more networks at network layer.
- EE. Server: Computer used to maintain system configuration, historical and programming database.
- FF. TCP/IP: Transport control protocol/Internet protocol incorporated into Microsoft Windows.
- GG. UPS: Uninterruptible power supply.
- HH. USB: Universal Serial Bus.
- II. User Datagram Protocol (UDP): This protocol assumes that the IP is used as the underlying protocol.
- JJ. VAV: Variable air volume.

1.3 ACTION SUBMITTALS

- A. Multiple Submissions:
 - 1. If multiple submissions are required to execute work within schedule, first submit a coordinated schedule clearly defining intent of multiple submissions. Include a proposed date of each submission with a detailed description of submittal content to be included in each submission.
 - 2. Clearly identify each submittal requirement indicated and in which submission the information will be provided.
 - 3. Include an updated schedule in each subsequent submission with changes highlighted to easily track the changes made to previous submitted schedule.
- B. Product Data: For each type of product include the following:

1. Construction details, material descriptions, dimensions of individual components and profiles, and finishes.
2. Operating characteristics, electrical characteristics, and furnished accessories indicating process operating range, accuracy over range, control signal over range, default control signal with loss of power, calibration data specific to each unique application, electrical power requirements, and limitations of ambient operating environment, including temperature and humidity.
3. Product description with complete technical data, performance curves, and product specification sheets.
4. Installation, operation and maintenance instructions including factors effecting performance.
5. Bill of materials of indicating quantity, manufacturer, and extended model number for each unique product.
 - a. Operator workstations.
 - b. Servers.
 - c. Gateways.
 - d. Routers.
 - e. Protocol analyzers.
 - f. DDC controllers.
 - g. Enclosures.
 - h. Electrical power devices.
 - i. UPS units.
 - j. Accessories.
 - k. Instruments.
 - l. Control dampers and actuators.
 - m. Control valves and actuators.
6. When manufacturer's product datasheets apply to a product series rather than a specific product model, clearly indicate and highlight only applicable information.
7. Each submitted piece of product literature shall clearly cross reference specification and drawings that submittal is to cover.

C. Software Submittal:

1. Cross-referenced listing of software to be loaded on each operator workstation, server, gateway, and DDC controller.
2. Description and technical data of all software provided, and cross-referenced to products in which software will be installed.
3. Operating system software, operator interface and programming software, color graphic software, DDC controller software, maintenance management software, and third-party software.
4. Include a flow diagram and an outline of each subroutine that indicates each program variable name and units of measure.
5. Listing and description of each engineering equation used with reference source.
6. Listing and description of each constant used in engineering equations and a reference source to prove origin of each constant.
7. Description of operator interface to alphanumeric and graphic programming.
8. Description of each network communication protocol.

9. Description of system database, including all data included in database, database capacity and limitations to expand database.
10. Description of each application program and device drivers to be generated, including specific information on data acquisition and control strategies showing their relationship to system timing, speed, processing burden and system throughout.
11. Controlled Systems: Instrumentation list with element name, type of device, manufacturer, model number, and product data. Include written description of sequence of operation including schematic diagram.

D. Shop Drawings:

1. General Requirements:
 - a. Include cover drawing with Project name, location, Owner, Architect/Engineer, Contractor and issue date with each Shop Drawings submission.
 - b. Include a drawing index sheet listing each drawing number and title that matches information in each title block.
 - c. Prepare Drawings using AutoCad or other CAD platform.
 - d. Drawings Size: 11x17.
2. Include plans, elevations, sections, and mounting details where applicable. (Eg.) Temperature Sensors/Thermostats.
3. Include details of product assemblies. Indicate dimensions, weights, loads, and required clearances, method of field assembly, components, and location and size of each field connection.
4. Detail means of vibration isolation and show attachments to rotating equipment.
5. Plan Drawings indicating the following:
 - a. Screened backgrounds of walls, structural grid lines, HVAC equipment, ductwork and piping.
 - b. Room names and numbers with coordinated placement to avoid interference with control products indicated.
 - c. Each desktop operator workstation, server, gateway, router, DDC controller, control panel instrument connecting to DDC controller, and damper and valve connecting to DDC controller, if included in Project.
 - d. Exact placement of products in rooms, ducts, and piping to reflect proposed installed condition.
 - e. Network communication cable and raceway routing.
 - f. Information, drawn to scale, of LAN.media layout and interconnecting accessories
 - g. Proposed routing of wiring, cabling, conduit, and tubing, coordinated with building services for review before installation.
6. Schematic drawings for each controlled HVAC system indicating the following:
 - a. I/O points labeled with point names shown. Indicate instrument range, normal operating set points, and alarm set points. Indicate fail position of each damper and valve, if included in Project.
 - b. I/O listed in table format showing point name, type of device, manufacturer, model number, and cross-reference to product data sheet number.
 - c. A graphic showing location of control I/O in proper relationship to HVAC system.

- d. Wiring diagram with each I/O point having a unique identification and indicating labels for all wiring terminals.
 - e. Unique identification of each I/O that shall be consistently used between different drawings showing same point.
 - f. Elementary wiring diagrams of controls for HVAC equipment motor circuits including interlocks, switches, relays and interface to DDC controllers.
 - g. Narrative sequence of operation.
 - h. Graphic sequence of operation, showing all inputs and output logical blocks.
7. Control panel drawings indicating the following:
- a. Panel dimensions, materials, size, and location of field cable, raceways, and tubing connections.
 - b. Interior subpanel layout, drawn to scale and showing all internal components, cabling and wiring raceways, nameplates and allocated spare space.
 - c. Front, rear, and side elevations and nameplate legend.
 - d. Unique drawing for each panel.
8. DDC system network riser diagram indicating the following:
- a. Each device connected to network with unique identification for each.
 - b. Interconnection of each different network in DDC system.
 - c. For each network, indicate communication protocol, speed and physical means of interconnecting network devices, such as copper cable type, or fiber-optic cable type. Indicate raceway type and size for each.
 - d. Each network port for connection of an operator workstation or other type of operator interface with unique identification for each.
9. DDC system electrical power riser diagram indicating the following:
- a. Each point of connection to field power with requirements (volts/phase/hertz/amperes/connection type) listed for each.
 - b. Each control power supply including, as applicable, transformers, power-line conditioners, transient voltage suppression and high filter noise units, DC power supplies, and UPS units with unique identification for each.
 - c. Each product requiring power with requirements (volts/phase/hertz/amperes/connection type) listed for each.
 - d. Power wiring type and size, race type, and size for each.
10. Monitoring and control signal diagrams indicating the following:
- a. Control signal cable and wiring between controllers and I/O.
 - b. Point-to-point schematic wiring diagrams for each product.
 - c. Control signal tubing to sensors, switches and transmitters.
 - d. Process signal tubing to sensors, switches and transmitters.
11. Color graphics indicating the following:
- a. Itemized list of color graphic displays to be provided.
 - b. For each display screen to be provided, a true color copy showing layout of pictures, graphics and data displayed.

- c. Intended operator access between related hierarchical display screens.

E. System Description:

1. Full description of DDC system architecture, network configuration, operator interfaces and peripherals, servers, controller types and applications, gateways, routers and other network devices, and power supplies.
2. Complete listing and description of each report, log and trend for format and timing and events which initiate generation.
3. System and product operation under each potential failure condition including, but not limited to, the following:
 - a. Loss of power.
 - b. Loss of network communication signal.
 - c. Loss of controller signals to inputs and outputs.
 - d. Server failure.
 - e. Gateway failure.
 - f. Network failure
 - g. Controller failure.
 - h. Instrument failure.
 - i. Control damper and valve actuator failure.
 - j. Specific equipment failure as indicated in the control sequences on the drawings..
4. Complete bibliography of documentation and media to be delivered to Owner.
5. Description of testing plans and procedures.
6. Description of Owner training.

F. Delegated-Design Submittal: For DDC system products and installation indicated as being delegated.

1. Supporting documentation showing DDC system design complies with performance requirements indicated, including calculations and other documentation necessary to prove compliance.
2. Where flow measuring stations are utilized they shall not be utilized as a commissioning tool for any contractor completed delegated design. Stand alone calibrate instrument shall be utilized for commissioning or other design verification of valves or correct operation.
3. Schedule and design calculations for control dampers and actuators.
 - a. Flow at Project design and minimum flow conditions.
 - b. Face velocity at Project design and minimum airflow conditions.
 - c. Pressure drop across damper at Project design and minimum airflow conditions.
 - d. AMCA 500-D damper installation arrangement used to calculate and schedule pressure drop, as applicable to installation.
 - e. Maximum close-off pressure.
 - f. Leakage airflow at maximum system pressure differential (fan close-off pressure).
 - g. Torque required at worst case condition for sizing actuator.
 - h. Actuator selection indicating torque provided.
 - i. Actuator signal to control damper (on, close or modulate).
 - j. Actuator position on loss of power.
 - k. Actuator position on loss of control signal.

4. Schedule and design calculations for control valves and actuators.
 - a. Flow at Project design and minimum flow conditions.
 - b. Pressure-differential drop across valve at Project design flow condition.
 - c. Maximum system pressure-differential drop (pump close-off pressure) across valve at Project minimum flow condition.
 - d. Design and minimum control valve coefficient with corresponding valve position.
 - e. Maximum close-off pressure.
 - f. Leakage flow at maximum system pressure differential.
 - g. Torque required at worst case condition for sizing actuator.
 - h. Actuator selection indicating torque provided.
 - i. Actuator signal to control damper (on, close or modulate).
 - j. Actuator position on loss of power.
 - k. Actuator position on loss of control signal.

5. Schedule and design calculations for selecting flow instruments.
 - a. Instrument flow range.
 - b. Project design and minimum flow conditions with corresponding accuracy, control signal to transmitter and output signal for remote control.
 - c. Extreme points of extended flow range with corresponding accuracy, control signal to transmitter and output signal for remote control.
 - d. Pressure-differential loss across instrument at Project design flow conditions.
 - e. Where flow sensors are mated with pressure transmitters, provide information for each instrument separately and as an operating pair.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings:

1. Plan drawings and corresponding product installation details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - a. Product installation location shown in relationship to room, duct, pipe and equipment.
 - b. Structural members to which products will be attached.
 - c. Wall-mounted instruments located in finished space showing relationship to light switches, fire-alarm devices and other installed devices.
 - d. Size and location of wall access panels for products installed behind walls and requiring access.

2. Reflected ceiling plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - a. Ceiling components.
 - b. Size and location of access panels for products installed above inaccessible ceiling assemblies and requiring access.
 - c. Items penetrating finished ceiling including the following:

- 1) Lighting fixtures.
- 2) Air outlets and inlets.
- 3) Speakers.
- 4) Sprinklers.
- 5) Access panels.
- 6) Motion sensors.
- 7) Pressure sensors.
- 8) Temperature sensors and other DDC control system instruments.
- 9) Architectural features or other design and construction elements encountered.

B. Qualification Data:

1. Systems Provider Qualification Data:

- a. Resume of project manager assigned to Project.
- b. Resumes of application engineering staff assigned to Project.
- c. Resumes of installation and programming technicians assigned to Project.
- d. Resumes of service technicians assigned to Project.
- e. Brief description of past project including physical address, floor area, number of floors, building system cooling and heating capacity and building's primary function.
- f. Description of past project DDC system, noting similarities to Project scope and complexity indicated.
- g. Names of staff assigned to past project that will also be assigned to execute work of this Project.
- h. Owner contact information for past project including name, phone number, and e-mail address.
- i. Contractor contact information for past project including name, phone number, and e-mail address.
- j. Engineer contact information for past project including name, phone number, and e-mail address.

2. Manufacturer's qualification data.
3. Testing agency's qualifications data.

C. Product Certificates:

1. Data Communications Protocol Certificates: Certifying that each proposed DDC system component complies with ASHRAE 135.

D. Sample Warranty: For manufacturer's warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For DDC system to include in emergency, operation and maintenance manuals.

1. In addition to items specified in Contract requirements, include the following:

- a. Project Record Drawings of as-built versions of submittal Shop Drawings provided in electronic PDF format.
- b. Testing and commissioning reports and checklists of completed final versions of reports, checklists, and trend logs.
- c. As-built versions of submittal Product Data.
- d. Names, addresses, e-mail addresses and 24-hour telephone numbers of Installer and service representatives for DDC system and products.
- e. Operator's manual with procedures for operating control systems including logging on and off, handling alarms, producing point reports, trending data, overriding computer control and changing set points and variables.
- f. Programming manuals with description of programming language and syntax, of statements for algorithms and calculations used, of point database creation and modification, of program creation and modification, and of editor use.
- g. Engineering, installation, and maintenance manuals that explain how to:
 - 1) Design and install new points, panels, and other hardware.
 - 2) Perform preventive maintenance and calibration.
 - 3) Debug hardware problems.
 - 4) Repair or replace hardware.
- h. Documentation of all programs created using custom programming language including set points, tuning parameters, and object database.
- i. Backup copy of graphic files, programs, and database on electronic media such as DVDs or USB type flash drive(s)thumb “Thumb Drive” (External storage device).
- j. List of recommended spare parts with part numbers and suppliers.
- k. Complete original-issue documentation, installation, and maintenance information for furnished third-party hardware including computer equipment and sensors.
- l. Complete original-issue copies of furnished software, including operating systems, custom programming language, operator workstation software, and graphics software.
- m. Licenses, guarantees, and warranty documents.
- n. Recommended preventive maintenance procedures for system components, including schedule of tasks such as inspection, cleaning, and calibration; time between tasks; and task descriptions.
- o. Owner training materials.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials and parts that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
- B. Include product manufacturers' recommended parts lists for proper product operation over four-year period following warranty period. Parts list shall be indicated for each year.
- C. Furnish parts, as indicated by manufacturer's recommended parts list, for product operation during one-year period following warranty period.
- D. Furnish quantity indicated of matching product(s) in Project inventory for each unique size and type of following:

1. Network Controller: One.
2. Programmable Application Controller: One.
3. Application-Specific Controller: One.
4. Room Carbon Dioxide Sensor and Transmitter: One.
5. Room Moisture Sensor and Transmitter: One.
6. Room Temperature Sensor: Three
7. General-Purpose Relay: Two.
8. Current-Sensing Relay: One.
9. Combination On-Off Status Sensor and On-Off Relay: One.
10. Transformer: One.
11. DC Power Supply: One.
12. Supply of 20 percent spare fiber-optic cable splice organizer cabinets for several re-terminations.

1.7 QUALITY ASSURANCE

A. DDC System Manufacturer Qualifications:

1. Nationally recognized manufacturer of DDC systems and products.
2. DDC systems with similar requirements to those indicated for a continuous period of five years within time of bid.
3. DDC systems and products that have been successfully tested and in use on at least three past projects.
4. Having complete published catalog literature, installation, operation and maintenance manuals for all products intended for use.
5. Having full-time in-house employees for the following:
 - a. Product research and development.
 - b. Product and application engineering.
 - c. Product manufacturing, testing and quality control.
 - d. Technical support for DDC system installation training, commissioning and troubleshooting of installations.
 - e. Owner operator training.

B. DDC System Provider Qualifications:

1. Authorized representative of, and trained by, DDC system manufacturer.
2. In-place facility located within 100 miles of Project.
3. Demonstrated past experience with installation of DDC system products being installed for period within five consecutive years before time of bid.
4. Demonstrated past experience on five projects of similar complexity, scope and value.
5. Each person assigned to Project shall have demonstrated past experience.
6. Staffing resources of competent and experienced full-time employees that are assigned to execute work according to schedule.
7. Service and maintenance staff assigned to support Project during warranty period.
8. Product parts inventory to support on-going DDC system operation for a period of not less than 5 years after Substantial Completion.

9. DDC system manufacturer's backing to take over execution of Work if necessary to comply with requirements indicated. Include Project-specific written letter, signed by manufacturer's corporate officer, if requested.

1.8 WARRANTY

- A. Manufacturer's Warranty: Manufacturer and Installer agree to repair or replace products that fail in materials or workmanship within specified warranty period.
 1. Failures shall be adjusted, repaired, or replaced at no additional cost or reduction in service to Owner.
 2. Include updates or upgrades to software and firmware if necessary to resolve deficiencies.
 - a. Install updates only after receiving Owner's written authorization.
 3. Warranty service shall occur during normal business hours and commence within 24 hours of Owner's warranty service request.
 4. Warranty Period: Two year(s) from date of Substantial Completion.
 - a. For Gateway: Two-year parts and labor warranty for each.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis-of-Design Product: Subject to compliance with requirements, provide as indicated and specified herein by one of the following or equal:
 1. Wykon Tridium – (Niagara Framework)
 2. KMC Controls – (Niagra Framework)
 3. Honeywell – (Niagra Framework)

2.2 DDC SYSTEM DESCRIPTION

- A. Microprocessor-based monitoring and control including analog/digital conversion and program logic. A control loop or subsystem in which digital and analog information is received and processed by a microprocessor, and digital control signals are generated based on control algorithms and transmitted to field devices to achieve a set of predefined conditions.
 1. DDC system shall consist of a high-speed, peer-to-peer network of distributed DDC controllers, other network devices, operator interfaces, and software.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.3 WEB ACCESS

- A. DDC system shall be Web based or Web compatible.
 - 1. Web-Based Access to DDC System:
 - a. DDC system software shall be based on server thin-client architecture, designed around open standards of Web technology. DDC system server shall be accessed using a Web browser over DDC system network, using an independent DDC LAN, and remotely over Internet
 - b. Intent of thin-client architecture is to provide operators complete access to DDC system via a Web browser. No special software other than a Web browser shall be required to access graphics, point displays, and trends; to configure trends, points, and controllers; and to edit programming.
 - c. Web access shall be password protected.
 - 2. Web-Compatible Access to DDC System:
 - a. Operator workstation and or server shall perform overall system supervision and configuration, graphical user interface, management report generation, and alarm annunciation.
 - b. DDC system shall support Web browser access to building data. Operator using a standard Web browser shall be able to access control graphics and change adjustable set points.
 - c. Web access shall be password protected.

2.4 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer to design DDC system to satisfy requirements indicated.
- B. Delegated Design: Engage a qualified professional to design DDC system to satisfy requirements indicated.
 - 1. System Performance Objectives:
 - a. DDC system shall manage HVAC systems.
 - b. DDC system control shall operate HVAC systems to achieve optimum operating costs while using least possible energy and maintaining specified performance.
 - c. DDC system shall respond to power failures, HVAC equipment failures, and adverse and emergency conditions encountered through connected I/O points.
 - d. DDC system shall operate while unattended by an operator and through operator interaction.
 - e. DDC system shall record trends and transaction of events and produce report information such as performance, energy, occupancies, and equipment operation.
- C. Surface-Burning Characteristics: Products installed in ducts, equipment, and return-air paths shall comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: 25 or less.
 2. Smoke-Developed Index: 50 or less.
- D. DDC System Speed:
1. Response Time of Connected I/O:
 - a. AI point values connected to DDC system shall be updated at least every five seconds for use by DDC controllers. Points used globally shall also comply with this requirement.
 - b. BI point values connected to DDC system shall be updated at least every five seconds for use by DDC controllers. Points used globally shall also comply with this requirement.
 - c. AO points connected to DDC system shall begin to respond to controller output commands within two second(s). Global commands shall also comply with this requirement.
 - d. BO point values connected to DDC system shall respond to controller output commands within two second(s). Global commands shall also comply with this requirement.
 2. Display of Connected I/O:
 - a. Analog point COV connected to DDC system shall be updated and displayed at least every five seconds for use by operator.
 - b. Binary point COV connected to DDC system shall be updated and displayed at least every five seconds for use by operator.
 - c. Alarms of analog and digital points connected to DDC system shall be displayed within 30 seconds of activation or change of state.
 - d. Graphic display refresh shall update within eight seconds.
 - e. Point change of values and alarms displayed from workstation to workstation when multiple operators are viewing from multiple workstations shall not exceed graphic refresh rate indicated.
- E. Network Bandwidth: Design each network of DDC system to include at least 30 percent available spare bandwidth with DDC system operating under normal and heavy load conditions indicated. Calculate bandwidth usage, and apply a safety factor to ensure that requirement is satisfied when subjected to testing under worst case conditions.
- F. DDC System Data Storage:
1. Include server(s) with disk drive data storage to archive not less than 48 consecutive months of historical data for all I/O points connected to system, including alarms, event histories, transaction logs, trends and other information indicated.
 2. When logged onto a server, operator shall be able to also interact with any DDC controller connected to DDC system as required for functional operation of DDC system.
 3. Server(s) shall be used for application configuration; for archiving, reporting and trending of data; for operator transaction archiving and reporting; for network information management; for alarm annunciation; and for operator interface tasks and controls application management.
 4. Server(s) shall use IT industry-standard database platforms such as Microsoft SQL Server and Microsoft Data Engine (MSDE).

- G. Future Expandability:
 - 1. DDC system size shall be expandable to an ultimate capacity of at least three times total I/O points indicated.
 - 2. Additional DDC controllers, I/O and associated wiring shall be all that is needed to achieve ultimate capacity. Initial network infrastructure shall be designed and installed to support ultimate capacity.
 - 3. Operator interfaces installed initially shall not require hardware and software additions and revisions for ultimate capacity.

- H. Input Point Displayed Accuracy: Input point displayed values shall meet following end-to-end overall system accuracy, including errors associated with meter, sensor, transmitter, lead wire or cable, and analog to digital conversion.
 - 1. Flow:
 - a. Air: Within 5 percent of design flow rate.
 - b. Water: Within 2 percent of design flow rate.
 - 2. Moisture (Relative Humidity):
 - a. Air: Within 2 percent RH.
 - b. Space: Within 2 percent RH.
 - c. Outdoor: Within 2 percent RH.
 - 3. Pressure:
 - a. Air, Ducts and Equipment: 1 percent of instrument range.
 - b. Water: Within 1 percent of instrument range.
 - 4. Temperature, Dry Bulb:
 - a. Air: Within 1 deg F.
 - b. Space: Within 1 deg F.
 - c. Outdoor: Within 2 deg F.
 - d. Cold Water: Within 1 deg F.
 - e. Process and Domestic Hot Water: Within 1 deg F.
 - f. Temperature Difference: Within 0.25 deg F.
 - g. Other Temperatures Not Indicated: Within 1 deg F.

- I. Precision of I/O Reported Values: Values reported in database and displayed shall have following precision:
 - 1. Current:
 - a. Milliamperes: Nearest 1/100th of a milliampere.
 - b. Amperes: Nearest 1/10th of an ampere up to 100 A; nearest ampere for 100 A and more.
 - 2. Flow:

- a. Air: Nearest 1/10th of a cfm through 100 cfm; nearest cfm between 100 and 1000 cfm; nearest 10 cfm between 1000 and 10,000 cfm; nearest 100 cfm above 10,000 cfm.
 - b. Water: Nearest 1/10th gpm through 100 gpm; nearest gpm between 100 and 1000 gpm; nearest 10 gpm between 1000 and 10,000 gpm; nearest 100 gpm above 10,000 gpm.
 3. Speed:
 - a. Rotation (rpm): Nearest 1 rpm.
 - b. Velocity: Nearest 1/10th fpm through 100 fpm; nearest fpm between 100 and 1000 fpm; nearest 10 fpm above 1000 fpm.
 4. Positioner, Dampers and Valves (Percentage Open): Nearest 1 percent.
 5. Pressure:
 - a. Air, Ducts and Equipment: Nearest 1/10th in. w.c..
 - b. Percent open shall not be signaled based, but physical position.
 - c. Water: Nearest 1/10 psig through 100 psig; nearest psig above 100 psig.
 6. Temperature:
 - a. Air, Ducts and Equipment: Nearest 1/10th of a degree.
 - b. Outdoor: Nearest degree.
 - c. Space: Nearest 1/10th of a degree.
 - d. Cold Water: Nearest 1/10th of a degree.
 - e. Hot Water (Heating and Domestic): Nearest degree.
- J. Control Stability: Control variables indicated within the following limits:
 1. Moisture (Relative Humidity):
 - a. Air: Within 2 percent RH.
 - b. Space: Within 2 percent RH.
 - c. Outdoor: Within 2 percent RH.
 2. Pressure:
 - a. Air, Ducts and Equipment: 0.5 percent of instrument range span.
 - b. Space: Within 1 percent of instrument span.
 - c. Water: Within 1 percent of instrument span.
 3. Temperature, Dry Bulb:
 - a. Air: Within 1 deg F.
 - b. Space: Within 1 deg F .
- K. Environmental Conditions for Controllers, Gateways, and Routers:
 1. Products shall operate without performance degradation under ambient environmental temperature, pressure and humidity conditions encountered for installed location.

- a. If product alone cannot comply with requirement, install product in a protective enclosure that is isolated and protected from conditions impacting performance. Enclosure shall be internally insulated, electrically heated, cooled and ventilated as required by product and application.
 2. Products shall be protected with enclosures satisfying the following minimum requirements unless more stringent requirements are indicated. Products not available with integral enclosures complying with requirements indicated shall be housed in protective secondary enclosures. Installed location shall dictate the following NEMA 250 enclosure requirements:
 - a. Indoors, Heated with Filtered Ventilation: Type 1.
 - b. Mechanical Equipment Rooms:
 - 1) Boiler Rooms: Type 4.
- L. Environmental Conditions for Instruments and Actuators:
1. Instruments and actuators shall operate without performance degradation under the ambient environmental temperature, pressure, humidity, and vibration conditions specified and encountered for installed location.
 - a. If instruments and actuators alone cannot comply with requirement, install instruments and actuators in protective enclosures that are isolated and protected from conditions impacting performance. Enclosure shall be internally insulated, electrically heated and ventilated as required by instrument and application.
 2. Instruments, actuators and accessories shall be protected with enclosures satisfying the following minimum requirements unless more stringent requirements are indicated. Instruments and actuators not available with integral enclosures complying with requirements indicated shall be housed in protective secondary enclosures. Installed location shall dictate the following NEMA 250 enclosure requirements:
 - a. Outdoors, Protected: Type 3R or Type 4.
 - b. Indoors, Heated with Filtered Ventilation: Type 1.
 - c. Indoors, Heated and Air-conditioned: Type 1.
 - d. Mechanical Equipment Rooms:
 - 1) Boiler Rooms: Type 4.
 - 2) Air-Moving Equipment Rooms: Type 2.
- M. Electric Power Quality:
1. Power-Line Surges:
 - a. Protect DDC system products connected to ac power circuits from power-line surges to comply with requirements of IEEE C62.41.
 - b. Do not use fuses for surge protection.
 - c. Test protection in the normal mode and in the common mode, using the following two waveforms:

- 1) 10-by-1000-mic.sec. waveform with a peak voltage of 1500 V and a peak current of 60 A.
- 2) 8-by-20-mic.sec. waveform with a peak voltage of 1000 V and a peak current of 500 A.

N. Backup Power Source:

1. HVAC systems and equipment served by a backup power source shall have associated DDC system products that control such systems and equipment also served from a backup power source. Coordinate with Division 26 (Electrical)

O. Continuity of Operation after Electric Power Interruption:

1. Equipment and associated factory-installed controls, field-installed controls, electrical equipment, and power supply connected to building normal and backup power systems shall automatically return equipment and associated controls to operating state occurring immediately before loss of normal power, without need for manual intervention by operator when power is restored either through backup power source or through normal power if restored before backup power is brought online.

2.5 SYSTEM ARCHITECTURE

A. System architecture shall consist of no more than two or three levels of LANs.

1. Level one LAN shall connect network controllers and operator workstations.
2. Level one or Level two LAN shall connect programmable application controllers to other programmable application controllers, and to network controllers.
3. Level two or Level three LAN shall connect application-specific controllers to programmable application controllers and network controllers.
4. Level two or Level three LAN shall connect application-specific controllers to application-specific controllers.

B. Minimum Data Transfer and Communication Speed:

1. LAN Connecting Operator Workstations and Network Controllers: 100 Mbps.
2. LAN Connecting Programmable Application Controllers: 1000 kbps.
3. LAN Connecting Application-Specific Controllers: 115,000 bps.

C. DDC system shall consist of dedicated and separated LANs that are not shared with other building systems and tenant data and communication networks.

D. System architecture shall be modular and have inherent ability to expand to not less than two times system size indicated with no impact to performance indicated.

E. System architecture shall perform modifications without having to remove and replace existing network equipment.

F. Number of LANs and associated communication shall be transparent to operator. All I/O points residing on any LAN shall be capable of global sharing between all system LANs.

- G. System design shall eliminate dependence on any single device for system alarm reporting and control execution. Each controller shall operate independently by performing its' own control, alarm management and historical data collection.
- H. Special Network Architecture Requirements:
 - 1. All Air handling, Boilers, Water Heaters and Pumps Systems: DDC System shall integrate to manufacturers central controllers while maintaining all performance stated previously and herein. A separate LAN and supervisory controller shall be provided if required to maintain performance.

2.6 DDC SYSTEM OPERATOR INTERFACES

- A. Operator Means of System Access: Operator shall be able to access entire DDC system through any of multiple means, including, but not limited to, the following:
 - 1. Desktop and/or portable operator workstation with hardwired connection through LAN port.
 - 2. Portable operator terminal with hardwired connection through LAN port.
 - 3. Portable operator workstation with wireless connection through LAN router.
 - 4. PDA (cell phone/smart phone) with wireless connection through LAN router.
 - 5. Remote connection using outside of system personal computer or PDA through Web access.
 - 6. Remote connection using portable operator workstation and telephone dial-up modem.
- B. Access to system, regardless of operator means used, shall be transparent to operator.
- C. Network Ports: For hardwired connection of desktop or portable operator workstation. Network port shall be easily accessible, properly protected, clearly labeled, and installed at the following locations:
 - 1. Mechanical equipment room.
- D. Portable Workstations:
 - 1. Connect to DDC system Level one LAN through a communications port directly on LAN or through a communications port on a DDC controller.
 - 2. Able to communicate with any device located on any DDC system LAN.
 - 3. Connect to DDC system Level two or Level three LAN through a communications port on an application-specific controller, or a room temperature sensor connected to an application-specific controller.
 - 4. Connect to system through a wireless router connected to Level one LAN.
 - 5. Portable workstation shall be able to communicate with any device connected to any system LAN regardless of point of physical connection to system.
 - 6. Monitor, program, schedule, adjust set points, and report capabilities of I/O connected anywhere in system.
 - 7. Have dynamic graphic displays that are identical to desktop workstations.
- E. Critical Alarm Reporting:

1. Operator-selected critical alarms shall be sent by DDC system to notify operator of critical alarms that require immediate attention.
 2. DDC system shall send alarm notification to multiple recipients that are assigned for each alarm.
 3. DDC system shall notify recipients by any or all means, including e-mail, text message and prerecorded phone message to mobile and landline phone numbers.
- F. Simultaneous Operator Use: Capable of accommodating up to five simultaneous operators that are accessing DDC system through any one of operator interfaces indicated.

2.7 NETWORKS

- A. Acceptable networks for connecting operator workstations and network controllers include the following:
1. IP.
 2. IEEE 8802-3, Ethernet.
 3. MS/TP
- B. Acceptable networks for connecting programmable application controllers include the following:
1. IP.
 2. IEEE 8802-3, Ethernet.
 3. MS/TP
- C. Acceptable networks for connecting application-specific controllers include the following:
1. IP.
 2. IEEE 8802-3, Ethernet.
 3. MS/TP

2.8 NETWORK COMMUNICATION PROTOCOL

- A. Network communication protocol(s) used throughout entire DDC system shall be open to public and available to other companies for use in making future modifications to DDC system.
- B. ASHRAE 135 Protocol:
1. ASHRAE 135 communication protocol shall be sole and native protocol used throughout entire DDC system.
 2. DDC system shall not require use of gateways except to integrate HVAC equipment and other building systems and equipment, not required to use ASHRAE 135 communication protocol.
 3. If used, gateways shall connect to DDC system using ASHRAE 135 communication protocol and Project object properties and read/write services indicated by interoperability schedule.
 4. Operator workstations, controllers and other network devices shall be tested and listed by BACnet Testing Laboratories.

C. Industry Standard Protocols:

1. DDC system shall use any one or a combination of the following industry standard protocols for network communication while complying with other DDC system requirements indicated:
 - a. ASHRAE 135.
 - b. CEA-709.1-C.
2. Operator workstations and network controllers shall communicate through ASHRAE 135 protocol.
3. Portions of DDC system networks using ASHRAE 135 communication protocol shall be an open implementation of network devices complying with ASHRAE 135. Network devices shall be tested and listed by BACnet Testing Laboratories.
4. Portions of DDC system networks using CEA-709.1-C communication protocol shall be an open implementation of LonWorks technology using CEA-709.1-C communication protocol and using LonMark SNVTs as defined in LonMark SNVT list exclusively for DDC system.
5. Gateways (translator) shall be used to connect networks and network devices using different protocols.

2.9 PORTABLE OPERATOR WORKSTATIONS

A. Basis-of-Design Product: Subject to compliance with requirements, provide as indicated and specified herein by one of the following or equal:

1. Dell Inc.

B. Performance Requirements:

1. Performance requirements may dictate equipment exceeding minimum requirements indicated.
2. Energy Star compliant.
3. Hardware and software shall support local down-loading to DDC controllers.
4. Data transfer rate to DDC controller shall be at network speed.

C. Processor:

1. Minimum Processor Speed: 1.7 GHz
2. RAM:
 - a. Capacity: 4 GB.
 - b. Speed and Type: 1600 MHz,.
3. Hard Drive:
 - a. Number of Hard Drives: One.
 - b. Capacity: 500 GB
 - c. Minimum Average Seek Time: <8.5 ms

- d. Cache Buffer Size: 16 MB
 - e. RPM: 5400
- 4. Video Card: 2 GB of RAM.
- D. Input and Output Ports:
 - 1. Serial port.
 - 2. Shared port for external keyboard or mouse.
 - 3. Four USB 2.0 ports.
 - 4. Ethernet port.
 - 5. IEEE 1394 integrated port.
 - 6. Serial infrared communications port.
- E. Battery:
 - 1. 9-cell, 81 Wh lithium ion battery and ac adapter.
 - 2. Battery life of at least three years.
 - 3. Battery charge time of less than three hours.
 - 4. Spare Battery(ies). One.
- F. Keyboard:
 - 1. 85-key keyboard.
 - 2. Full upper- and lowercase ASCII keyset.
- G. Integral Pointing Device: Touchpad with two buttons or equivalent pointing device.
- H. Display:
 - 1. 15.6 inches diagonal or larger high-definition WLED color display.
 - 2. Antiglare screen.
 - 3. 1920 by 1080 pixel resolution.
 - 4. Brightness: 300 nits.
- I. Network Interface Card: Include card with connection, as application.
 - 1. 10-100-1000 base TX Ethernet with RJ45 connector port.
 - 2. 100 base FX Ethernet with SC or ST port.
- J. Digital Video Disc Rewrite Recorder (DVD+/-RW):
 - 1. Compatible with DVD disks and data, audio, recordable and rewritable compact disks.
 - a. 8X DVD +/-RW
 - 2. 160-ms access time.
- K. Accessories:
 - 1. Leather carrying case.
 - 2. Wireless-N communication card.

3. .
4. Mobile broadband card.
5. Wireless optical mouse.
6. 500 GB portable hard drive..
7. Cable with network jackets on each end. Minimum cable length shall be 10 feet.

2.10 SYSTEM SOFTWARE

A. System Software Minimum Requirements:

1. Real-time multitasking and multiuser 32- or 64-bit operating system that allows concurrent multiple operator workstations operating and concurrent execution of multiple real-time programs and custom program development.
2. Operating system shall be capable of operating DOS and Microsoft Windows applications.
3. Database management software shall manage all data on an integrated and non-redundant basis. Additions and deletions to database shall be without detriment to existing data. Include cross linkages so no data required by a program can be deleted by an operator until that data have been deleted from respective programs.
4. Network communications software shall manage and control multiple network communications to provide exchange of global information and execution of global programs.
5. Operator interface software shall include day-to-day operator transaction processing, alarm and report handling, operator privilege level and data segregation control, custom programming, and online data modification capability.
6. Scheduling software shall schedule centrally based time and event, temporary, and exception day programs.

B. Operator Interface Software:

1. Minimize operator training through use of English language prorating and English language point identification.
2. Minimize use of a typewriter-style keyboard through use of a pointing device similar to a mouse.
3. Operator sign-off shall be a manual operation or, if no keyboard or mouse activity takes place, an automatic sign-off.
4. Automatic sign-off period shall be programmable from one to 60 minutes in one-minute increments on a per operator basis.
5. Operator sign-on and sign-off activity shall be recorded and sent to printer.
6. Security Access:
 - a. Operator access to DDC system shall be under password control.
 - b. An alphanumeric password shall be field assignable to each operator.
 - c. Operators shall be able to access DDC system by entry of proper password.
 - d. Operator password shall be same regardless of which computer or other interface means is used.
 - e. Additions or changes made to passwords shall be updated automatically.
 - f. Each operator shall be assigned an access level to restrict access to data and functions the operator is cable of performing.
 - g. Software shall have at least five access levels.

- h. Each menu item shall be assigned an access level so that a one-for-one correspondence between operator assigned access level(s) and menu item access level(s) is required to gain access to menu item.
 - i. Display menu items to operator with those capable of access highlighted. Menu and operator access level assignments shall be online programmable and under password control.
7. Data Segregation:
- a. Include data segregation for control of specific data routed to a workstation, to an operator or to a specific output device, such as a printer.
 - b. Include at least 32 segregation groups.
 - c. Segregation groups shall be selectable such as "fire points," "fire points on second floor," "space temperature points," "HVAC points," and so on.
 - d. Points shall be assignable to multiple segregation groups. Display and output of data to printer or monitor shall occur where there is a match of operator or peripheral segregation group assignment and point segregations.
 - e. Alarms shall be displayed and printed at each peripheral to which segregation allows, but only those operators assigned to peripheral and having proper authorization level will be allowed to acknowledge alarms.
 - f. Operators and peripherals shall be assignable to multiple segregation groups and all assignments are to be online programmable and under password control.
8. Operators shall be able to perform commands including, but not limited to, the following:
- a. Start or stop selected equipment.
 - b. Adjust set points.
 - c. Add, modify, and delete time programming.
 - d. Enable and disable process execution.
 - e. Lock and unlock alarm reporting for each point.
 - f. Enable and disable totalization for each point.
 - g. Enable and disable trending for each point.
 - h. Override control loop set points.
 - i. Enter temporary override schedules.
 - j. Define holiday schedules.
 - k. Change time and date.
 - l. Enter and modify analog alarm limits.
 - m. Enter and modify analog warning limits.
 - n. View limits.
 - o. Enable and disable demand limiting.
 - p. Enable and disable duty cycle.
 - q. Display logic programming for each control sequence.
 - r. Trend points
9. Reporting:
- a. Generated automatically and manually.
 - b. Sent to displays, printers and disk files.
 - c. Types of Reporting:

- 1) General listing of points.
 - 2) List points currently in alarm.
 - 3) List of off-line points.
 - 4) List points currently in override status.
 - 5) List of disabled points.
 - 6) List points currently locked out.
 - 7) List of items defined in a "Follow-Up" file.
 - 8) List weekly schedules.
 - 9) List holiday programming.
 - 10) List of limits and deadbands.
10. Summaries: For specific points, for a logical point group, for an operator selected group(s), or for entire system without restriction due to hardware configuration.

C. Graphic Interface Software:

1. Include a full interactive graphical selection means of accessing and displaying system data to operator. Include at least five levels with the penetration path operator assignable (for example, site, building, floor, air-handling unit, and supply temperature loop). Native language descriptors assigned to menu items are to be operator defined and modifiable under password control.
2. Include a hierarchical-linked dynamic graphic operator interface for accessing and displaying system data and commanding and modifying equipment operation. Interface shall use a pointing device with pull-down or penetrating menus, color and animation to facilitate operator understanding of system.
3. Include at least 10 levels of graphic penetration with the hierarchy operator assignable.
4. Descriptors for graphics, points, alarms and such shall be modified through operator's workstation under password control.
5. Graphic displays shall be online user definable and modifiable using the hardware and software provided.
6. Data to be displayed within a graphic shall be assignable regardless of physical hardware address, communication or point type.
7. Graphics are to be online programmable and under password control.
8. Points may be assignable to multiple graphics where necessary to facilitate operator understanding of system operation.
9. Graphics shall also contain software points.
10. Penetration within a graphic hierarchy shall display each graphic name as graphics are selected to facilitate operator understanding.
11. Back-trace feature shall permit operator to move upward in the hierarchy using a pointing device. Back trace shall show all previous penetration levels. Include operator with option of showing each graphic full screen size with back trace as horizontal header or by showing a "stack" of graphics, each with a back trace.
12. Display operator accessed data on the monitor.
13. Operator shall select further penetration using pointing device to click on a site, building, floor, area, equipment, and so on. Defined and linked graphic below that selection shall then be displayed.
14. Include operator with means to directly access graphics without going through penetration path.
15. Dynamic data shall be assignable to graphics.
16. Display points (physical and software) with dynamic data provided by DDC system with appropriate text descriptors, status or value, and engineering unit.

17. Use color, rotation, or other highly visible means, to denote status and alarm states. Color shall be variable for each class of points, as chosen by operator.
 18. Points shall be dynamic with operator adjustable update rates on a per point basis from one second to over a minute.
 19. For operators with appropriate privilege, points shall be commanded directly from display using pointing device.
 - a. For an analog command point such as set point, current conditions and limits shall be displayed and operator can position new set point using pointing device.
 - b. For a digital command point such as valve position, valve shall show its current state such as open or closed and operator could select alternative position using pointing device.
 - c. Keyboard equivalent shall be available for those operators with that preference.
 20. Operator shall be able to split or resize viewing screen into quadrants to show one graphic on one quadrant of screen and other graphics or spreadsheet, bar chart, word processing, curve plot and other information on other quadrants on screen. This feature shall allow real-time monitoring of one part of system while displaying other parts of system or data to better facilitate overall system operation.
 21. Help Features:
 - a. On-line context-sensitive help utility to facilitate operator training and understanding.
 - b. Bridge to further explanation of selected keywords. Document shall contain text and graphics to clarify system operation.
 - 1) If help feature does not have ability to bridge on keywords for more information, a complete set of user manuals shall be provided in an indexed word-processing program, which shall run concurrently with operating system software.
 - c. Available for Every Menu Item:
 - 1) Index items for each system menu item.
 22. Graphic generation software shall allow operator to add, modify, or delete system graphic displays.
 - a. Include libraries of symbols depicting HVAC symbols such as fans, coils, filters, dampers, valves pumps, and electrical symbols.
 - b. Graphic development package shall use a pointing device in conjunction with a drawing program to allow operator to perform the following:
 - 1) Define background screens.
 - 2) Define connecting lines and curves.
 - 3) Locate, orient and size descriptive text.
 - 4) Define and display colors for all elements.
 - 5) Establish correlation between symbols or text and associated system points or other displays.
- D. Project-Specific Graphics: Graphics documentation including, but not limited to, the following:

1. Site plan showing each building, and additional site elements, which are being controlled or monitored by DDC system.
2. Plan for each building floor, including interstitial floors, and each roof level of each building, showing the following:
 - a. Room layouts with room identification and name.
 - b. Locations and identification of all monitored and controlled HVAC equipment and other equipment being monitored and controlled by DDC system.
 - c. Location and identification of each hardware point being controlled or monitored by DDC system.
 - d. Setpoint and Real Time readings for all instruments and hardware including, but not limited to Temperature, Pressure, Speed, Hz, Current etc..
3. Control schematic for each of following, including a graphic system schematic representation, similar to that indicated on Drawings, with point identification, set point and dynamic value indication, sequence of operation and control logic diagram.
4. Graphic display for each piece of equipment connected to DDC system through a data communications link. Include dynamic indication of all points associated with equipment.
5. DDC system network riser diagram that shows schematic layout for entire system including all networks and all controllers, gateways operator workstations and other network devices.

E. Customizing Software:

1. Software to modify and tailor DDC system to specific and unique requirements of equipment installed, to programs implemented and to staffing and operational practices planned.
2. Online modification of DDC system configuration, program parameters, and database using menu selection and keyboard entry of data into preformatted display templates.
3. As a minimum, include the following modification capability:
 - a. Operator assignment shall include designation of operator passwords, access levels, point segregation and auto sign-off.
 - b. Peripheral assignment capability shall include assignment of segregation groups and operators to consoles and printers, designation of backup workstations and printers, designation of workstation header points and enabling and disabling of print-out of operator changes.
 - c. System configuration and diagnostic capability shall include communications and peripheral port assignments, DDC controller assignments to network, DDC controller enable and disable, assignment of command trace to points and application programs and initiation of diagnostics.
 - d. System text addition and change capability shall include English or native language descriptors for points, segregation groups and access levels and action messages for alarms, run time and trouble condition.
 - e. Time and schedule change capability shall include time and date set, time and occupancy schedules, exception and holiday schedules and daylight savings time schedules.
 - f. Point related change capability shall include the following:
 - 1) System and point enable and disable.
 - 2) Run-time enable and disable.

- 3) Assignment of points to segregation groups, calibration tables, lockout, and run time and to a fixed I/O value.
 - 4) Assignment of alarm and warning limits.
- g. Application program change capability shall include the following:
- 1) Enable and disable of software programs.
 - 2) Programming changes.
 - 3) Assignment of comfort limits, global points, time and event initiators, time and event schedules and enable and disable time and event programs.
4. Software shall allow operator to add points, or groups of points, to DDC system and to link them to energy optimization and management programs. Additions and modifications shall be online programmable using operator workstation, downloaded to other network devices and entered into their databases. After verification of point additions and associated program operation, database shall be uploaded and recorded on hard drive and disk for archived record.
 5. Include high-level language programming software capability for implementation of custom DDC programs. Software shall include a compiler, linker, and up- and down-load capability.
 6. Include a library of DDC algorithms, intrinsic control operators, arithmetic, logic and relational operators for implementation of control sequences. Also include, as a minimum, the following:
 - a. Proportional control (P).
 - b. Proportional plus integral (PI).
 - c. Proportional plus integral plus derivative (PID).
 - d. Adaptive and intelligent self-learning control.
 - 1) Algorithm shall monitor loop response to output corrections and adjust loop response characteristics according to time constant changes imposed.
 - 2) Algorithm shall operate in a continuous self-learning manner and shall retain in memory a stored record of system dynamics so that on system shut down and restart, learning process starts from where it left off.
 7. Fully implemented intrinsic control operators including sequence, reversing, ratio, time delay, time of day, highest select AO, lowest select AO, analog controlled digital output, analog control AO, and digitally controlled AO.
 8. Logic operators such as "And," "Or," "Not," and others that are part of a standard set available with a high-level language.
 9. Arithmetic operators such as "Add," "Subtract," "Multiply," "Divide," and others that are part of a standard set available with a high-level language.
 10. Relational operators such as "Equal To," "Not Equal To," "Less Than," "Greater Than," and others that are part of a standard set available with a high-level language.
- F. Alarm Handling Software:
1. Include alarm handling software to report all alarm conditions monitored and transmitted through DDC controllers, gateways and other network devices.

2. Include first in, first out handling of alarms according to alarm priority ranking, with most critical alarms first, and with buffer storage in case of simultaneous and multiple alarms.
3. Alarm handling shall be active at all times to ensure that alarms are processed even if an operator is not currently signed on to DDC system.
4. Alarms display shall include the following:
 - a. Indication of alarm condition such as "Abnormal Off," "Hi Alarm," and "Low Alarm."
 - b. "Analog Value" or "Status" group and point identification with native language point descriptor such as "Space Temperature, Building 110, 2nd Floor, Room 212."
 - c. Discrete per point alarm action message, such as "Call Maintenance Dept. Ext-5561."
 - d. Include extended message capability to allow assignment and printing of extended action messages. Capability shall be operator programmable and assignable on a per point basis.
5. Alarms shall be directed to appropriate operator workstations, printers, and individual operators by privilege level and segregation assignments.
6. Send e-mail alarm messages to designated operators.
7. Send e-mail, page, text and voice messages to designated operators for critical alarms.
8. Alarms shall be categorized and processed by class.
 - a. Class 1:
 - 1) Associated with fire, security and other extremely critical equipment monitoring functions; have alarm, trouble, return to normal, and acknowledge conditions printed and displayed.
 - 2) Unacknowledged alarms to be placed in unacknowledged alarm buffer.
 - 3) All conditions shall cause an audible sound and shall require individual acknowledgment to silence audible sound.
 - b. Class 2:
 - 1) Critical, but not life-safety related, and processed same as Class 1 alarms, except do not require individual acknowledgment.
 - 2) Acknowledgement may be through a multiple alarm acknowledgment.
 - c. Class 3:
 - 1) General alarms; printed, displayed and placed in unacknowledged alarm buffer queues.
 - 2) Each new alarm received shall cause an audible sound. Audible sound shall be silenced by "acknowledging" alarm or by pressing a "silence" key.
 - 3) Acknowledgement of queued alarms shall be either on an individual basis or through a multiple alarm acknowledgement.
 - 4) Alarms returning to normal condition shall be printed and not cause an audible sound or require acknowledgment.
 - d. Class 4:

- 1) Routine maintenance or other types of warning alarms.
 - 2) Alarms to be printed only, with no display, no audible sound and no acknowledgment required.
9. Include an unacknowledged alarm indicator on display to alert operator that there are unacknowledged alarms in system. Operator shall be able to acknowledge alarms on an individual basis or through a multiple alarm acknowledge key, depending on alarm class.
10. To ensure that no alarm records are lost, it shall be possible to assign a backup printer to accept alarms in case of failure of primary printer.
- G. Reports and Logs:
1. Include reporting software package that allows operator to select, modify, or create reports using DDC system I/O point data available.
 2. Each report shall be definable as to data content, format, interval and date.
 3. Report data shall be sampled and stored on DDC controller, within storage limits of DDC controller, and then uploaded to archive on workstation for historical reporting.
 4. Operator shall be able to obtain real-time logs of all I/O points by type or status, such as alarm, point lockout, or normal.
 5. Reports and logs shall be stored on workstation hard drives in a format that is readily accessible by other standard software applications, including spreadsheets and word processing.
 6. Reports and logs shall be readily printed and set to be printed either on operator command or at a specific time each day.
- H. Standard Reports: Standard DDC system reports shall be provided and operator shall be able to customize reports later.
1. All I/O: With current status and values.
 2. Alarm: All current alarms, except those in alarm lockout.
 3. Disabled I/O: All I/O points that are disabled.
 4. Alarm Lockout I/O: All I/O points in alarm lockout, whether manual or automatic.
 5. Alarm Lockout I/O in Alarm: All I/O in alarm lockout that are currently in alarm.
 6. Logs:
 - a. Alarm history.
 - b. System messages.
 - c. System events.
 - d. Trends.
- I. Custom Reports: Operator shall be able to easily define any system data into a daily, weekly, monthly, or annual report. Reports shall be time and date stamped and shall contain a report title.
- J. Standard Trends:
1. Trend all I/O point present values, set points, and other parameters indicated for trending.
 2. Trends shall be associated into groups, and a trend report shall be set up for each group.

3. Trends shall be stored within DDC controller and uploaded to hard drives automatically on reaching 75 % of DDC controller buffer limit, or by operator request, or by archiving time schedule.
 4. Preset trend intervals for each I/O point after review with Owner.
 5. Trend intervals shall be operator selectable from 10 seconds up to 60 minutes. Minimum number of consecutive trend values stored at one time shall be 100 per variable.
 6. When drive storage memory is full, most recent data shall overwrite oldest data.
 7. Archived and real-time trend data shall be available for viewing numerically and graphically by operators.
- K. Custom Trends: Operator shall be able to define a custom trend log for any I/O point in DDC system.
1. Each trend shall include interval, start time, and stop time.
 2. Data shall be sampled and stored on DDC controller, within storage limits of DDC controller, and then uploaded to archive on workstation hard drives.
 3. Data shall be retrievable for use in spreadsheets and standard database programs.
- L. Programming Software:
1. Include programming software to execute sequences of operation indicated.
 2. Include programming routines in simple and easy to follow logic with detailed text comments describing what the logic does and how it corresponds to sequence of operation.
 3. Programming software shall be as follows:
 - a. Graphic Based: Programming shall use a library of function blocks made from preprogrammed code designed for DDC control systems.
 - 1) Function blocks shall be assembled with interconnection lines that represent to control sequence in a flowchart.
 - 2) Programming tools shall be viewable in real time to show present values and logical results of each function block.
 4. Include means for detecting programming errors and testing software control strategies with a simulation tool before implementing in actual control. Simulation tool may be inherent with programming software or as a separate product.

2.11 OFFICE APPLICATION SOFTWARE

- A. Basis-of-Design Product: Subject to compliance with requirements, provide as indicated and specified herein by one of the following or equal:
1. Microsoft Corporation.
- B. Include current version of office application software at time of Substantial Completion.
- C. Office application software package shall include multiple separate applications and use a common platform for all applications, similar to Microsoft's "Office Professional."

1. Database.
2. E-mail.
3. Presentation.
4. Publisher.
5. Spreadsheet.
6. Word processing.

2.12 ASHRAE 135 GATEWAYS

- A. Include BACnet communication ports, whenever available as an equipment OEM standard option, for integration via a single communication cable. BACnet-controlled plant equipment includes, but is not limited to, VRF System (condensers, evaporators and associated control panels), Air Handling Units, Condensing Units, Water Heaters, Electric Meters, Water Meters, variable speed drives, Heat Trace Power/Control Panels, flow measuring stations and split system air conditioners.
- B. Gateway Minimum Requirements:
1. Read and view all readable object properties on non-BACnet network to BACnet network and vice versa where applicable.
 2. Write to all writeable object properties on non-BACnet network from BACnet network and vice versa where applicable.
 3. Include single-pass (only one protocol to BACnet without intermediary protocols) translation from non-BACnet protocol to BACnet and vice versa.
 4. Comply with requirements of Data Sharing Read Property, Data Sharing Write Property, Device Management Dynamic Device Binding-B, and Device Management Communication Control BIBBs according to ASHRAE 135.
 5. Hardware, software, software licenses, and configuration tools for operator-to-gateway communications.
 6. Backup programming and parameters on CD media and the ability to modify, download, backup, and restore gateway configuration.

2.13 DDC CONTROLLERS

- A. DDC system shall consist of a combination of network controllers, programmable application controllers and application-specific controllers to satisfy performance requirements indicated.
- B. DDC controllers shall perform monitoring, control, energy optimization and other requirements indicated.
- C. DDC controllers shall use a multitasking, multiuser, real-time digital control microprocessor with a distributed network database and intelligence.
- D. Each DDC controller shall be capable of full and complete operation as a completely independent unit and as a part of a DDC system wide distributed network.
- E. Environment Requirements:

1. Controller hardware shall be suitable for the anticipated ambient conditions.
2. Controllers located in conditioned space shall be rated for operation at 32 to 120 deg F.
3. Controllers located outdoors shall be rated for operation at 40 to 150 deg F.

F. Power and Noise Immunity:

1. Controller shall operate at 90 to 110 percent of nominal voltage rating and shall perform an orderly shutdown below 80 percent of nominal voltage.
2. Operation shall be protected against electrical noise of 5 to 120 Hz and from keyed radios with up to 5 W of power located within 36 inches of enclosure.

G. DDC Controller Spare Processing Capacity:

1. Include spare processing memory for each controller. RAM, PROM, or EEPROM will implement requirements indicated with the following spare memory:
 - a. Network Controllers: 50 percent.
 - b. Programmable Application Controllers: Not less than 60 percent.
 - c. Application-Specific Controllers: Not less than 70 percent.
2. Memory shall support DDC controller's operating system and database and shall include the following:
 - a. Monitoring and control.
 - b. Energy management, operation and optimization applications.
 - c. Alarm management.
 - d. Historical trend data of all connected I/O points.
 - e. Maintenance applications.
 - f. Operator interfaces.
 - g. Monitoring of manual overrides.

H. DDC Controller Spare I/O Point Capacity: Include spare I/O point capacity for each controller as follows:

1. Network Controllers:
 - a. 10 percent of each AI, AO, BI, and BO point connected to controller.
2. Programmable Application Controllers:
 - a. 10 percent of each AI, AO, BI, and BO point connected to controller.
3. Application-Specific Controllers:
 - a. 10 percent of each AI, AO, BI, and BO point connected to controller.

I. Maintenance and Support: Include the following features to facilitate maintenance and support:

1. Mount microprocessor components on circuit cards for ease of removal and replacement.
2. Means to quickly and easily disconnect controller from network.
3. Means to quickly and easily access connect to field test equipment.

4. Visual indication that controller electric power is on, of communication fault or trouble, and that controller is receiving and sending signals to network.

J. Input and Output Point Interface:

1. Hardwired input and output points shall connect to network, programmable application and application-specific controllers.
2. Input and output points shall be protected so shorting of point to itself, to another point, or to ground will not damage controller.
3. Input and output points shall be protected from voltage up to 24 V of any duration so that contact will not damage controller.
4. AIs:
 - a. AIs shall include monitoring of low-voltage (zero- to 10-V dc), current (4 to 20 mA) and resistance signals from thermistor and RTD sensors.
 - b. AIs shall be compatible with, and field configurable to, sensor and transmitters installed.
 - c. Controller AIs shall perform analog-to-digital (A-to-D) conversion with a minimum resolution of 12 bits or better to comply with accuracy requirements indicated.
 - d. Signal conditioning including transient rejection shall be provided for each AI.
 - e. Capable of being individually calibrated for zero and span.
 - f. Incorporate common-mode noise rejection of at least 50 dB from zero to 100 Hz for differential inputs, and normal-mode noise rejection of at least 20 dB at 60 Hz from a source impedance of 10000 ohms.
5. AOs:
 - a. Controller AOs shall perform analog-to-digital (A-to-D) conversion with a minimum resolution of 12 bits or better to comply with accuracy requirements indicated.
 - b. Output signals shall have a range of 4 to 20 mA dc or zero- to 10-V dc as required to include proper control of output device.
 - c. Capable of being individually calibrated for zero and span.
 - d. AOs shall not exhibit a drift of greater than 0.4 percent of range per year.
6. BIs:
 - a. Controller BIs shall accept contact closures and shall ignore transients of less than 5-ms duration.
 - b. Isolation and protection against an applied steady-state voltage of up to 180-V ac peak.
 - c. BIs shall include a wetting current of at least 12 mA to be compatible with commonly available control devices and shall be protected against effects of contact bounce and noise.
 - d. BIs shall sense "dry contact" closure without external power (other than that provided by the controller) being applied.
 - e. Pulse accumulation input points shall comply with all requirements of BIs and accept up to 10 pulses per second for pulse accumulation. Buffer shall be provided to totalize pulses. Pulse accumulator shall accept rates of at least 20 pulses per second. The totalized value shall be reset to zero on operator's command.

7. BOs:
 - a. Controller BOs shall include relay contact closures or triac outputs for momentary and maintained operation of output devices.
 - 1) Relay contact closures shall have a minimum duration of 0.1 second. Relays shall include at least 180 V of isolation. Electromagnetic interference suppression shall be provided on all output lines to limit transients to non-damaging levels. Minimum contact rating shall be 1 A at 24-V ac.
 - 2) Triac outputs shall include at least 180 V of isolation. Minimum contact rating shall be 1 A at 24-V ac.
 - b. BOs shall include for two-state operation or a pulsed low-voltage signal for pulse-width modulation control.
 - c. BOs shall be selectable for either normally open or normally closed operation.
 - d. Include tristate outputs (two coordinated BOs) for control of three-point floating-type electronic actuators without feedback.

2.14 NETWORK CONTROLLERS

A. General Network Controller Requirements:

1. Include adequate number of controllers to achieve performance indicated.
2. System shall consist of one or more independent, standalone, microprocessor-based network controllers to manage global strategies indicated.
3. Controller shall have enough memory to support its operating system, database, and programming requirements.
4. Data shall be shared between networked controllers and other network devices.
5. Operating system of controller shall manage input and output communication signals to allow distributed controllers to share real and virtual object information and allow for central monitoring and alarms.
6. Controllers that perform scheduling shall have a real-time clock.
7. Controller shall continually check status of its processor and memory circuits. If an abnormal operation is detected, controller shall assume a predetermined failure mode and generate an alarm notification.
8. Controllers shall be fully programmable.

B. Communication:

1. Network controllers shall communicate with other devices on DDC system Level one network.
2. Network controller also shall perform routing if connected to a network of programmable application and application-specific controllers.

C. Operator Interface:

1. Controller shall be equipped with a service communications port for connection to a portable operator's workstation.

D. Serviceability:

1. Controller shall be equipped with diagnostic LEDs or other form of local visual indication of power, communication, and processor.
2. Wiring and cable connections shall be made to field-removable, modular terminal strips or to a termination card connected by a ribbon cable.
3. Controller shall maintain BIOS and programming information in event of a power loss for at least 72 hours.

2.15 PROGRAMMABLE APPLICATION CONTROLLERS

A. General Programmable Application Controller Requirements:

1. Include adequate number of controllers to achieve performance indicated.
2. Controller shall have enough memory to support its operating system, database, and programming requirements.
3. Data shall be shared between networked controllers and other network devices.
4. Operating system of controller shall manage input and output communication signals to allow distributed controllers to share real and virtual object information and allow for central monitoring and alarms.
5. Controllers that perform scheduling shall have a real-time clock.
6. Controller shall continually check status of its processor and memory circuits. If an abnormal operation is detected, controller shall assume a predetermined failure mode and generate an alarm notification.
7. Controllers shall be fully programmable.

B. Communication:

1. Programmable application controllers shall communicate with other devices on network.

C. Operator Interface:

1. Controller shall be equipped with a service communications port for connection to a portable operator's workstation.

D. Serviceability:

1. Controller shall be equipped with diagnostic LEDs or other form of local visual indication of power, communication, and processor.
2. Wiring and cable connections shall be made to field-removable, modular terminal strips or to a termination card connected by a ribbon cable.
3. Controller shall maintain BIOS and programming information in event of a power loss for at least 72 hours.

2.16 APPLICATION-SPECIFIC CONTROLLERS

- A. Description: Microprocessor-based controllers, which through hardware or firmware design are dedicated to control a specific piece of equipment. Controllers are not fully user-programmable but are configurable and customizable for operation of equipment they are designed to control.

1. Capable of standalone operation and shall continue to include control functions without being connected to network.
 2. Data shall be shared between networked controllers and other network devices.
- B. Communication: Application-specific controllers shall communicate with other application-specific controller and devices on network, and to programmable application and network controllers.
- C. Operator Interface: Controller shall be equipped with a service communications port for connection to a portable operator's workstation. Connection shall extend to port on space temperature sensor that is connected to controller.
- D. Serviceability:
1. Controller shall be equipped with diagnostic LEDs or other form of local visual indication of power, communication, and processor.
 2. Wiring and cable connections shall be made to field-removable, modular terminal strips or to a termination card connected by a ribbon cable.
 3. Controller shall use nonvolatile memory and maintain all BIOS and programming information in event of power loss.

2.17 CONTROLLER SOFTWARE

- A. General Controller Software Requirements:
1. Software applications shall reside and operate in controllers. Editing of applications shall occur at operator workstations.
 2. I/O points shall be identified by up to 30-character point name and up to 16-character point descriptor. Same names shall be used at operator workstations.
 3. Control functions shall be executed within controllers using DDC algorithms.
 4. Controllers shall be configured to use stored default values to ensure fail-safe operation. Default values shall be used when there is a failure of a connected input instrument or loss of communication of a global point value.
- B. Security:
1. Operator access shall be secured using individual security passwords and user names.
 2. Passwords shall restrict operator to points, applications, and system functions as assigned by system manager.
 3. Operator log-on and log-off attempts shall be recorded.
 4. System shall protect itself from unauthorized use by automatically logging off after last keystroke. The delay time shall be operator-definable.
- C. Scheduling: Include capability to schedule each point or group of points in system. Each schedule shall consist of the following:
1. Weekly Schedule:
 - a. Include separate schedules for each day of week.

- b. Each schedule should include the capability for start, stop, optimal start, optimal stop, and night economizer.
 - c. Each schedule may consist of up to 10 events.
 - d. When a group of objects are scheduled together, include capability to adjust start and stop times for each member.
- 2. Exception Schedules:
 - a. Include ability for operator to designate any day of the year as an exception schedule.
 - b. Exception schedules may be defined up to a year in advance. Once an exception schedule is executed, it will be discarded and replaced by regular schedule for that day of week.
- 3. Holiday Schedules:
 - a. Include capability for operator to define up to 99 special or holiday schedules.
 - b. Schedules may be placed on scheduling calendar and will be repeated each year.
 - c. Operator shall be able to define length of each holiday period.
- D. System Coordination:
 - 1. Include standard application for proper coordination of equipment.
 - 2. Application shall include operator with a method of grouping together equipment based on function and location.
 - 3. Group may then be used for scheduling and other applications.
- E. Binary Alarms:
 - 1. Each binary point shall be set to alarm based on operator-specified state.
 - 2. Include capability to automatically and manually disable alarming.
- F. Analog Alarms:
 - 1. Each analog object shall have both high and low alarm limits.
 - 2. Alarming shall be able to be automatically and manually disabled.
- G. Alarm Reporting:
 - 1. Operator shall be able to determine action to be taken in event of an alarm.
 - 2. Alarms shall be routed to appropriate operator workstations based on time and other conditions.
 - 3. Alarm shall be able to start programs, print, be logged in event log, generate custom messages, and display graphics.
- H. Remote Communication:
 - 1. System shall have ability to dial out in the event of an alarm.
- I. Sequencing: Include application software based on sequences of operation indicated to properly sequence chillers, boilers, and other applicable HVAC equipment.

- J. Control Loops:
1. Support any of the following control loops, as applicable to control required:
 - a. Two-position (on/off, open/close, slow/fast) control.
 - b. Proportional control.
 - c. Proportional plus integral (PI) control.
 - d. Proportional plus integral plus derivative (PID) control.
 - 1) Include PID algorithms with direct or reverse action and anti-windup.
 - 2) Algorithm shall calculate a time-varying analog value used to position an output or stage a series of outputs.
 - 3) Controlled variable, set point, and PID gains shall be operator-selectable.
 - e. Adaptive (automatic tuning).
- K. Staggered Start: Application shall prevent all controlled equipment from simultaneously restarting after a power outage. Order which equipment (or groups of equipment) is started, along with the time delay between starts, shall be operator-selectable.
- L. Energy Calculations:
1. Include software to allow instantaneous power or flow rates to be accumulated and converted to energy usage data.
 2. Include an algorithm that calculates a sliding-window average (rolling average). Algorithm shall be flexible to allow window intervals to be operator specified (such as 15, 30, or 60 minutes).
 3. Include an algorithm that calculates a fixed-window average. A digital input signal shall define start of window period (such as signal from utility meter) to synchronize fixed-window average with that used by utility.
- M. Anti-Short Cycling:
1. BO points shall be protected from short cycling.
 2. Feature shall allow minimum on-time and off-time to be selected.
- N. On and Off Control with Differential:
1. Include an algorithm that allows a BO to be cycled based on a controlled variable and set point.
 2. Algorithm shall be direct- or reverse-acting and incorporate an adjustable differential.
- O. Run-Time Totalization:
1. Include software to totalize run-times for all BI and BO points.
 2. A high run-time alarm shall be assigned, if required, by operator.

2.18 ENCLOSURES

- A. General Enclosure Requirements:

1. House each controller and associated control accessories in an enclosure. Enclosure shall serve as central tie-in point for control devices such as switches, transmitters, transducers, power supplies and transformers.
2. Include enclosure door with key locking mechanism. Key locks alike for all enclosures and include one pair of keys per enclosure.
3. Individual wall-mounted single-door enclosures shall not exceed 36 inches wide and 48 inches high.
4. Individual wall-mounted double-door enclosures shall not exceed 60 inches wide and 36 inches high.
5. Freestanding enclosures shall not exceed 48 inches wide and 72 inches high.
6. Include wall-mounted enclosures with brackets suitable for mounting enclosures to wall or freestanding support stand as indicated.
7. Supply each enclosure with a complete set of as-built schematics, tubing, and wiring diagrams and product literature located in a pocket on inside of door.

B. Internal Arrangement:

1. Internal layout of enclosure shall group and protect pneumatic, electric, and electronic components associated with a controller, but not an integral part of controller.
2. Arrange layout to group similar products together.
3. Include a barrier between line-voltage and low-voltage electrical and electronic products.
4. Factory or shop install products, tubing, cabling and wiring complying with requirements and standards indicated.
5. Terminate field cable and wire using heavy-duty terminal blocks.
6. Include spare terminals, equal to not less than 10 percent of used terminals.
7. Include spade lugs for stranded cable and wire.
8. Install a maximum of two wires on each side of a terminal.
9. Include enclosure field power supply with a toggle-type switch located at entrance inside enclosure to disconnect power.
10. Include enclosure with a line-voltage nominal 20-A GFCI duplex receptacle for service and testing tools. Wire receptacle on hot side of enclosure disconnect switch and include with a 5-A circuit breaker.
11. Mount products within enclosure on removable internal panel(s).
12. Include products mounted in enclosures with engraved, laminated phenolic nameplates (black letters on a white background). The nameplates shall have at least 1/4-inch-high lettering.
13. Route tubing cable and wire located inside enclosure within a raceway with a continuous removable cover.
14. Label each end of cable, wire and tubing in enclosure following an approved identification system that extends from field I/O connection and all intermediate connections throughout length to controller connection.
15. Size enclosure internal panel to include at least 25 percent spare area on face of panel.

C. Environmental Requirements:

1. Evaluate temperature and humidity requirements of each product to be installed within each enclosure.
2. Calculate enclosure internal operating temperature considering heat dissipation of all products installed within enclosure and ambient effects (solar, conduction and wind) on enclosure.

3. Where required by application, include temperature-controlled electrical heat to maintain inside of enclosure above minimum operating temperature of product with most stringent requirement.
4. Where required by application, include temperature-controlled ventilation fans with filtered louver(s) to maintain inside of enclosure below maximum operating temperature of product with most stringent requirement.
5. Include temperature-controlled cooling within the enclosure for applications where ventilation fans cannot maintain inside temperature of enclosure below maximum operating temperature of product with most stringent requirement.
6. Where required by application, include humidity-controlled electric dehumidifier or cooling to maintain inside of enclosure below maximum relative humidity of product with most stringent requirement and to prevent surface condensation within enclosure.

D. Wall-Mounted, NEMA 250, Type 1:

1. Basis-of-Design Product: Subject to compliance with requirements, provide as indicated and specified herein by one of the following or equal:
 - a. Hoffman; a brand of Pentair Equipment Protection.
2. Enclosure shall be NRTL listed according to UL 50 or UL 50E.
3. Construct enclosure of steel, not less than:
 - a. Enclosure size less than 24 in.: 0.053 in. or 0.067 in. thick.
 - b. Enclosure size 24 in. and larger: 0.067 in. or 0.093 in. thick.
4. Finish enclosure inside and out with polyester powder coating that is electrostatically applied and then baked to bond to substrate.
 - a. Exterior color shall be manufacturer's standard.
 - b. Interior color shall be manufacturer's standard.
5. Hinged door full size of front face of enclosure and supported using:
 - a. Enclosures sizes less than 36 in. tall: Multiple butt hinges.
 - b. Enclosures sizes 36 in. tall and larger: Continuous piano hinges.
6. Removable internal panel with a white polyester powder coating that is electrostatically applied and then baked to bond to substrate.
 - a. Size less than 24 in.: Solid steel, 0.053 in. thick.
 - b. Size 24 in. and larger: Solid aluminum, 0.10 in. or steel, 0.093 in. thick.
7. Internal panel mounting hardware, grounding hardware and sealing washers.
8. Grounding stud on enclosure body.
9. Thermoplastic pocket on inside of door for record Drawings and Product Data.

E. Wall Mounted NEMA 250, Types 4 and 12:

1. Basis-of-Design Product: Subject to compliance with requirements, provide as indicated and specified herein by one of the following or equal:

- a. Hoffman; a brand of Pentair Equipment Protection.
 2. Enclosure shall be NRTL listed according to UL 508A.
 3. Seam and joints are continuously welded and ground smooth.
 4. Where recessed enclosures are indicated, include enclosures with face flange for flush mounting.
 5. Externally formed body flange around perimeter of enclosure face for continuous perimeter seamless gasket door seal.
 6. Single-door enclosure sizes up to 60 inches tall by 36 inches wide.
 7. Double-door enclosure sizes up to 36 inches tall by 60 inches wide.
 8. Construct enclosure of steel, not less than the following:
 - a. Size Less Than 24 Inches: 0.053 inch or 0.067 inch thick.
 - b. Size 24 Inches and Larger: 0.067 inch thick.
 9. Finish enclosure with polyester powder coating that is electrostatically applied and then baked to bond to substrate.
 - a. Exterior color shall be manufacturer's standard.
 - b. Interior color shall be manufacturer's standard.
 10. Corner-formed door, full size of enclosure face, supported using multiple concealed hinges with easily removable hinge pins.
 - a. Sizes through 24 Inches Tall: Two hinges.
 - b. Sizes between 24 Inches through 48 Inches Tall: Three hinges.
 - c. Sizes Larger 48 Inches Tall: Four hinges.
 11. Double-door enclosures with overlapping door design to include unobstructed full-width access.
 - a. Single-door enclosures 48 inches and taller, and all double-door enclosures, with three-point (top, middle and bottom) latch system.
 12. Removable internal panel with a white polyester powder coating that is electrostatically applied and then baked to bond to substrate.
 - a. Size Less Than 24 Inches: Solid steel, 0.053 inch thick.
 - b. Size 24 Inches and Larger: Solid aluminum, 0.10 inch or steel, 0.093 inch thick.
 13. Internal panel mounting studs with hardware, grounding hardware, and sealing washers.
 14. Grounding stud on enclosure body.
 15. Thermoplastic pocket on inside of door for record Drawings and Product Data.
- F. Accessories:
1. Electric Heater (for outdoor ambient mounted panels only):
 - a. Aluminum housing with brushed finish.
 - b. Thermostatic control with adjustable set point from zero to 100 deg F.
 - c. Capacity: 100, 200, 400, and 800 W as required by application.

- d. Fan draws cool air from bottom of enclosure and passes air across thermostat and heating elements before being released into enclosure cavity. Heated air is discharged through the top of heater.
2. Ventilation Fans, Filtered Intake and Exhaust Grilles:
- a. Number and size of fans, filters and grilles as required by application.
 - b. Compact cooling fans engineered for 50,000 hours of continuous operation without lubrication or service.
 - c. Fans capable of being installed on any surface and in any position within enclosure for spot cooling or air circulation.
 - d. Thermostatic control with adjustable set point from 32 to 140 deg F.
 - e. Airflow Capacity at Zero Pressure:
 - 1) 4-Inch Fan: 100 cfm.
 - 2) 6-Inch Fan: 240 cfm.
 - 3) 10-Inch Fan: 560 cfm.
 - f. Maximum operating temperature of 158 deg F.
 - g. 4-inch fan thermally protected and provided with permanently lubricated ball-bearings.
 - h. 6- and 10-inch fans with ball-bearing construction and split capacitor motors thermally protected to avoid premature failure.
 - i. Dynamically balanced impellers molded from polycarbonate material.
 - j. Fan furnished with power cord and polarized plug for power connection.
 - k. Fan brackets, finger guards and mounting hardware provided with fans to complete installation.
 - l. Removable Intake and Exhaust Grilles: ABS plastic or stainless steel of size to match fan size and suitable for NEMA 250, Types 1 and 12 enclosures.
 - m. Filters for NEMA 250, Type 1 Enclosures: Washable aluminum, of a size to match intake grille.
 - n. Filters for NEMA 250, Type 12 Enclosures: Disposable, of a size to match intake grille.
3. Bar handle with keyed cylinder lock set.

2.19 RELAYS

A. General-Purpose Relays:

- 1. Basis-of-Design Product: Subject to compliance with requirements, provide as indicated and specified herein by one of the following or equal:
 - a. Siemens Building Technologies, Inc.
- 2. Relays shall be heavy duty and rated for at least 10 A at 250-V ac and 60 Hz.

3. Relays shall be either double pole double throw (DPDT) or three-pole double throw, depending on the control application.
4. Use a plug-in-style relay with an eight-pin octal plug for DPDT relays and an 11-pin octal plug for three-pole double-throw relays.
5. Construct the contacts of either silver cadmium oxide or gold.
6. Enclose the relay in a clear transparent polycarbonate dust-tight cover.
7. Relays shall have LED indication and a manual reset and push-to-test button.
8. Performance:
 - a. Mechanical Life: At least 10 million cycles.
 - b. Electrical Life: At least 100,000 cycles at rated load.
 - c. Pickup Time: 15 ms or less.
 - d. Dropout Time: 10 ms or less.
 - e. Pull-in Voltage: 85 percent of rated voltage.
 - f. Dropout Voltage: 50 percent of nominal rated voltage.
 - g. Power Consumption: 2 VA.
 - h. Ambient Operating Temperatures: Minus 40 to 115 deg F.
9. Equip relays with coil transient suppression to limit transients to non-damaging levels.
10. Plug each relay into an industry-standard, 35-mm DIN rail socket. Plug all relays located in control panels into sockets that are mounted on a DIN rail.
11. Relay socket shall have screw terminals. Mold into the socket the coincident screw terminal numbers and associated octal pin numbers.

B. Multifunction Time-Delay Relays:

1. Basis-of-Design Product: Subject to compliance with requirements, provide as indicated and specified herein by one of the following or equal:
 - a. Siemens Building Technologies, Inc.
2. Relays shall be continuous duty and rated for at least 10 A at 240-V ac and 60 Hz.
3. Relays shall be DPDT relay with up to eight programmable functions to provide on/off delay, interval and recycle timing functions.
4. Use a plug-in-style relay with either an 8- or 11-pin octal plug.
5. Construct the contacts of either silver cadmium oxide or gold.
6. Enclose the relay in a dust-tight cover.
7. Include knob and dial scale for setting delay time.
8. Performance:
 - a. Mechanical Life: At least 10 million cycles.
 - b. Electrical Life: At least 100,000 cycles at rated load.
 - c. Timing Ranges: Multiple ranges from 0.1 seconds to 100 minutes.
 - d. Repeatability: Within 2 percent.
 - e. Recycle Time: 45 ms.
 - f. Minimum Pulse Width Control: 50 ms.
 - g. Power Consumption: 5 VA or less at 120-V ac.
 - h. Ambient Operating Temperatures: Minus 40 to 115 deg F.
9. Equip relays with coil transient suppression to limit transients to non-damaging levels.

10. Plug each relay into an industry-standard, 35-mm DIN rail socket. Plug all relays located in control panels into sockets that are mounted on a DIN rail.
11. Relay socket shall have screw terminals. Mold into the socket the coincident screw terminal numbers and associated octal pin numbers.

C. Latching Relays:

1. Basis-of-Design Product: Subject to compliance with requirements, provide as indicated and specified herein by one of the following or equal:
 - a. Siemens Building Technologies, Inc.
2. Relays shall be continuous duty and rated for at least 10 A at 250-V ac and 60 Hz.
3. Relays shall be either DPDT or three-pole double throw, depending on the control application.
4. Use a plug-in-style relay with a multibladed plug.
5. Construct the contacts of either silver cadmium oxide or gold.
6. Enclose the relay in a clear transparent polycarbonate dust-tight cover.
7. Performance:
 - a. Mechanical Life: At least 10 million cycles.
 - b. Electrical Life: At least 100,000 cycles at rated load.
 - c. Pickup Time: 15 ms or less.
 - d. Dropout Time: 10 ms or less.
 - e. Pull-in Voltage: 85 percent of rated voltage.
 - f. Dropout Voltage: 50 percent of nominal rated voltage.
 - g. Power Consumption: 2 VA.
 - h. Ambient Operating Temperatures: Minus 40 to 115 deg F.
8. Equip relays with coil transient suppression to limit transients to non-damaging levels.
9. Plug each relay into an industry-standard, 35-mm DIN rail socket. Plug all relays located in control panels into sockets that are mounted on a DIN rail.
10. Relay socket shall have screw terminals. Mold into the socket the coincident screw terminal numbers and associated octal pin numbers.

D. Current Sensing Relay:

1. Basis-of-Design Product: Subject to compliance with requirements, provide as indicated and specified herein by one of the following or equal:
 - a. Square D; by Schneider Electric.
2. Monitors ac current.
3. Independent adjustable controls for pickup and dropout current.
4. Energized when supply voltage is present and current is above pickup setting.
5. De-energizes when monitored current is below dropout current.
6. Dropout current is adjustable from 50 to 95 percent of pickup current.
7. Include a current transformer, if required for application.
8. House current sensing relay and current transformer in its own enclosure. Use NEMA 250, Type 12 enclosure for indoors and NEMA 250, Type 4 for outdoors.

E. Combination On-Off Status Sensor and On-Off Relay:

1. Basis-of-Design Product: Subject to compliance with requirements, provide as indicated and specified herein by one of the following or equal:
 - a. Functional Devices Inc.
2. Description:
 - a. On-off control and status indication in a single device.
 - b. LED status indication of activated relay and current trigger.
 - c. Closed-Open-Auto override switch located on the load side of the relay.
3. Performance:
 - a. Ambient Temperature: Minus 30 to 140 deg F.
 - b. Voltage Rating: Single-phase loads rated for 300-V ac. Three-phase loads rated for 600-V ac.
4. Status Indication:
 - a. Current Sensor: Integral sensing for single-phase loads up to 20 A and external solid or split sensing ring for three-phase loads up to 150 A.
 - b. Current Sensor Range: As required by application.
 - c. Current Set Point: Fixed or adjustable as required by application.
 - d. Current Sensor Output: (Provide as required for application one of the following)
 - 1) Solid-state, single-pole double-throw contact rated for 30-V ac and dc and for 0.4 A.
 - 2) Solid-state, single-pole double-throw contact rated for 120-V ac and 1.0 A.
 - 3) Analog, zero- to 5- or 10-V dc.
 - 4) Analog, 4 to 20 mA, loop powered.
5. Relay: Single-pole double-throw, continuous-duty coil; rated for 10-million mechanical cycles.
6. Enclosure: NEMA 250, Type 1 enclosure.

2.20 ELECTRICAL POWER DEVICES

A. Transformers:

1. Transformer shall be sized for the total connected load, plus an additional 25 percent of connected load.
2. Transformer shall be at least 100 VA.
3. Transformer shall have both primary and secondary fuses.

2.21 PIPING AND TUBING

A. Pneumatic, and Pressure Instrument Signal Air, Tubing and Piping:

1. Products in this paragraph are intended for use with the following:
 - a. Signal air between pressure instruments, such as sensors, switches, transmitters, controllers and accessories.
2. Copper Tubing:
 - a. Seamless phosphor deoxidized copper, soft annealed or drawn tempered, with chemical and physical properties according to ASTM B 75.
 - b. Performance, dimensions, weight and tolerance according to ASTM B 280.
 - c. Diameter, as required by application, not less than nominal 0.25 inch.
 - d. Wall thickness, as required by the application, but not less than 0.030 inch.
3. Copper Tubing Connectors and Fittings:
 - a. Brass, compression type.
 - 1) Basis-of-Design Product: Subject to compliance with requirements, provide as indicated and specified herein by one of the following or equal:
 - a) Parker Hannifin Corporation.
 - b. Brass, solder-joint type.
 - 1) Basis-of-Design Product: Subject to compliance with requirements, provide as indicated and specified herein by one of the following or equal:
 - a) Paul Mueller Company.
4. Polyethylene Tubing:
 - a. Fire-resistant black virgin polyethylene according to ASTM D 1248, Type 1, Class C and Grade 5.
 - b. Tubing shall comply with stress crack test according to ASTM D 1693.
 - c. Diameter, as required by application, of not less than nominal 0.25 inch.
5. Polyethylene Tubing Connectors and Fittings:
 - a. Brass, barbered fittings.
 - 1) Basis-of-Design Product: Subject to compliance with requirements, provide as indicated and specified herein by one of the following or equal:
 - a) Parker Hannifin Corporation.
 - b. Brass, compression type.
 - 1) Basis-of-Design Product: Subject to compliance with requirements, provide as indicated and specified herein by one of the following or equal:
 - a) Parker Hannifin Corporation.

2.22 CONTROL WIRE AND CABLE

- A. Wire: Single conductor control wiring above 24 V.
1. Wire size shall be at least No. 16 Insert value AWG.
 2. Conductor shall be 7/24 soft annealed copper strand with 2- to 2.5-inch lay.
 3. Conductor insulation shall be 600 V, Type THWN or Type THHN, and 90 deg C according to UL 83.
 4. Conductor colors shall be black (hot), white (neutral), and green (ground).
 5. Furnish wire on spools.
- B. Single Twisted Shielded Instrumentation Cable above 24 V:
1. Wire size shall be a minimum No. 18 AWG.
 2. Conductors shall be a twisted, 7/24 soft annealed copper strand with a 2- to 2.5-inch lay.
 3. Conductor insulation shall have a Type THHN/THWN or Type TFN rating.
 4. Shielding shall be 100 percent type, 0.35/0.5-mil aluminum/Mylar tape, helically applied with 25 percent overlap, and aluminum side in with tinned copper drain wire.
 5. Outer jacket insulation shall have a 600-V, 90-deg C rating and shall be Type TC cable.
 6. For twisted pair, conductor colors shall be black and white. For twisted triad, conductor colors shall be black, red and white.
 7. Furnish wire on spools.
- C. Single Twisted Shielded Instrumentation Cable 24 V and Less:
1. Wire size shall be a minimum No. 20 AWG.
 2. Conductors shall be a twisted, 7/24 soft annealed copper stranding with a 2- to 2.5-inch lay.
 3. Conductor insulation shall have a nominal 15-mil thickness, constructed from flame-retardant PVC.
 4. Shielding shall be 100 percent type, 1.35-mil aluminum/polymer tape, helically applied with 25 percent overlap, and aluminum side in with tinned copper drain wire.
 5. Outer jacket insulation shall have a 300-V, 105-deg C rating and shall be Type PLTC cable.
 6. For twisted pair, conductor colors shall be black and white. For twisted triad, conductor colors shall be black, red and white.
 7. Furnish wire on spools.
- D. LAN and Communication Cable: Comply with DDC system manufacturer requirements for network being installed.
1. Cable shall be plenum rated.
 2. Cable shall comply with NFPA 70.
 3. Cable shall have a unique color that is different from other cables used on Project.
 4. Copper Cable for Ethernet Network:
 - a. 1000BASE-T or 1000BASE-TX.
 - b. TIA/EIA 586, Category 5e or Category 6.
 - c. Minimum No. 24 AWG solid.
 - d. Shielded Twisted Pair (STP).

- e. Thermoplastic insulated conductors, enclosed in a thermoplastic outer jacket, Class CMP as plenum rated.

2.23 RACEWAYS FOR CONTROL WIRING, CABLING, AND TUBING

A. Metal Conduits, Tubing, and Fittings:

1. Basis-of-Design Product: Subject to compliance with requirements, provide as indicated and specified herein by one of the following or equal:
 - a. AFC Cable Systems, Inc.
 - b. Allied Tube & Conduit; a brand of Atkore International.
 - c. Anamet Electrical, Inc.
 - d. Current Technology Inc.
 - e. Electri-Flex Company.
2. Listing and Labeling: Metal conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
3. GRC: Comply with NEMA ANSI C80.1 and UL 6.
4. IMC: Comply with NEMA ANSI C80.6 and UL 1242.
5. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit.
 - a. Comply with NEMA RN 1.
 - b. Coating Thickness: 0.040 inch, minimum.
6. EMT: Comply with NEMA ANSI C80.3 and UL 797.
7. FMC: Comply with UL 1; zinc-coated steel or aluminum.
8. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.
9. Fittings for Metal Conduit: Comply with NEMA ANSI FB 1 and UL 514B.
 - a. Fittings for EMT:
 - 1) Material: Steel or die cast.
 - 2) Type: Setscrew or compression.
 - b. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.
 - c. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch, with overlapping sleeves protecting threaded joints.
10. Joint Compound for IMC, GRC, or ARC: Approved, as defined in NFPA 70 with Massachusetts amendments, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

B. Nonmetallic Conduits, Tubing, and Fittings:

1. Basis-of-Design Product: Subject to compliance with requirements, provide **<insert manufacturer name, product name or designation>** or comparable product by one of the following:
 - a. AFC Cable Systems, Inc.
 - b. Anamet Electrical, Inc.
 - c. CANTEX INC.
 - d. CertainTeed Corporation.
2. Listing and Labeling: Nonmetallic conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
3. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.
4. Fittings for RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.
5. Solvent cements and adhesive primers shall have a VOC content of 510 and 550 g/L or less.

2.24 CONTROL POWER WIRING AND RACEWAYS

- A. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" electrical power conductors and cables.
- B. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems" for electrical power raceways and boxes.

2.25 FIBER-OPTIC CABLE, CONNECTORS, AND RACEWAY

- A. Cables:
 1. Basis-of-Design Product: Subject to compliance with requirements, provide as indicated and specified herein by one of the following or equal:
 - a. AMP NETCONNECT; a Tyco Electronics brand; a TE Connectivity Ltd. company.
 - b. AT&T.
 - c. Belden Inc.
 - d. Corning Cable Systems.
 2. Performance Requirements:
 - a. Fiber: Multimode graded index. Core/cladding size shall be either 62.5/125 or 100/140 micrometers.
 - b. Numerical Aperture:
 - 1) 62.5/125 Micrometer Fiber: 0.275 plus or minus 0.015.
 - 2) 100/140 Micrometer Fiber: 0.29 plus or minus 0.015.

- c. Maximum Attenuation:
 - 1) 850 nm: 6.0 dB/km.
 - 2) 1300 nm: 5.0 dB/km.
 - d. Minimum Bandwidth Dispersion: 300 Mhz-km at 850 nm.
 - e. Core/Cladding Index Difference: 0.3 percent plus or minus 0.05 percent, measured using refractive rear field measurement procedure.
 - f. Color-code finished fibers for easy identification.
 - g. Splice Loss: Fibers shall be spliced together to form a longer fiber using a commercially available fiber splicing machine recommended by cable manufacturer. Maximum loss per fiber splice shall be 0.20 dB.
 - h. Connection: Fibers shall be connected using fiber-optic connectors. Nominal connector loss shall not be greater than 1 dB.
 - i. Fiber-optic cable shall be suitable for use with 100Base-FX or 100Base-SX standard (as applicable) as defined in IEEE 802.3.
3. Mechanical and Environmental Requirements:
- a. Tensile Strength: Fiber cable shall withstand a minimum tensile strength of 2700 N with maximum elongation of less than 0.5 percent.
 - b. Bending Radius: Minimum static bending radius for cable shall be 10 times outside diameter for non-armored cables and 20 times outside diameter for armored cables. Non-armored cables shall withstand being flexed at minimum static bending radius plus or minus 90 degrees for at least 20 cycles at 20 to 40 cycles per minute at 20 deg C. Armored cables shall withstand being flexed at minimum static bending radius plus or minus 90 degrees for at least 10 cycles at 20 to 40 cycles per minute at 20 deg C.
 - c. Vibration: Cable shall withstand a vibration test with vibration amplitude of 5 mm and frequency of 10 cycles per second for at least five hours.
 - d. Twist: Cable shall withstand twisting of 360 degrees over a length of 2 m for at least 10 cycles at 10 cycles per minute.
 - e. Temperature: Cable shall withstand the following temperatures:
 - 1) Installation: Minus 30 to 70 deg C.
 - 2) Operation: Minus 40 to 70 deg C.
 - 3) Storage/Shipping: Minus 40 to 70 deg C.
 - f. Lifetime: Average lifetime of a 2-km, 12-fiber cable shall be at least 20 years when installed in a natural ambient environment. End of useful life shall be reached if failing to comply with requirements indicated or a spontaneous catastrophic fiber failure.
 - g. Crush Resistance: Cable shall withstand a compressive force of 705 N/cm for armored cables and 600 N/cm for non-armored cables. There shall be no attenuation increase after force is removed.
4. Cable Structure:
- a. Number of Fibers: Supply the required number of fibers in each cable for DDC system indicated, plus not less than 50 percent spare. Cable structure shall have fibers grouped for easy handling.

- b. Strength Members: Include cable with strength members to satisfy mechanical and environmental conditions indicated.
- c. Cable Core: Core shall consist of stranded buffer tubes around a central member of appropriate geometric size and shall be filled and bound to maintain core integrity. A fibrous strength member may be stranded around core to provide necessary strength for cable.
- d. Cable Jacket: Protect cable by an extruded-polyethylene jacket.
- e. Cable Armor: For cables requiring extra mechanical protection, one or two layers of galvanized corrugated steel tape coated by an anticorrosive compound shall be either helically or longitudinally applied over standard outer jacket. Apply a second outer jacket of polyethylene over coated steel tape. Thickness of sheaths and jackets are not specified as long as mechanical and environmental conditions are satisfied.
- f. Cable Installation: Cables shall be suitable for a semiprotected outdoor installation.

5. Packaging and Shipping:

- a. Seal both ends of each length of cable.
- b. Test individual fibers in each cable before shipping to verify compliance with Specifications.

B. Connectors:

1. Basis-of-Design Product: Subject to compliance with requirements, provide as indicated and specified herein by one of the following or equal:

- a. AMP NETCONNECT; a Tyco Electronics brand; a TE Connectivity Ltd. company.
- b. AT&T.
- c. Communications Specialties, Inc.
- d. Corning Cable Systems.

2. Performance Requirements:

- a. Type: Fiber-optic connectors shall be either Type ST or Type SMA. Use either connector type exclusively. No substitutions are allowed.
- b. Insertion Loss: Connector shall have an insertion loss of not greater than 1 dB.
- c. Coupling Tolerance: Connector shall withstand at least 500 couplings with insertion loss within 0.25-dB tolerance limit.
- d. Mechanical Requirements:
 - 1) Connector shall enclose outermost coating of single fiber cable and be able to be mated or unmated without using a tool.
 - 2) Mount connector rigidly in a metal frame.
 - 3) Connector shall allow a semiskilled person to properly install connector to a single fiber easily in a field environment with simple tools.

C. Cable Identification:

1. Basis-of-Design Product: Subject to compliance with requirements, provide as indicated and specified herein by one of the following or equal:

- a. Paul Mueller Company.
2. Labeling product shall be self-laminating cable marker.
3. Cable labeling shall include numeric designation, source, destination, and cable type.

2.26 ACCESSORIES

A. Damper Blade Limit Switches:

1. Sense positive open and/or closed position of the damper blades.
2. NEMA 250, Type 13, oil-tight construction.
3. Arrange for the mounting application.
4. Additional waterproof enclosure when required by its environment.
5. Arrange to prevent "over-center" operation.

B. Instrument Enclosures:

1. Basis-of-Design Product: Subject to compliance with requirements, provide as indicated and specified herein by one of the following or equal:
 - a. Hoffman; a brand of Pentair Equipment Protection.
2. Include instrument enclosure for secondary protection to comply with requirements indicated in "Performance Requirements" Article.
3. NRTL listed and labeled to UL 50.
4. Sized to include at least 25 percent spare area on subpanel.
5. Instrument(s) mounted within enclosure on internal subpanel(s).
6. Enclosure face with engraved, laminated phenolic nameplate for each instrument within enclosure.
7. Enclosures housing pneumatic instruments shall include main pressure gage and a branch pressure gage for each pneumatic device, installed inside.
8. Enclosures housing multiple instruments shall route tubing and wiring within enclosure in a raceway having a continuous removable cover.
9. Enclosures larger than 12 inches shall have a hinged full-size face cover.
10. Equip enclosure with lock and common key.

C. Manual Valves:

1. Ball Type:
 - a. Basis-of-Design Product: Subject to compliance with requirements, provide as indicated and specified herein by one of the following or equal:
 - 1) NIBCO INC.

- b. Body: Bronze ASTM B 62 or ASTM B 61.
- c. Ball: Type 316 stainless steel.
- d. Stem: Type 316 stainless steel.
- e. Seats: Reinforced PTFE.
- f. Packing Ring: Reinforced PTFE.
- g. Lever: Stainless steel with a vinyl grip.
- h. 600 WOG.
- i. Threaded end connections.

2.27 IDENTIFICATION

A. Control Equipment, Instruments, and Control Devices:

1. Engraved tag bearing unique identification.
 - a. Include instruments with unique identification identified by equipment being controlled or monitored, followed by point identification.
2. Letter size shall be as follows:
 - a. Operator Workstations: Minimum of 0.5 inch high.
 - b. Servers: Minimum of 0.5 inch high.
 - c. Printers: Minimum of 0.5 inch high.
 - d. DDC Controllers: Minimum of 0.5 inch high.
 - e. Gateways: Minimum of 0.5 inch high.
 - f. Repeaters: Minimum of 0.5 inch high.
 - g. Enclosures: Minimum of 0.5 inch high.
 - h. Electrical Power Devices: Minimum of 0.25 inch high.
 - i. Accessories: Minimum of 0.25 inch high.
 - j. Instruments: Minimum of 0.25 inch high.
 - k. Control Damper and Valve Actuators: Minimum of 0.25 inch high.
3. Tag shall consist of white lettering on black background.
4. Tag shall be engraved phenolic consisting of three layers of rigid laminate. Top and bottom layers are color-coded black with contrasting white center exposed by engraving through outer layer.
5. Tag shall be fastened with drive pins.
6. Instruments, control devices and actuators with Project-specific identification tags having unique identification numbers following requirements indicated and provided by original manufacturer do not require an additional tag.

B. Valve Tags:

1. Brass tags and brass chains attached to valve.
2. Tags shall be at least 1.5 inches in diameter.
3. Include tag with unique valve identification indicating control influence such as flow, level, pressure, or temperature; followed by location of valve, and followed by three-digit sequential number. For example: TV-1.001.

4. Valves with Project-specific identification tags having unique identification numbers following requirements indicated and provided by original manufacturer do not require an additional tag.
- C. Raceway and Boxes:
1. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
 2. Paint cover plates on junction boxes and conduit same color as the tape banding for conduits. After painting, label cover plate "HVAC Controls," using an engraved phenolic tag.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
1. Verify compatibility with and suitability of substrates.
- B. Examine roughing-in for products to verify actual locations of connections before installation.
1. Examine roughing-in for instruments installed in piping to verify actual locations of connections before installation.
 2. Examine roughing-in for instruments installed in duct systems to verify actual locations of connections before installation.
- C. Examine walls, floors, roofs, and ceilings for suitable conditions where product will be installed.
- D. Prepare written report, endorsed by Installer, listing conditions detrimental to performance of the Work.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 DDC SYSTEM INTERFACE WITH OTHER SYSTEMS AND EQUIPMENT

- A. Communication Interface to Equipment with Integral Controls:
1. DDC system shall have communication interface with equipment having integral controls and having a communication interface for remote monitoring or control.

3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install products to satisfy more stringent of all requirements indicated.
- B. Install products level, plumb, parallel, and perpendicular with building construction.

- C. Support products, tubing, piping wiring and raceways. Brace products to prevent lateral movement and sway or a break in attachment when subjected to a force.
- D. If codes and referenced standards are more stringent than requirements indicated, comply with requirements in codes and referenced standards.
- E. Fabricate openings and install sleeves in ceilings, floors, roof, and walls required by installation of products. Before proceeding with drilling, punching, and cutting, check for concealed work to avoid damage. Patch, flash, grout, seal, and refinish openings to match adjacent condition.
- F. Firestop penetrations made in fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."
- G. Seal penetrations made in acoustically rated assemblies. Comply with requirements in Section 079200 "Joint Sealants."
- H. Welding Requirements:
 - 1. Restrict welding and burning to supports and bracing.
 - 2. No equipment shall be cut or welded without approval. Welding or cutting will not be approved if there is risk of damage to adjacent Work.
 - 3. Welding, where approved, shall be by inert-gas electric arc process and shall be performed by qualified welders according to applicable welding codes.
 - 4. If requested on-site, show satisfactory evidence of welder certificates indicating ability to perform welding work intended.
- I. Fastening Hardware:
 - 1. Stillson wrenches, pliers, and other tools that damage surfaces of rods, nuts, and other parts are prohibited for work of assembling and tightening fasteners.
 - 2. Tighten bolts and nuts firmly and uniformly. Do not overstress threads by excessive force or by oversized wrenches.
 - 3. Lubricate threads of bolts, nuts and screws with graphite and oil before assembly.
- J. If product locations are not indicated, install products in locations that are accessible and that will permit service and maintenance from floor, equipment platforms, or catwalks without removal of permanently installed furniture and equipment.

3.4 OPERATOR WORKSTATION INSTALLATION

- A. Desktop Operator Workstations Installation:
 - 1. Install operator workstation at location directed by Owner.
 - 2. Install multiple-receptacle power strip with cord for use in connecting multiple workstation components to a single duplex electrical power receptacle.
 - 3. Install software on workstation and verify software functions properly.
 - 4. Develop Project-specific graphics, trends, reports, logs and historical database.
- B. Portable Operator Workstations Installation:
 - 1. Turn over portable operator workstations to Owner at Substantial Completion.

2. Install software on workstation(s) and verify software functions properly.

C. Color Graphics Application:

1. Use system schematics indicated as starting point to create graphics.
2. Develop Project-specific library of symbols for representing system equipment and products.
3. Incorporate digital images of Project-completed installation into graphics where beneficial to enhance effect.
4. Submit sketch of graphic layout with description of all text for each graphic for Owner's and Engineer's review before creating graphic using graphics software.
5. Seek Owner input in graphics development once using graphics software.
6. Final editing shall be done on-site with Owner's and Engineer's review and feedback.
7. Refine graphics as necessary for Owner acceptance.
8. On receiving Owner acceptance, print a hard copy for inclusion in operation and maintenance manual. Prepare a scanned copy PDF file of each graphic and include with softcopy of DDC system operation and maintenance manual.

3.5 POT INSTALLATION

- A. Install one portable operator terminal.
- B. Turn over POTs to Owner at Substantial Completion.
- C. Install software on each POT and verify that software functions properly.

3.6 PRINTER INSTALLATION

- A. Provide the following printer(s) at location(s) directed by Owner:
 1. Color Inkjet: Quantity, one.
- B. Install printer software on workstations and verify that software functions properly.

3.7 GATEWAY INSTALLATION

- A. Install gateways if required for DDC system communication interface requirements.
 1. Install gateway(s) required to suit indicated requirements as shown on the drawings.
- B. Test gateway to verify that communication interface functions properly.

3.8 ROUTER INSTALLATION

- A. Install routers if required for DDC system communication interface.
 1. Install router(s) required to suit indicated requirements shown on the drawings..
- B. Test router to verify that communication interface functions properly.

3.9 CONTROLLER INSTALLATION

- A. Install controllers in enclosures to comply with indicated requirements.
- B. Connect controllers to field power supply.
- C. Install controller with latest version of applicable software and configure to execute requirements indicated.
- D. Test and adjust controllers to verify operation of connected I/O to achieve performance indicated requirements while executing sequences of operation.
- E. Installation of Network Controllers:
 - 1. Quantity and location of network controllers shall be determined by DDC system manufacturer to satisfy requirements indicated.
 - 2. Install controllers in a protected location that is easily accessible by operators.
- F. Installation of Programmable Application Controllers:
 - 1. Quantity and location of programmable application controllers shall be determined by DDC system manufacturer to satisfy requirements indicated.
 - 2. Install controllers in a protected location that is easily accessible by operators.
- G. Application-Specific Controllers:
 - 1. Quantity and location of application-specific controllers shall be determined by DDC system manufacturer to satisfy requirements indicated.
 - 2. For controllers not mounted directly on equipment being controlled, install controllers in a protected location that is easily accessible by operators.

3.10 ENCLOSURES INSTALLATION

- A. Install the following items in enclosures, to comply with indicated requirements:
 - 1. Gateways.
 - 2. Routers.
 - 3. Controllers.
 - 4. Electrical power devices.
 - 5. Relays.
 - 6. Accessories.
 - 7. Instruments.
 - 8. Actuators
- B. Attach wall-mounted enclosures to wall using the following types of steel struts:
 - 1. For NEMA 250, Type 1 Enclosures: Use painted steel strut and hardware.
 - 2. For NEMA 250, Type 4 Enclosures and Enclosures Located Outdoors: Use stainless-steel strut and hardware.
 - 3. Install plastic caps on exposed cut edges of strut.

- C. Align top or bottom of adjacent enclosures of like size.

3.11 ELECTRIC POWER CONNECTIONS

- A. Connect electrical power to DDC system products requiring electrical power connections.
- B. Design of electrical power to products not indicated with electric power is delegated to DDC system provider and installing trade. Work shall comply with NFPA 70 with Massachusetts amendments and other requirements indicated.
- C. Comply with requirements in Section 262816 "Enclosed Switches and Circuit Breakers" for electrical power circuit breakers.
- D. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" for electrical power conductors and cables.
- E. Comply with requirements in Section 260533 "Raceways and Boxes for Electrical Systems" for electrical power raceways and boxes.

3.12 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements in Section 260553 "Identification for Electrical Systems" for identification products and installation.
- B. Install engraved phenolic nameplate with unique identification on face for each of the following:
 - 1. Operator workstation.
 - 2. Server.
 - 3. Printer.
 - 4. Gateway.
 - 5. Router.
 - 6. DDC controller.
 - 7. Enclosure.
 - 8. Accessory.
- C. Where product is installed above accessible tile ceiling, also install matching engraved phenolic nameplate with identification on face of ceiling grid located directly below.
- D. Where product is installed above an inaccessible ceiling, also install engraved phenolic nameplate with identification on face of access door directly below.

3.13 NETWORK INSTALLATION

- A. Install fiber-optic cable when connecting between the following network devices when distance between devices exceeds 400 ft:
 - 1. Operator workstations.

2. Operator workstations and network controllers.
 3. Network controllers.
 4. Network controllers and application specific controllers
 5. Application Specific Controllers and Manufacturers Panels
- B. Install copper or fiber-optic cable when connecting between the following network devices located in same building:
1. Operator workstations.
 2. Operator workstations and network controllers.
 3. Network controllers.
 4. Network controllers and application specific controllers
 5. Application Specific Controllers and Manufacturers Panels
- C. Install copper cable when connecting between the following:
1. Gateways.
 2. Gateways and network controllers or programmable application controllers.
 3. Routers.
 4. Routers and network controllers or programmable application controllers.
 5. Network controllers and programmable application controllers.
 6. Programmable application controllers.
 7. Programmable application controllers and application-specific controllers.
 8. Application-specific controllers.

3.14 NETWORK NAMING AND NUMBERING

- A. Coordinate with Owner and provide unique naming and addressing for networks and devices.
- B. ASHRAE 135 Networks:
1. MAC Address:
 - a. Every network device shall have an assigned and documented MAC address unique to its network.
 - b. Ethernet Networks: Document MAC address assigned at its creation.
 - c. ARCNET or MS/TP networks: Assign from 00 to 64.
 2. Network Numbering:
 - a. Assign unique numbers to each new network.
 - b. Provide ability for changing network number through device switches or operator interface.
 - c. DDC system, with all possible connected LANs, can contain up to 65,534 unique networks.
 3. Device Object Identifier Property Number:

- a. Assign unique device object identifier property numbers or device instances for each device network.
 - b. Provide for future modification of device instance number by device switches or operator interface.
 - c. LAN shall support up to 4,194,302 unique devices.
4. Device Object Name Property Text:
- a. Device object name property field shall support 32 minimum printable characters.
 - b. Assign unique device "Object Name" property names with plain-English descriptive names for each device.
 - 1) Example 1: Device object name for device controlling boiler plant at Building 1000 would be "HW System B1000."
 - 2) Example 2: Device object name for a VAV terminal unit controller could be "VAV unit 102".
5. Object Name Property Text for Other Than Device Objects:
- a. Object name property field shall support 32 minimum printable characters.
 - b. Assign object name properties with plain-English names descriptive of application.
 - 1) Example 1: "Zone 1 Temperature."
 - 2) Example 2 "Fan Start and Stop."
6. Object Identifier Property Number for Other Than Device Objects:
- a. Assign object identifier property numbers according to Drawings indicated.
 - b. If not indicated, object identifier property numbers may be assigned at Installer's discretion but must be approved by Owner in advance, be documented and be unique for like object types within device.

3.15 PIPING AND TUBING INSTALLATION

A. Above-Grade Pneumatic Tubing Installation:

- 1. Material Application:
 - a. Install copper tubing, except as follows:
 - 1) Concealed Tubing: Polyethylene tubing may be used in lieu of copper tubing when concealed behind accessible ceilings and concealed in walls and connecting wall-mounted instruments with recessed connections.
 - b. Install copper tubing for sizes up through NPS 1 Install drawn-temper copper tubing, except within 36 inches of device terminations tubing shall be annealed-tempered copper tubing.
 - c. Install compression fittings to connect copper tubing to instruments, control devices, and accessories.
 - d. Install barbed or compression fittings to connect polyethylene tubing to instruments, control devices, and accessories.

2. Routing:
 - a. Do not expose tubing in finished spaces, such as spaces with ceilings; occupied spaces, offices, and conference rooms, unless expressly approved in writing by Architect. Tubing may be exposed in areas without ceilings.
 - b. Where tubing is installed in finished occupied spaces, install the tubing in surface metal raceway with appropriate fittings only where not feasible to conceal in wall, above ceiling or behind architectural enclosures or covers.
 - c. Install piping and tubing plumb and parallel to and at right angles with building construction.
 - d. Install multiple runs of tubing or piping in equally spaced parallel lines.
 - e. Piping and tubing shall not interfere with access to valves, equipment, duct and equipment access doors, or obstruct personnel access and passageways of any kind.
 - f. Coordinate with other trades before installation to prevent proposed piping and tubing from interfering with pipe, duct, terminal equipment, light fixtures, conduit and cable tray space. If changes to Shop Drawings are necessary due to field coordination, document changes on record Drawings.
 - g. Install vibration loops in copper tubing when connecting to instrument and actuators that vibrate.
3. Support:
 - a. According to MSS SP-69, Table 3, except support spacing shall not exceed 60 inches.
 - b. Support copper tubing with copper hangers, clips, and tube trays.
 - c. Do not use tape for support or dielectric isolation.
 - d. Install supports at each change in direction and at each branch take off.
 - e. Attached supports to building structure independent of work of other trades. Support from ducts, pipes, cable trays, and conduits is prohibited.
 - f. Attached support from building structure with threaded rods, structural shapes, or channel strut.
 - g. Install and brace supports to carry static load plus a safety margin, which will allow tubing to be serviced.
 - h. Brace supports to prevent lateral movement.
 - i. Paint steel support members that are not galvanized or zinc coated.
 - j. Support polyethylene tubing same as copper tubing.
4. Do not attach piping and tubing to equipment that may be removed frequently for maintenance or that may impart vibration and expansion from temperature change.
5. Joining and Makeup:
 - a. Where joining and mating dissimilar metals where galvanic action could occur, install dielectric isolation.
 - b. Make threaded joints for connecting to instrument equipment with connectors with a compression tubing connector on one end and threaded connection on other end.
 - c. Make tubing bends with a tube-bending tool. Hard bends, wrinkled or flattened bends are unacceptable.
 - d. Install tube fittings according to manufacturer's written instructions.
 - e. Do not make tubing connections to a fitting before completing makeup of the connection.

- f. Align tubing with the fitting. Avoid springing tube into position, as this may result in excessive stress on both tubing and fitting with possible resulting leaks.
 - g. Do not install fittings close to a bend. A length of straight tubing, not deformed by bending, is required for a proper connection.
 - h. Check tubing for correct diameter and wall thickness.
 - i. Tube ends shall be cut square and deburred. Exercise care during cutting to keep tubing round.
 - j. Thread pipe on a threading machine. Ream inner edges of pipe ends, file and grind to remove burrs.
 - k. Wrap pipe threads of fittings on pneumatic lines with a single wrap of PTFE tape.
 - l. Protect piping and tubing from entrance of foreign matter.
6. Conduit in which nonmetallic tubing is installed shall not exceed 50 percent fill. Support conduit according to NFPA 70 unless otherwise indicated.

B. Isolation Valves Installation:

1. Install valves full size of piping and tubing.
2. Install isolation valves at the following locations:
 - a. Inlet to each instrument including, sensors, transmitters, switches, gages, and other control devices.

3.16 CONTROL WIRE, CABLE AND RACEWAYS INSTALLATION

- A. Comply with NECA 1.
- B. Comply with TIA 568-C.1.
- C. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.
- D. Field Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.
- E. Conduit Installation:
 1. Install conduit expansion joints where conduit runs exceed 200 feet, and conduit crosses building expansion joints.
 2. Coordinate conduit routing with other trades to avoid conflicts with ducts, pipes and equipment and service clearance.
 3. Maintain at least 3-inch separation where conduits run axially above or below ducts and pipes.
 4. Limit above-grade conduit runs to 100 feet without pull or junction box.
 5. Do not install raceways or electrical items on any "explosion-relief" walls, or rotating equipment.
 6. Do not fasten conduits onto the bottom side of a metal deck roof.
 7. Flexible conduit is permitted only where flexibility and vibration control is required.
 8. Limit flexible conduit to 3 feet long.

9. Conduit shall be continuous from outlet to outlet, from outlet to enclosures, pull and junction boxes, and shall be secured to boxes in such manner that each system shall be electrically continuous throughout.
10. Direct bury conduits underground where indicated or required.
 - a. Use rigid, nonmetallic, Schedule 80 PVC.
 - b. Provide a burial depth according to NFPA 70, but not less than 24 inches.
11. Secure threaded conduit entering an instrument enclosure, cabinet, box, and trough, with a locknut on outside and inside, such that conduit system is electrically continuous throughout. Provide a metal bushing on inside with insulated throats. Locknuts shall be the type designed to bite into the metal or, on inside of enclosure, shall have a grounding wedge lug under locknut.
12. Conduit box-type connectors for conduit entering enclosures shall have an insulated throat.
13. Connect conduit entering enclosures in wet locations with box-type connectors or with watertight sealing locknuts or other fittings.
14. Offset conduits where entering surface-mounted equipment.
15. Seal conduit runs used by sealing fittings to prevent the circulation of air for the following:
 - a. Conduit extending from interior to exterior of building.
 - b. Conduit extending into pressurized duct and equipment.
 - c. Conduit extending into pressurized zones that are automatically controlled to maintain different pressure set points.

F. Wire and Cable Installation:

1. Cables serving a common system may be grouped in a common raceway. Install control wiring and cable in separate raceway from power wiring. Do not group conductors from different systems or different voltages.
2. Install cables with protective sheathing that is waterproof and capable of withstanding continuous temperatures of 90 deg C with no measurable effect on physical and electrical properties of cable.
 - a. Provide shielding to prevent interference and distortion from adjacent cables and equipment.
3. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
4. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIMM, "Cabling Termination Practices" Chapter. Install lacing bars and distribution spools.
5. UTP Cable Installation:
 - a. Comply with TIA 568-C.2.
 - b. Do not untwist UTP cables more than 1/2 inch from the point of termination, to maintain cable geometry.
6. Installation of Cable Routed Exposed under Raised Floors:

- a. Install plenum-rated cable only.
 - b. Install cabling after the flooring system has been installed in raised floor areas.
 - c. Coil cable 6 feet long not less than 12 inches in diameter below each feed point.
7. Identify each wire on each end and at each terminal with a number-coded identification tag. Each wire shall have a unique tag.
 8. Provide strain relief.
 9. Terminate wiring in a junction box.
 - a. Clamp cable over jacket in junction box.
 - b. Individual conductors in the stripped section of the cable shall be slack between the clamping point and terminal block.
 10. Terminate field wiring and cable not directly connected to instruments and control devices having integral wiring terminals using terminal blocks.
 11. Install signal transmission components according to IEEE C2, REA Form 511a, NFPA 70, and as indicated.
 12. Keep runs short. Allow extra length for connecting to terminal boards. Do not bend flexible coaxial cables in a radius less than 10 times the cable OD. Use sleeves or grommets to protect cables from vibration at points where they pass around sharp corners and through penetrations.
 13. Ground wire shall be copper and grounding methods shall comply with IEEE C2. Demonstrate ground resistance.
 14. Wire and cable shall be continuous from terminal to terminal without splices.
 15. Use insulated spade lugs for wire and cable connection to screw terminals.
 16. Use shielded cable to transmitters.
 17. Use shielded cable to temperature sensors.
 18. Perform continuity and meager testing on wire and cable after installation.
 19. Do not install bruised, kinked, scored, deformed, or abraded wire and cable. Remove and discard wire and cable if damaged during installation, and replace it with new cable.
 20. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
 21. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.
 22. Protection from Electro-Magnetic Interference (EMI): Provide installation free of (EMI). As a minimum, comply with the following requirements:
 - a. Comply with BICSI TDMM and TIA 569-C for separating unshielded cable from potential EMI sources, including electrical power lines and equipment.
 - b. Separation between open cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
 - 1) Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.
 - 2) Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
 - 3) Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.
 - c. Separation between cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
 - 1) Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.

- 2) Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
 - 3) Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.
- d. Separation between cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
- 1) Electrical Equipment Rating Less Than 2 kVA: No requirement.
 - 2) Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.
 - 3) Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.
- e. Separation between Cables and Electrical Motors and Transformers, 5 kVA or 5 HP and Larger: A minimum of 48 inches.
- f. Separation between Cables and Fluorescent Fixtures: A minimum of 5 inches.

3.17 FIBER-OPTIC CABLE SYSTEM INSTALLATION

- A. Comply with TIA 568-C.3, except where requirements indicated are more stringent.
- B. Raceway Installation:
1. Install continuous raceway for routing fiber-optic cables.
 2. Install raceways continuously between pull boxes and junction boxes. Raceways shall enter and be secured to enclosures.
 3. Make bends in raceway using large-radius preformed ells. Field bending shall be according to NFPA 70 minimum radii requirements. Use only equipment specifically designed for material and size involved.
 4. Install no more than the equivalent of two 90-degree bends in any pathway run. Support within 12 inches of changes in direction. Use long radius elbows for all fiber-optic cables.
 5. Entire raceway shall be complete and raceway interior cleaned before installation of fiber-optic cables.
 6. Securely fasten raceway to building structure using clamps and clips designed for purpose.
 7. Install nylon or polyethylene pulling line in raceways. Clearly label as "pulling line," indicating source and destination.
- C. Fiber-Optic Cable Installation:
1. Route cables as efficiently as possible, minimizing amount of cable required.
 2. Continuously lubricate cables during pulling-in process.
 3. Do not exceed maximum pulling tensions provided by cable manufacturer. Monitor cable pulling tension with a mechanical tension meter.
 4. Arrange cables passing through pull boxes to obtain maximum clearance among cables within box.
 5. As cables emerge from intermediate point pull boxes, coil cable in a figure eight pattern with loops not less than 24 inches in diameter.
 6. Terminate fiber-optic cables in a fiber-optic splice organizer cabinet, unless connected equipment can accept fiber-optic cables directly. Terminate cables with connectors.

7. Install and connect appropriate opto-electronic equipment and fiber jumper cables between opto-electronic equipment and fiber-optic cable system to DDC system fiber-optic cable system. Verify interface compatibility.

D. Cable and Raceway Identification:

1. Label cables at both ends. Labels shall be typed, not handwritten.
2. Mark raceways at each pull box indicating the type and number of cables within.

3.18 DDC SYSTEM I/O CHECKOUT PROCEDURES

A. Check installed products before continuity tests, leak tests and calibration.

B. Check instruments for proper location and accessibility.

C. Check instruments for proper installation on direction of flow, elevation, orientation, insertion depth, or other applicable considerations that will impact performance.

D. Check instrument tubing for proper isolation, fittings, slope, dirt legs, drains, material and support.

E. For pneumatic products, verify that air supply for each product is properly installed.

F. Control Damper Checkout:

1. For pneumatic dampers, verify that pressure gages are provided in each air line to damper actuator and positioner.
2. Verify that control dampers are installed correctly for flow direction.
3. Verify that proper blade alignment, either parallel or opposed, has been provided.
4. Verify that damper frame attachment is properly secured and sealed.
5. Verify that damper actuator and linkage attachment is secure.
6. Verify that actuator wiring is complete, enclosed and connected to correct power source.
7. Verify that damper blade travel is unobstructed.

G. Control Valve Checkout:

1. For pneumatic valves, verify that pressure gages are provided in each air line to valve actuator and positioner.
2. Verify that control valves are installed correctly for flow direction.
3. Verify that valve body attachment is properly secured and sealed.
4. Verify that valve actuator and linkage attachment is secure.
5. Verify that actuator wiring is complete, enclosed and connected to correct power source.
6. Verify that valve ball, disc or plug travel is unobstructed.
7. After piping systems have been tested and put into service, but before insulating and balancing, inspect each valve for leaks. Adjust or replace packing to stop leaks. Replace the valve if leaks persist.

H. Instrument Checkout:

1. Verify that instrument is correctly installed for location, orientation, direction and operating clearances.

2. Verify that attachment is properly secured and sealed.
3. Verify that conduit connections are properly secured and sealed.
4. Verify that wiring is properly labeled with unique identification, correct type and size and is securely attached to proper terminals.
5. Inspect instrument tag against approved submittal.
6. For instruments with tubing connections, verify that tubing attachment is secure and isolation valves have been provided.
7. For flow instruments, verify that recommended upstream and downstream distances have been maintained.
8. For temperature instruments:
 - a. Verify sensing element type and proper material.
 - b. Verify length and insertion.

3.19 DDC SYSTEM I/O ADJUSTMENT, CALIBRATION AND TESTING:

- A. Calibrate each instrument installed that is not factory calibrated and provided with calibration documentation.
- B. Provide a written description of proposed field procedures and equipment for calibrating each type of instrument. Submit procedures before calibration and adjustment.
- C. For each analog instrument, make a three-point test of calibration for both linearity and accuracy.
- D. Equipment and procedures used for calibration shall comply with instrument manufacturer's written instructions.
- E. Provide diagnostic and test equipment for calibration and adjustment.
- F. Field instruments and equipment used to test and calibrate installed instruments shall have accuracy at least twice the instrument accuracy being calibrated. An installed instrument with an accuracy of 1 percent shall be checked by an instrument with an accuracy of 0.5 percent.
- G. Calibrate each instrument according to instrument instruction manual supplied by manufacturer.
- H. If after calibration indicated performance cannot be achieved, replace out-of-tolerance instruments.
- I. Comply with field testing requirements and procedures indicated by ASHRAE's Guideline 11, "Field Testing of HVAC Control Components," in the absence of specific requirements, and to supplement requirements indicated.
- J. Analog Signals:
 1. Check analog voltage signals using a precision voltage meter at zero, 50, and 100 percent.
 2. Check analog current signals using a precision current meter at zero, 50, and 100 percent.
 3. Check resistance signals for temperature sensors at zero, 50, and 100 percent of operating span using a precision-resistant source.

K. Digital Signals:

1. Check digital signals using a jumper wire.
2. Check digital signals using an ohmmeter to test for contact making or breaking.

L. Control Dampers:

1. Stroke and adjust control dampers following manufacturer's recommended procedure, from 100 percent open to 100 percent closed and back to 100 percent open.
2. Stroke control dampers with pilot positioners. Adjust damper and positioner following manufacturer's recommended procedure, so damper is 100 percent closed, 50 percent closed and 100 percent open at proper air pressure.
3. Check and document open and close cycle times for applications with a cycle time less than 30 seconds.
4. For control dampers equipped with positive position indication, check feedback signal at multiple positions to confirm proper position indication.

M. Control Valves:

1. Stroke and adjust control valves following manufacturer's recommended procedure, from 100 percent open to 100 percent closed and back to 100 percent open.
2. Stroke control valves with pilot positioners. Adjust valve and positioner following manufacturer's recommended procedure, so valve is 100 percent closed, 50 percent closed and 100 percent open at proper air pressures.
3. Check and document open and close cycle times for applications with a cycle time less than 30 seconds.
4. For control valves equipped with positive position indication, check feedback signal at multiple positions to confirm proper position indication.

N. Meters: Check sensors at zero, 50, and 100 percent of Project design values.

O. Sensors: Check sensors at zero, 50, and 100 percent of Project design values.

P. Switches: Calibrate switches to make or break contact at set points indicated.

Q. Transmitters:

1. Check and calibrate transmitters at zero, 50, and 100 percent of Project design values.
2. Calibrate resistance temperature transmitters at zero, 50, and 100 percent of span using a precision-resistant source.

3.20 DDC SYSTEM CONTROLLER CHECKOUT

A. Verify power supply.

1. Verify voltage, phase and hertz.
2. Verify that protection from power surges is installed and functioning.
3. Verify that ground fault protection is installed.
4. If applicable, verify if connected to UPS unit.
5. If applicable, verify if connected to a backup power source.

6. If applicable, verify that power conditioning units, transient voltage suppression and high-frequency noise filter units are installed.
- B. Verify that wire and cabling is properly secured to terminals and labeled with unique identification.
- C. Verify that spare I/O capacity is provided.

3.21 DDC CONTROLLER I/O CONTROL LOOP TESTS

- A. Testing:
 1. Test every I/O point connected to DDC controller to verify that safety and operating control set points are as indicated and as required to operate controlled system safely and at optimum performance.
 2. Test every I/O point throughout its full operating range.
 3. Test every control loop to verify operation is stable and accurate.
 4. Adjust control loop proportional, integral and derivative settings to achieve optimum performance while complying with performance requirements indicated. Document testing of each control loop's precision and stability via trend logs.
 5. Test and adjust every control loop for proper operation according to sequence of operation.
 6. Test software and hardware interlocks for proper operation. Correct deficiencies.
 7. Operate each analog point at the following:
 - a. Upper quarter of range.
 - b. Lower quarter of range.
 - c. At midpoint of range.
 8. Exercise each binary point.
 9. For every I/O point in DDC system, read and record each value at operator workstation, at DDC controller and at field instrument simultaneously. Value displayed at operator workstation, at DDC controller and at field instrument shall match.
 10. Prepare and submit a report documenting results for each I/O point in DDC system and include in each I/O point a description of corrective measures and adjustments made to achieve desired results.

3.22 DDC SYSTEM VALIDATION TESTS

- A. Perform validation tests before requesting final review of system. Before beginning testing, first submit Pretest Checklist and Test Plan.
- B. After approval of Test Plan, execute all tests and procedures indicated in plan.
- C. After testing is complete, submit completed test checklist.
- D. Pretest Checklist: Submit the following list with items checked off once verified:
 1. Detailed explanation for any items that are not completed or verified.

2. Required mechanical installation work is successfully completed and HVAC equipment is working correctly.
3. HVAC equipment motors operate below full-load amperage ratings.
4. Required DDC system components, wiring, and accessories are installed.
5. Installed DDC system architecture matches approved Drawings.
6. Control electric power circuits operate at proper voltage and are free from faults.
7. Required surge protection is installed.
8. DDC system network communications function properly, including uploading and downloading programming changes.
9. Each controller's programming is backed up.
10. Equipment, products, tubing, wiring cable and conduits are properly labeled.
11. All I/O points are programmed into controllers.
12. Testing, adjusting and balancing work affecting controls is complete.
13. Dampers and actuators zero and span adjustments are set properly.
14. Each control damper and actuator goes to failed position on loss of power.
15. Valves and actuators zero and span adjustments are set properly.
16. Each control valve and actuator goes to failed position on loss of power.
17. Meter, sensor and transmitter readings are accurate and calibrated.
18. Control loops are tuned for smooth and stable operation.
19. View trend data where applicable.
20. Each controller works properly in standalone mode.
21. Safety controls and devices function properly.
22. Interfaces with fire-alarm system function properly.
23. Electrical interlocks function properly.
24. Operator workstations and other interfaces are delivered, all system and database software is installed, and graphic are created.
25. Record Drawings are completed.

E. Test Plan:

1. Prepare and submit a validation test plan including test procedures for performance validation tests.
2. Test plan shall address all specified functions of DDC system and sequences of operation.
3. Explain detailed actions and expected results to demonstrate compliance with requirements indicated.
4. Explain method for simulating necessary conditions of operation used to demonstrate performance.
5. Include a test checklist to be used to check and initial that each test has been successfully completed.
6. Submit test plan documentation 10 business days before start of tests.

F. Validation Test:

1. Verify operating performance of each I/O point in DDC system.
 - a. Verify analog I/O points at operating value.
 - b. Make adjustments to out-of-tolerance I/O points.
 - 1) Identify I/O points for future reference.
 - 2) Simulate abnormal conditions to demonstrate proper function of safety devices.

- 3) Replace instruments and controllers that cannot maintain performance indicated after adjustments.
 2. Simulate conditions to demonstrate proper sequence of control.
 3. Readjust settings to design values and observe ability of DDC system to establish desired conditions.
 4. After 24 Hours following Initial Validation Test:
 - a. Re-check I/O points that required corrections during initial test.
 - b. Identify I/O points that still require additional correction and make corrections necessary to achieve desired results.
 5. After 24 Hours of Second Validation Test:
 - a. Re-check I/O points that required corrections during second test.
 - b. Continue validation testing until I/O point is normal on two consecutive tests.
 6. Completely check out, calibrate, and test all connected hardware and software to ensure that DDC system performs according to requirements indicated.
 7. After validation testing is complete, prepare and submit a report indicating all I/O points that required correction and how many validation re-tests it took to pass. Identify adjustments made for each test and indicate instruments that were replaced.
- G. DDC System Response Time Test:
1. Simulate HLC.
 - a. Heavy load shall be an occurrence of 50 percent of total connected binary COV, one-half of which represent an "alarm" condition, and 50 percent of total connected analog COV, one-half of which represent an "alarm" condition, that are initiated simultaneously on a one-time basis.
 2. Initiate 10 successive occurrences of HLC and measure response time to typical alarms and status changes.
 3. Measure with a timer having at least 0.1-second resolution and 0.01 percent accuracy.
 4. Purpose of test is to demonstrate DDC system, as follows:
 - a. Reaction to COV and alarm conditions during HLC.
 - b. Ability to update DDC system database during HLC.
 5. Passing test is contingent on the following:
 - a. Alarm reporting at printer beginning no more than two seconds after the initiation (time zero) of HLC.
 - b. All alarms, both binary and analog, are reported and printed; none are lost.
 - c. Compliance with response times specified.
 6. Prepare and submit a report documenting HLC tested and results of test including time stamp and print out of all alarms.
- H. DDC System Network Bandwidth Test:

1. Test network bandwidth usage on all DDC system networks to demonstrate bandwidth usage under DDC system normal operating conditions and under simulated HLC.
2. To pass, none of DDC system networks shall use more than 70 percent of available bandwidth under normal and HLC operation.

3.23 DDC SYSTEM WIRELESS NETWORK VERIFICATION

- A. DDC system Installer shall design wireless DDC system networks to comply with performance requirements indicated.
- B. Installer shall verify wireless network performance through field testing and shall document results in a field test report.
- C. Testing and verification of all wireless devices shall include, but not be limited to, the following:
 1. Speed.
 2. Online status.
 3. Signal strength.

3.24 FINAL REVIEW

- A. Submit written request to Engineer and Construction Manager when DDC system is ready for final review. Written request shall state the following:
 1. DDC system has been thoroughly inspected for compliance with contract documents and found to be in full compliance.
 2. DDC system has been calibrated, adjusted and tested and found to comply with requirements of operational stability, accuracy, speed and other performance requirements indicated.
 3. DDC system monitoring and control of HVAC systems results in operation according to sequences of operation indicated.
 4. DDC system is complete and ready for final review.
- B. Review by Engineer and Construction Manager shall be made after receipt of written request. A field report shall be issued to document observations and deficiencies.
- C. Take prompt action to remedy deficiencies indicated in field report and submit a second written request when all deficiencies have been corrected. Repeat process until no deficiencies are reported.
- D. Should more than two reviews be required, DDC system manufacturer and Installer shall compensate entity performing review for total costs, labor and expenses, associated with third and subsequent reviews. Estimated cost of each review shall be submitted and approved by DDC system manufacturer and Installer before making the review.
- E. Prepare and submit closeout submittals when no deficiencies are reported.
- F. A part of DDC system final review shall include a demonstration to parties participating in final review.

1. Provide staff familiar with DDC system installed to demonstrate operation of DDC system during final review.
2. Provide testing equipment to demonstrate accuracy and other performance requirements of DDC system that is requested by reviewers during final review.
3. Demonstration shall include, but not be limited to, the following:
 - a. Accuracy and calibration of 20 I/O points randomly selected by reviewers. If review finds that some I/O points are not properly calibrated and not satisfying performance requirements indicated, additional I/O points may be selected by reviewers until total I/O points being reviewed that satisfy requirements equals quantity indicated.
 - b. HVAC equipment and system hardwired and software safeties and life-safety functions are operating according to sequence of operation. Up to 10 I/O points shall be randomly selected by reviewers. Additional I/O points may be selected by reviewers to discover problems with operation.
 - c. Correct sequence of operation after electrical power interruption and resumption after electrical power is restored for randomly selected HVAC systems.
 - d. Operation of randomly selected dampers and valves in normal-on, normal-off and failed positions.
 - e. Reporting of alarm conditions for randomly selected alarms, including different classes of alarms, to ensure that alarms are properly received by operators and operator workstations.
 - f. Trends, summaries, logs and reports set-up for Project.
 - g. For up to two HVAC systems randomly selected by reviewers, use graph trends to show that sequence of operation is executed in correct manner and that HVAC systems operate properly through complete sequence of operation including different modes of operations indicated. Show that control loops are stable and operating at set points and respond to changes in set point of 20 percent or more.
 - h. Software's ability to communicate with controllers, operator workstations, uploading and downloading of control programs.
 - i. Software's ability to edit control programs off-line.
 - j. Data entry to show Project-specific customizing capability including parameter changes.
 - k. Step through penetration tree, display all graphics, demonstrate dynamic update, and direct access to graphics.
 - l. Execution of digital and analog commands in graphic mode.
 - m. Spreadsheet and curve plot software and its integration with database.
 - n. Online user guide and help functions.
 - o. Multitasking by showing different operations occurring simultaneously on four quadrants of split screen.
 - p. System speed of response compared to requirements indicated.
 - q. For Each Network and Programmable Application Controller:
 - 1) Memory: Programmed data, parameters, trend and alarm history collected during normal operation is not lost during power failure.
 - 2) Operator Interface: Ability to connect directly to each type of digital controller with a portable operator workstation and PDA. Show that maintenance personnel interface tools perform as indicated in manufacturer's technical literature.

- 3) Standalone Ability: Demonstrate that controllers provide stable and reliable standalone operation using default values or other method for values normally read over network.
 - 4) Electric Power: Ability to disconnect any controller safely from its power source.
 - 5) Wiring Labels: Match control drawings.
 - 6) Network Communication: Ability to locate a controller's location on network and communication architecture matches Shop Drawings.
 - 7) Nameplates and Tags: Accurate and permanently attached to control panel doors, instrument, actuators and devices.
- r. For Each Operator Workstation:
- 1) I/O points lists agree with naming conventions.
 - 2) Graphics are complete.
 - 3) UPS unit, if applicable, operates.
- s. Communications and Interoperability: Demonstrate proper interoperability of data sharing, alarm and event management, trending, scheduling, and device and network management. Requirements must be met even if only one manufacturer's equipment is installed.
- 1) Data Presentation: On each operator workstation, demonstrate graphic display capabilities.
 - 2) Reading of Any Property: Demonstrate ability to read and display any used readable object property of any device on network.
 - 3) Set Point and Parameter Modifications: Show ability to modify set points and tuning parameters indicated.
 - 4) Peer-to-Peer Data Exchange: Network devices are installed and configured to perform without need for operator intervention to implement Project sequence of operation and to share global data.
 - 5) Alarm and Event Management: Alarms and events are installed and prioritized according to Owner. Demonstrate that time delays and other logic are set up to avoid nuisance tripping. Show that operators with sufficient privileges are permitted.
 - 6) Schedule Lists: Schedules are configured for start and stop, mode change, occupant overrides, and night setback as defined in sequence of operations.
 - 7) Schedule Display and Modification: Ability to display any schedule with start and stop times for calendar year. Show that all calendar entries and schedules are modifiable from any connected operator workstation by an operator with sufficient privilege.
 - 8) Archival Storage of Data: Data archiving is handled by operator workstation and server and local trend archiving and display is accomplished.
 - 9) Modification of Trend Log Object Parameters: Operator with sufficient privilege can change logged data points, sampling rate, and trend duration.
 - 10) Device and Network Management:
 - a) Display of network device status.
 - b) Display of BACnet Object Information.
 - c) Silencing devices transmitting erroneous data.
 - d) Time synchronization.

- e) Remote device re-initialization.
- f) Backup and restore network device programming and master database(s).
- g) Configuration management of routers..

3.25 EXTENDED OPERATION TEST

- A. Extended operation test is intended to simulate normal operation of DDC system by Owner.
- B. Operate DDC system for an operating period of 21 consecutive calendar days following Substantial Completion. Coordinate exact start date of testing with Owner.
- C. Provide an operator familiar with DDC system installed to man an operator workstation while on-site during eight hours of each normal business day occurring during operating period.
- D. During operating period, DDC system shall demonstrate correct operation and accuracy of monitored and controlled points as well as operation capabilities of sequences, logs, trends, reports, specialized control algorithms, diagnostics, and other software indicated.
 - 1. Correct defects of hardware and software when it occurs.
- E. Definition of Failures and Downtime during Operating Period:
 - 1. Failed I/O point constituting downtime is an I/O point failing to perform its intended function consistently and a point physically failed due to hardware and software.
 - 2. Downtime is when any I/O point in DDC system is unable to fulfill its' required function.
 - 3. Downtime shall be calculated as elapsed time between a detected point failure as confirmed by an operator and time point is restored to service.
 - 4. Maximum time interval allowed between DDC system detection of failure occurrence and operator confirmation shall be 0.5 hours.
 - 5. Downtime shall be logged in hours to nearest 0.1 hour.
 - 6. Power outages shall not count as downtime, but shall suspend test hours unless systems are provided with UPS and served through a backup power source.
 - 7. Hardware or software failures caused by power outages shall count as downtime.
- F. During operating period, log downtime and operational problems are encountered.
 - 1. Identify source of problem.
 - 2. Provide written description of corrective action taken.
 - 3. Record duration of downtime.
 - 4. Maintain log showing the following:
 - a. Time of occurrence.
 - b. Description of each occurrence and pertinent written comments for reviewer to understand scope and extent of occurrence.
 - c. Downtime for each failed I/O point.
 - d. Running total of downtime and total time of I/O point after each problem has been restored.
 - 5. Log shall be available to Owner for review at any time.

- G. For DDC system to pass extended operation test, total downtime shall not exceed 1 percent of total point-hours during operating period.
 - 1. Failure to comply with minimum requirements of passing at end of operating period indicated shall require that operating period be extended one consecutive day at a time until DDC system passes requirement.
- H. Evaluation of DDC system passing test shall be based on the following calculation:
 - 1. Downtime shall be counted on a point-hour basis where total number of DDC system point-hours is equal to total number of I/O points in DDC system multiplied by total number of hours during operating period.
 - 2. One point-hour of downtime is one I/O point down for one hour. Three points down for five hours is a total of 15 point-hours of downtime. Four points down for one-half hour is 2 point-hours of downtime.
 - 3. Example Calculation: Maximum allowable downtime for 30-day test when DDC system has 1000 total I/O points (combined analog and binary) and has passing score of 1 percent downtime is computed by 30 days x 24 h/day x 1000 points x 1 percent equals 7200 point-hours of maximum allowable downtime.
- I. Prepare test and inspection reports.

3.26 ADJUSTING

- A. Occupancy Adjustments: When requested within 12 months from date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.27 SOFTWARE SERVICE AGREEMENT

- A. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two year(s).
- B. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within two year(s) from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.
 - 1. Upgrade Notice: At least 30 days to allow Owner to schedule and access system and to upgrade computer equipment if necessary.

3.28 DEMONSTRATION

- A. Engage a factory-authorized service representative with complete knowledge of Project-specific system installed to train Owner's maintenance personnel to adjust, operate, and maintain DDC system.
- B. Extent of Training:

1. Base extent of training on scope and complexity of DDC system indicated and training requirements indicated. Provide extent of training required to satisfy requirements indicated even if more than minimum training requirements are indicated.
2. Inform Owner of anticipated training requirements if more than minimum training requirements are indicated.
3. Minimum Training Requirements:
 - a. Provide not less than 10 days of training total.
 - b. Stagger training over multiple training classes to accommodate Owner's requirements. All training shall occur before end of warranty period.
 - c. Total days of training shall be broken into not more than three separate training classes.
 - d. Each training class shall be not less than two consecutive day(s).

C. Training Schedule:

1. Schedule training with Owner 20 business days before expected Substantial Completion.
2. Schedule training to provide Owner with at least 10 business days of notice in advance of training.
3. Training shall occur within normal business hours at a mutually agreed on time. Unless otherwise agreed to, training shall occur Monday through Friday, except on U.S. Federal holidays, with two morning sessions and two afternoon sessions. Each morning session and afternoon session shall be split in half with 15-minute break between sessions. Morning and afternoon sessions shall be separated by 30-minute lunch period. Training, including breaks and excluding lunch period, shall not exceed eight hours per day.
4. Provide staggered training schedule as requested by Owner.

D. Training Attendee List and Sign-in Sheet:

1. Request from Owner in advance of training a proposed attendee list with name, phone number and e-mail address.
2. Provide a preprinted sign-in sheet for each training session with proposed attendees listed and no fewer than six blank spaces to add additional attendees.
3. Preprinted sign-in sheet shall include training session number, date and time, instructor name, phone number and e-mail address, and brief description of content to be covered during session. List attendees with columns for name, phone number, e-mail address and a column for attendee signature or initials.
4. Circulate sign-in sheet at beginning of each session and solicit attendees to sign or initial in applicable location.
5. At end of each training day, send Owner an e-mail with an attachment of scanned copy (PDF) of circulated sign-in sheet for each session.

E. Training Attendee Headcount:

1. Plan in advance of training for two attendees.
2. Make allowance for Owner to add up to one attendee(s) at time of training.
3. Headcount may vary depending on training content covered in session. Attendee access may be restricted to some training content for purposes of maintaining system security.

F. Training Attendee Prior Knowledge: For guidance in planning required training and instruction, assume attendees have the following:

1. High school education and degree.
2. Basic user knowledge of computers and office applications.
3. Basic knowledge of HVAC systems.
4. Basic knowledge of DDC systems.
5. Basic knowledge of DDC system and products installed.

G. Attendee Training Manuals:

1. Provide each attendee with a color hard copy of all training materials and visual presentations.
2. Hard-copy materials shall be organized in a three-ring binder with table of contents and individual divider tabs marked for each logical grouping of subject matter. Organize material to provide space for attendees to take handwritten notes within training manuals.
3. In addition to hard-copy materials included in training manual, provide each binder with a sleeve or pocket that includes a DVD or flash drive with PDF copy of all hard-copy materials.

H. Instructor Requirements:

1. One or multiple qualified instructors, as required, to provide training.
2. Instructors shall have not less than five years of providing instructional training on not less than five past projects with similar DDC system scope and complexity to DDC system installed.

I. Organization of Training Sessions:

1. Organize training sessions into logical groupings of technical content and to reflect different levels of operators having access to system. Plan training sessions to accommodate the following three levels of operators:
 - a. Daily operators.
 - b. Advanced operators.
 - c. System managers and administrators.
2. Plan and organize training sessions to group training content to protect DDC system security. Some attendees may be restricted to some training sessions that cover restricted content for purposes of maintaining DDC system security.

J. Training Outline:

1. Submit training outline for Owner review at least 10 business day before scheduling training.
2. Outline shall include a detailed agenda for each training day that is broken down into each of four training sessions that day, training objectives for each training session and synopses for each lesson planned.

K. On-Site Training:

1. Owner will provide conditioned classroom or workspace with ample desks or tables, chairs, power and data connectivity for instructor and each attendee.

2. Instructor shall provide training materials, projector and other audiovisual equipment used in training.
3. Provide as much of training located on-site as deemed feasible and practical by Owner.
4. On-site training shall include regular walk-through tours, as required, to observe each unique product type installed with hands-on review of operation, calibration and service requirements.
5. Operator workstation provided with DDC system shall be used in training. If operator workstation is not indicated, provide a temporary workstation to convey training content.

L. Off-Site Training:

1. Provide conditioned training rooms and workspace with ample tables desks or tables, chairs, power and data connectivity for each attendee.
2. Provide capability to remotely access to Project DDC system for use in training.
3. Provide a workstation for use by each attendee.

M. Training Content for Daily Operators:

1. Basic operation of system.
2. Understanding DDC system architecture and configuration.
3. Understanding each unique product type installed including performance and service requirements for each.
4. Understanding operation of each system and equipment controlled by DDC system including sequences of operation, each unique control algorithm and each unique optimization routine.
5. Operating operator workstations, printers and other peripherals.
6. Logging on and off system.
7. Accessing graphics, reports and alarms.
8. Adjusting and changing set points and time schedules.
9. Recognizing DDC system malfunctions.
10. Understanding content of operation and maintenance manuals including control drawings.
11. Understanding physical location and placement of DDC controllers and I/O hardware.
12. Accessing data from DDC controllers.
13. Operating portable operator workstations.
14. Review of DDC testing results to establish basic understanding of DDC system operating performance and HVAC system limitations as of Substantial Completion.
15. Running each specified report and log.
16. Displaying and demonstrating each data entry to show Project-specific customizing capability. Demonstrating parameter changes.
17. Stepping through graphics penetration tree, displaying all graphics, demonstrating dynamic updating, and direct access to graphics.
18. Executing digital and analog commands in graphic mode.
19. Demonstrating control loop precision and stability via trend logs of I/O for not less than 10 percent of I/O installed.
20. Demonstrating DDC system performance through trend logs and command tracing.
21. Demonstrating scan, update, and alarm responsiveness.
22. Demonstrating spreadsheet and curve plot software, and its integration with database.
23. Demonstrating on-line user guide, and help function and mail facility.
24. Demonstrating multitasking by showing dynamic curve plot, and graphic construction operating simultaneously via split screen.

25. Demonstrating the following for HVAC systems and equipment controlled by DDC system:
 - a. Operation of HVAC equipment in normal-off, -on and failed conditions while observing individual equipment, dampers and valves for correct position under each condition.
 - b. For HVAC equipment with factory-installed software, show that integration into DDC system is able to communicate with DDC controllers or gateways, as applicable.
 - c. Using graphed trends, show that sequence of operation is executed in correct manner, and HVAC systems operate properly through complete sequence of operation including seasonal change, occupied and unoccupied modes, warm-up and cool-down cycles and other modes of operation indicated.
 - d. Hardware interlocks and safeties function properly and DDC system performs correct sequence of operation after electrical power interruption and resumption after power is restored.
 - e. Reporting of alarm conditions for each alarm, and confirm that alarms are received at assigned locations, including operator workstations.
 - f. Each control loop responds to set point adjustment and stabilizes within time period indicated.
 - g. Sharing of previously graphed trends of all control loops to demonstrate that each control loop is stable and set points are being maintained..

N. Video of Training Sessions:

1. Provide a digital video and audio recording of each training session. Create a separate recording file for each session.
2. Stamp each recording file with training session number, session name and date.
3. Provide Owner with two copies of digital files on DVDs or flash drives for later reference and for use in future training.
4. Owner retains right to make additional copies for intended training purposes without having to pay royalties.

END OF SECTION 230923

SECTION 231126
FACILITY LIQUEFIED-PETROLEUM GAS PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Pipes, tubes, and fittings.
2. Piping specialties.
3. Piping and tubing joining materials.
4. Valves.
5. Pressure regulators.
6. Storage containers.
7. Transport truck unloading facility specialties.
8. Pumps.
9. Vaporizers.

1.2 PERFORMANCE REQUIREMENTS

A. Minimum Operating-Pressure Ratings:

1. For Piping Containing Only Vapor:
 - a. Piping and Valves: 125 psig unless otherwise indicated.
2. For Piping Containing Liquid:
 - a. Piping between Shutoff Valves: 350 psig unless otherwise indicated.

B. LPG System Pressure within Buildings: One pressure range. 0.5 psig or less.

C. Delegated Design: Design restraints and anchors for LPG piping and equipment, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

D. Seismic Performance: Vaporizers and storage container supports shall withstand the effects of earthquake motions determined according to SEI/ASCE 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

1.3 ACTION SUBMITTALS

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

- B. Shop Drawings: For facility LPG piping layout. Include plans, piping layout and elevations, sections, and details for fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to building structure. Detail location of anchors, alignment guides, and expansion joints and loops.

1.4 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Data: Submit certification that vaporizer, storage container supports, accessories, and components will withstand seismic forces defined in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment." Include the following:
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - 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.
- B. Welding certificates.
- C. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and maintenance data.

1.6 QUALITY ASSURANCE

- A. Steel Support Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- B. Pipe Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

PART 2 - PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

- A. Steel Pipe: ASTM A53/A53M, black steel, Schedules 40 and 80, Type E or S, Grade B.
 - 1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.
 - 2. Wrought-Steel Welding Fittings: ASTM A234/A234M for butt welding and socket welding.

3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.
4. Protective Coating for Underground Piping: Factory-applied, three-layer coating of epoxy, adhesive, and PE.
 - a. Joint Cover Kits: Epoxy paint, adhesive, and heat-shrink PE sleeves.

B. PE Pipe: ASTM D2513, SDR 11.

1. PE Fittings: ASTM D2683, socket-fusion type or ASTM D3261, butt-fusion type with dimensions matching PE pipe.
2. PE Transition Fittings: Factory-fabricated fittings with PE pipe complying with ASTM D2513, SDR 11; and steel pipe complying with ASTM A53/A53M, black steel, Schedule 40, Type E or S, Grade B.
3. Anodeless Service-Line Risers: Factory fabricated and leak tested.
 - a. Underground Portion: PE pipe complying with ASTM D2513, SDR 11 inlet.
 - b. Casing: Steel pipe complying with ASTM A53/A53M, Schedule 40, black steel, Type E or S, Grade B with corrosion-protective coating covering.
 - c. Aboveground Portion: PE transition fitting.
 - d. Outlet shall be threaded suitable for welded connection.
 - e. Tracer wire connection.
 - f. Ultraviolet shield.
 - g. Stake supports with factory finish to match steel pipe casing or carrier pipe.
4. Transition Service-Line Risers: Factory fabricated and leak tested.
 - a. Underground Portion: PE pipe complying with ASTM D2513, SDR 11 inlet connected to steel pipe complying with ASTM A53/A53M, Schedule 40, Type E or S, Grade B, with corrosion-protective coating for aboveground outlet.
 - b. Outlet shall be threaded suitable for welded connection.
 - c. Bridging sleeve over mechanical coupling.
 - d. Factory-connected anode.
 - e. Tracer wire connection.
 - f. Ultraviolet shield.
 - g. Stake supports with factory finish to match steel pipe casing or carrier pipe.

2.2 PIPING SPECIALTIES

A. Appliance Flexible Connectors:

1. Indoor, Fixed-Appliance Flexible Connectors: Comply with ANSI Z21.24.
2. Indoor, Movable-Appliance Flexible Connectors: Comply with ANSI Z21.69.
3. Outdoor, Appliance Flexible Connectors: Comply with ANSI Z21.75.
4. Corrugated stainless-steel tubing with polymer coating.
5. Operating-Pressure Rating: 0.5 psig.
6. End Fittings: Zinc-coated steel.
7. Threaded Ends: Comply with ASME B1.20.1.
8. Maximum Length: 72 inches

- B. Y-Pattern Strainers:
 - 1. Body: ASTM A126, Class B, cast iron with bolted cover and bottom drain connection.
 - 2. End Connections: Threaded ends for NPS 2 and smaller.
 - 3. Strainer Screen: 60-mesh startup strainer and perforated stainless-steel basket with 50 percent free area.
 - 4. CWP Rating: 125 psig.
- C. Weatherproof Vent Cap: Cast- or malleable-iron increaser fitting with corrosion-resistant wire screen, with free area at least equal to cross-sectional area of connecting pipe and threaded-end connection.

2.3 JOINING MATERIALS

- A. Joint Compound and Tape: Suitable for LPG.
- B. Welding Filler Metals: Comply with AWS D10.12/D10.12M for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.4 MANUAL GAS SHUTOFF VALVES

- A. See "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles for where each valve type is applied in various services.
- B. Metallic Valves, NPS 2 and Smaller for Liquid Service: Comply with ASME B16.33 and UL 842.
 - 1. CWP Rating: 250 psig.
 - 2. Threaded Ends: Comply with ASME B1.20.1.
 - 3. Socket ends for brazed joints.
 - 4. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 - 5. Listing by CSA or agency acceptable to authorities having jurisdiction for valves 1 inch and smaller.
 - 6. Valves 1-1/4 inch and larger shall be suitable for LPG service, with "WOG" indicated on valve body.
- C. General Requirements for Metallic Valves, NPS 2 and Smaller for Vapor Service: Comply with ASME B16.33.
 - 1. CWP Rating: 125 psig.
 - 2. Threaded Ends: Comply with ASME B1.20.1.
 - 3. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.
 - 4. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
 - 5. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch and smaller.

6. Service Mark: Valves 1-1/4 inch to NPS 2 shall have initials "WOG" permanently marked on valve body.

D. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim: MSS SP-110.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. A.Y. McDonald Mfg. Co.
 - b. Apollo Flow Controls; Conbraco Industries, Inc.
 - c. BrassCraft Manufacturing Co.; a Masco company.
2. Body: Bronze, complying with ASTM B584.
3. Ball: Chrome-plated bronze.
4. Stem: Bronze; blowout proof.
5. Seats: Reinforced TFE; blowout proof.
6. Packing: Threaded-body packnut design with adjustable-stem packing.
7. Ends: Threaded, flared, or socket as indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
8. CWP Rating: 600 psig.
9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
10. Service: Suitable for LPG service with "WOG" indicated on valve body.

2.5 PRESSURE REGULATORS

A. General Requirements:

1. Single stage, second stage and suitable for LPG.
2. Steel jacket and corrosion-resistant components.
3. Elevation compensator.
4. End Connections: Threaded for regulators NPS 2 and smaller.

B. Line Pressure Regulators: Comply with ANSI Z21.80.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal:
 - a. Eclipse Innovative Thermal Technologies.
 - b. Fisher Control Valves & Instruments; a brand of Emerson Process Management.
 - c. Maxitrol Company.
2. Body and Diaphragm Case: Cast iron or die-cast aluminum.
3. Springs: Zinc-plated steel; interchangeable.
4. Diaphragm Plate: Zinc-plated steel.
5. Seat Disc: Nitrile rubber resistant to gas impurities, abrasion, and deformation at the valve port.
6. Orifice: Aluminum; interchangeable.
7. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.

8. Single-port, self-contained regulator with orifice no larger than required at maximum pressure inlet and no pressure sensing piping external to the regulator.
9. Pressure regulator shall maintain discharge pressure setting downstream and not exceed 150 percent of design discharge pressure at shutoff.
10. Overpressure Protection Device: Factory mounted on pressure regulator.
11. Atmospheric Vent: Factory- or field-installed, stainless-steel screen in opening if not connected to vent piping.
12. Maximum Inlet Pressure: 10 psig.

C. Appliance Pressure Regulators: Comply with ANSI Z21.18.

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Eaton.
 - b. Maxitrol Company.
 - c. SCP, Inc.
2. Body and Diaphragm Case: Die-cast aluminum.
3. Springs: Zinc-plated steel; interchangeable.
4. Diaphragm Plate: Zinc-plated steel.
5. Seat Disc: Nitrile rubber.
6. Seal Plug: Ultraviolet-stabilized, mineral-filled nylon.
7. Factory-Applied Finish: Minimum three-layer polyester and polyurethane paint finish.
8. Regulator may include vent limiting device, instead of vent connection, if approved by authorities having jurisdiction.
9. Maximum Inlet Pressure: 10 psig
10. Maximum Outlet pressure: 0.5 psig (14" w.c.)

2.6 DIELECTRIC UNIONS

A. Dielectric Unions:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. A.Y. McDonald Mfg. Co.
 - b. WATTS.
 - c. Wilkins.
2. Standard: ASSE 1079.
3. Pressure Rating: 250 psig.
4. End Connections: Solder-joint copper alloy and threaded ferrous.

2.7 STORAGE CONTAINERS

- A. Description: Factory fabricated, complying with requirements in NFPA 58 and ASME Boiler and Pressure Vessel Code and bearing the ASME label. Tanks shall be rated for 250-psig minimum working pressure.
1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. American Welding & Tank.
 - b. Trinity Industries, Inc.
 - c. United Industries Group, Inc.
 2. Liquid outlet and vapor inlet and outlet connections shall have shutoff valves with excess-flow safety shutoff valves and bypass and back-pressure check valves with smaller than 0.039-inch drill-size hole to equalize pressure. Liquid-fill connection shall have backflow check valve.
 - a. Connections: Color-code and tag valves to indicate type.
 - 1) Liquid fill and outlet, red.
 - 2) Vapor inlet and outlet, yellow.
 3. Level gage shall indicate current level of liquid in the container. Gages shall also indicate storage container contents; e.g., "Butane," "50-50 LPG Mix," or "Propane."
 4. Pressure relief valves, type and number as required by NFPA 58, connected to vapor space and having discharge piping same size as relief-valve outlet and long enough to extend at least 84 inches directly overhead. Identify relief valves as follows:
 - a. Discharge pressure in psig.
 - b. Rate of discharge for standard air in cfm.
 - c. Manufacturer's name.
 - d. Catalog or model number.
 5. Container pressure gage.
 6. For outdoor installation, exposed metal surfaces mechanically cleaned, primed, and painted for resistance to corrosion.
 7. Ladders for access to valves more than 72 inches aboveground.
 8. Stainless-Steel Nameplate: Attach to aboveground storage container or to adjacent structure for underground storage container.
 - a. Name and address of supplier or trade name of container.
 - b. Water capacity in gallons and liters.
 - c. Design pressure in psig (kPa).
 - d. Statement, "This container shall not contain a product having a vapor pressure in excess of 125 psig
 - e. Outside surface area in sq. ft. (sq. m).
 - f. Year of manufacture.
 - g. Shell thickness in inches (mm).
 - h. Overall length in feet (m).

- i. OD in feet (m).
 - j. Manufacturer's serial number.
 - k. ASME Code label.
- 9. Felt support pads and two concrete or painted-steel saddles per storage container. Corrosion protection required at container-to-felt contact.
 - 10. Tie straps for each saddle.

2.8 VAPORIZERS

- A. Description: Factory-fabricated, -assembled, and -tested vaporizer with heat exchanger sealed pressure-tight, built on a steel base; including insulated jacket, flue-gas vent, liquid fuel supply and vapor connections, and controls. Assembly shall be FMG labeled and comply with NFPA 58 and NFPA 70.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Algas-SDI.
 - b. Ely Energy, Inc.
 - c. Ransome Manufacturing; a division of Meeder Equipment Company.
- B. Fabricate base and attachment to vaporizers with reinforcement strong enough to resist vaporizer movement during a seismic event when steel base is anchored to a concrete base.
- C. Casing:
 - 1. Mineral-fiber insulation, a minimum of 2 inches thick, surrounding the heat exchanger.
 - 2. Integral one-piece skid with forklift access holes.
 - 3. Lifting lugs on top of vaporizer.
 - 4. Flue rain cap and bird screen.
 - 5. Sheet metal jacket with screw-fastened closures and baked-enamel protective finish.
 - 6. Mounting base to secure boiler to concrete base.
 - 7. Control Compartment Enclosure: NEMA 250, Type 4, enclosure housing control panels for LPG-fired vaporizers. Explosion-proof control compartment construction required for electric vaporizers.
- D. LPG Liquid and Vapor Circuit Specialties:
 - 1. Y-type strainer with drain valve at inlet.
 - 2. Vaporizer coil safety pressure relief valve.
 - 3. Vaporizer coil blowdown valve.
 - 4. Vapor outlet isolation valve.
 - 5. Pressure gages, a minimum of 2-1/2 inches in diameter, at liquid inlet and vapor discharge. Gages shall have operating-temperature ranges so normal operating range is at approximately 50 percent of full range.

- E. Building Management System Interface: Factory-installed hardware and software to enable building management system to monitor and control set points and display vaporizer status and alarms.
- F. Capacities and Characteristics:
 - 1. Heating Fuel: Propane.
 - 2. Vaporization Heat Exchanger:
 - a. Minimum Working-Pressure Rating: 250 psig.
 - b. Test Pressure: 375 psig.
 - 3. LPG Vaporization Rate: as scheduled on drawings
 - 4. Entering-LPG Temperature: Minus 30 deg F.
 - 5. Leaving-LPG Temperature: 80 deg F.
 - 6. Discharge-LPG Pressure: 90 psig.

2.9 LABELING AND IDENTIFYING

- A. Detectable Warning Tape: Acid- and alkali-resistant PE film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils thick, continuously inscribed with a description of utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored yellow.

PART 3 - EXECUTION

3.1 EARTHWORK

- A. Comply with requirements in Section 203- Excavation and Embankment for excavating, trenching, and backfilling.

3.2 OUTDOOR PIPING INSTALLATION

- A. Comply with NFPA 58 and NFPA 54 requirements for installation and purging of LPG piping.
- B. Install underground, LPG piping buried at least 36 inches below finished grade. Comply with requirements in Section 203- Excavation and Embankment for excavating, trenching, and backfilling.
 - 1. If LPG piping is installed less than 36 inches below finished grade, install it in containment conduit.
- C. Install underground, PE, LPG piping according to ASTM D2774.
- D. Steel Piping with Protective Coating:
 - 1. Apply joint cover kits to pipe after joining to cover, seal, and protect joints.

2. Replace pipe having damaged PE coating with new pipe.

E. Install fittings for changes in direction and branch connections.

F. Install pressure gage upstream and downstream from each service regulator. Pressure gages are specified in Section 220519 "Meters and Gages for Plumbing Piping."

3.3 INDOOR PIPING INSTALLATION

A. Comply with NFPA 54 for installation and purging of LPG piping.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

C. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction, to allow for mechanical installations.

D. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.

E. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

F. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

G. Locate valves for easy access.

H. Install LPG piping at uniform grade of 2 percent down toward drip and sediment traps.

I. Install piping free of sags and bends.

J. Install fittings for changes in direction and branch connections.

K. Verify final equipment locations for roughing-in.

L. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.

M. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets. Locate where readily accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.

1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 3 inches long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.

- N. Extend relief vent connections for service regulators, line regulators, and overpressure protection devices to outdoors and terminate with weatherproof vent cap.
- O. Conceal pipe installations in walls, pipe spaces, utility spaces, above ceilings, below grade or floors, and in floor channels unless indicated to be exposed to view.
- P. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.
- Q. Connect branch piping from top or side of horizontal piping.
- R. Install unions in pipes NPS 2 and smaller, adjacent to each valve, at final connection to each piece of equipment.
- S. Do not use LPG piping as grounding electrode.
- T. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.
- U. Install pressure gage upstream and downstream from each line regulator. Pressure gages are specified in Section 220519 "Meters and Gages for Plumbing Piping."
- V. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."
- W. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."
- X. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230518 "Escutcheons for HVAC Piping."

3.4 VALVE INSTALLATION

- A. Install manual gas shutoff valve for each gas appliance ahead of corrugated stainless-steel tubing, or copper connector.
- B. Install underground valves with valve boxes.
- C. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.
- D. Install anode for metallic valves in underground PE piping.

3.5 PIPING JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

C. Threaded Joints:

1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
2. Cut threads full and clean using sharp dies.
3. Ream threaded pipe ends to remove burrs and restore full ID of pipe.
4. Apply appropriate tape or thread compound to external pipe threads unless dryseal threading is specified.
5. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

D. Welded Joints:

1. Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators.
2. Bevel plain ends of steel pipe.
3. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.

E. Flared Joints: Cut tubing with roll cutting tool. Flare tube end with tool to result in flare dimensions complying with SAE J513. Tighten finger tight, then use wrench. Do not overtighten.

F. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D2657.

1. Plain-End Pipe and Fittings: Use butt fusion.
2. Plain-End Pipe and Socket Fittings: Use socket fusion.

3.6 HANGER AND SUPPORT INSTALLATION

- A. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."
- B. Comply with requirements for pipe hangers, and supports specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."
- C. Install hangers for steel piping, with maximum spacing and minimum rod diameters, to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
- D. Support horizontal piping within 12 inches of each fitting.
- E. Support vertical runs of steel piping to comply with MSS-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.

3.7 CONNECTIONS

- A. Install LPG piping electrically continuous, and bonded to gas appliance equipment grounding conductor of the circuit powering the appliance according to NFPA 70.

- B. Install piping adjacent to appliances to allow service and maintenance of appliances.
- C. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches of each gas-fired appliances and equipment. Install union between valve and appliances or equipment.
- D. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.

3.8 STORAGE CONTAINER INSTALLATION

- A. Fill storage container to at least 80 percent capacity with propane.
- B. Install piping connections with swing joints or flexible connectors to allow for storage container settlement and for thermal expansion and contraction.
- C. Ground containers according to NFPA 780. Grounding is specified in Section 264113 "Lightning Protection for Structures."
- D. Set storage containers in felt pads on concrete or steel saddles. Install corrosion protection at container-to-felt contact.
- E. Install tie-downs over storage containers on saddles with proper tension.
- F. Set concrete saddles on dowels set in concrete base. Anchor steel saddles to concrete base.

3.9 VAPORIZER INSTALLATION

- A. Install vaporizer with access space for periodic maintenance.
- B. Set vaporizers on and anchor to concrete base.
- C. Connect liquid line from pump set, and vapor supply to distribution piping.
- D. Install backup connection from vapor space of container to inlet of pressure-regulating valve at vaporizer discharge to bypass the vaporizer during maintenance. Install shutoff valves to change source from vaporizer to storage container.

3.10 LABELING AND IDENTIFYING

- A. Comply with requirements in Section 220553 "Identification for Plumbing Piping and Equipment" for piping and valve identification.
- B. Install detectable warning tape directly above gas piping, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.11 FIELD QUALITY CONTROL

- A. Test, inspect, and purge LPG according to NFPA 58 and NFPA 54 and requirements of authorities having jurisdiction.
- B. LPG piping will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

3.12 OUTDOOR PIPING SCHEDULE

- A. Underground LPG liquid piping shall be the following:
 - 1. Schedule 40 steel pipe with wrought-steel fittings and welded joints. Coat pipe and fittings with protective coating for steel piping.
- B. Aboveground LPG liquid piping shall be the following:
 - 1. NPS 2 and Smaller: Schedule 80 steel pipe, malleable-iron threaded fittings and threaded and seal welded joints. Coat pipe and fittings with protective coating for steel piping.
- C. Underground LPG vapor piping shall be the following:
 - 1. PE pipe and fittings joined by heat-fusion; service-line risers with tracer wire terminated in an accessible location.
- D. Aboveground LPG vapor piping shall be one of the following:
 - 1. Schedule 40, steel pipe with malleable-iron fittings and threaded joints.
 - 2. Schedule 40, steel pipe with wrought-steel fittings and welded joints.

3.13 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURES LESS THAN 0.5 PSIG

- A. Aboveground, piping 2" and smaller shall be the following:
 - 1. Schedule 40, steel pipe with malleable-iron fittings and threaded joints.

3.14 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

- A. Aboveground Liquid Piping:
 - 1. Two-piece, full-port, bronze ball valves with bronze trim.
- B. Valves for pipe NPS 2 and smaller at service meter shall be the following:
 - 1. Two-piece, full-port, bronze ball valves with bronze trim.

END OF SECTION 231126

SECTION 232113
HYDRONIC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes pipe and fitting materials and joining methods for the following:
 - 1. Hot-water heating piping.
 - 2. Makeup-water piping.
 - 3. Air-vent piping.
 - 4. Condensate-drain piping.
 - 5. Safety-valve-inlet and -outlet piping.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of the following:
 - 1. Plastic pipe and fittings with solvent cement.
 - 2. RTRP and RTRF with adhesive.
 - 3. Pressure-seal fittings.
 - 4. Chemical treatment.
- B. Delegated-Design Submittal:
 - 1. Design calculations and detailed fabrication and assembly of pipe anchors and alignment guides, hangers and supports for multiple pipes, expansion joints and loops, and attachments of the same to the building structure.
 - 2. Locations of pipe anchors and alignment guides and expansion joints and loops.
 - 3. Locations of and details for penetrations, including sleeves and sleeve seals for exterior walls, floors, basement, and foundation walls.
 - 4. Locations of and details for penetration and firestopping for fire- and smoke-rated wall and floor and ceiling assemblies.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Piping layout, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Suspended ceiling components.

2. Other building services.
 3. Structural members.
- B. Qualification Data: For Installer.
- C. Welding certificates.
- D. Field quality-control reports.
- E. Water Analysis: Submit a copy of the water analysis to illustrate water quality available at Project site.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications:
1. Installers of Pressure-Sealed Joints: Installers shall be certified by pressure-seal joint manufacturer as having been trained and qualified to join piping with pressure-seal pipe couplings and fittings.
 2. Fiberglass Pipe and Fitting Installers: Installers of RTRF and RTRP shall be certified by manufacturer of pipes and fittings as having been trained and qualified to join fiberglass piping with manufacturer-recommended adhesive.
- B. Steel Support Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- C. Pipe Welding: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code: Section IX.
1. Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation.
 2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature unless otherwise indicated:
1. Working pressure is equal to the relief pressure plus the static height of the system and pumping head. The only working pressure mandated by authorities having jurisdiction is for makeup water.
 2. Hot-Water Heating Piping: Insert 150 psig at 200 deg F.
 3. Makeup-Water Piping: 80 psig at 150 deg F.

4. Condensate-Drain Piping: 155 deg F.
5. Air-Vent Piping: 200 deg F.
6. Safety-Valve-Inlet and -Outlet Piping: Equal to the pressure of the piping system to which it is attached.

2.2 COPPER TUBE AND FITTINGS

- A. Drawn-Temper Copper Tubing: ASTM B 88, Type L.
- B. Annealed-Temper Copper Tubing: ASTM B 88, Type K.
- C. DWV Copper Tubing: ASTM B 306, Type DWV.
- D. Wrought-Copper Unions: ASME B16.22.

2.3 JOINING MATERIALS

- A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
 1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness unless otherwise indicated.
 - a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
- B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
- C. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.
- D. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.
- E. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- F. Gasket Material: Thickness, material, and type suitable for fluid to be handled and working temperatures and pressures.

2.4 DIELECTRIC FITTINGS

- A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
- B. Dielectric Unions:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. A.Y. McDonald Mfg. Co.
 - b. Watts; a Watts Water Technologies company.
 - c. Zurn Industries, LLC.
2. Description:
 - a. Standard: ASSE 1079.
 - b. Pressure Rating: 250 psig.
 - c. End Connections: Solder-joint copper alloy and threaded ferrous.

C. Dielectric Nipples:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Elster Perfection Corporation.
 - b. Grinnell Mechanical Products.
 - c. Victaulic Company.
2. Description:
 - a. Standard: IAPMO PS 66.
 - b. Electroplated steel nipple, complying with ASTM F 1545.
 - c. Pressure Rating: 300 psig at 225 deg F.
 - d. End Connections: Male threaded or grooved.
 - e. Lining: Inert and noncorrosive, propylene.

2.5 BYPASS CHEMICAL FEEDER

- A. Description: Welded steel construction; 125-psig working pressure; 5-gal. capacity; with fill funnel and inlet, outlet, and drain valves.
- B. Chemicals: Specially formulated, based on analysis of makeup water, to prevent accumulation of scale and corrosion in piping and connected equipment.

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

- A. Hot-water heating piping, aboveground, NPS 2 and smaller, shall be any of the following:
 1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered or brazed joints.
- A. Makeup-water piping installed aboveground shall be the following:

1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
- B. Condensate-Drain Piping: Type DWV, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.
- C. Air-Vent Piping:
 1. Inlet: Same as service where installed with metal-to-plastic transition fittings for plastic piping systems according to piping manufacturer's written instructions.
 2. Outlet: Type K, annealed-temper copper tubing with soldered or flared joints.
- D. Safety-Valve-Inlet and -Outlet Piping for Hot-Water Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed with metal-to-plastic transition fittings for plastic piping systems according to piping manufacturer's written instructions.

3.2 PIPING INSTALLATIONS

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.
- B. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
- C. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
- D. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
- E. Install piping to permit valve servicing.
- F. Install piping at indicated slopes.
- G. Install piping free of sags and bends.
- H. Install fittings for changes in direction and branch connections.
- I. Install piping to allow application of insulation.
- J. Select system components with pressure rating equal to or greater than system operating pressure.
- K. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

- L. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.
- M. Install piping at a uniform grade of 0.2 percent upward in direction of flow.
- N. Reduce pipe sizes using eccentric reducer fitting installed with level side up.
- O. Install valves according to Section 230523.12 "Ball Valves for HVAC Piping," and Section 230523.14 "Check Valves for HVAC Piping."
- P. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.
- Q. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.
- R. Install shutoff valve immediately upstream of each dielectric fitting.
- S. Comply with requirements in Section 230516 "Expansion Fittings and Loops for HVAC Piping" for installation of expansion loops, expansion joints, anchors, and pipe alignment guides.
- T. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for identifying piping.
- U. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."
- V. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 230517 "Sleeves and Sleeve Seals for HVAC Piping."
- W. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230518 "Escutcheons for HVAC Piping."

3.3 DIELECTRIC FITTING INSTALLATION

- A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
- B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric nipples or unions.
- C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric nipples.

3.4 HANGERS AND SUPPORTS

- A. Comply with requirements in Section 230529 "Hangers and Supports for HVAC Piping and Equipment" for hanger, support, and anchor devices. Comply with the following requirements for maximum spacing of supports.

- B. Comply with requirements in Section 230548 "Vibration and Seismic Controls for HVAC" for seismic restraints.
- C. Install the following pipe attachments:
 - 1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet long.
 - 2. Adjustable roller hangers and spring hangers for individual horizontal piping 20 feet or longer.
 - 3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
 - 4. Spring hangers to support vertical runs.
 - 5. Provide copper-clad hangers and supports for hangers and supports in direct contact with copper pipe.
- D. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:
 - 1. NPS 3/4: Maximum span, 7 feet.
 - 2. NPS 1: Maximum span, 7 feet.
 - 3. NPS 1-1/2: Maximum span, 9 feet.
 - 4. NPS 2: Maximum span, 10 feet.
 - 5. NPS 2-1/2: Maximum span, 11 feet.
 - 6. NPS 3 and Larger: Maximum span, 12 feet.
- E. Install hangers for drawn-temper copper piping with the following maximum spacing and minimum rod sizes:
 - 1. NPS 3/4: Maximum span, 5 feet; minimum rod size, 1/4 inch.
 - 2. NPS 1: Maximum span, 6 feet; minimum rod size, 1/4 inch.
 - 3. NPS 1-1/4: Maximum span, 7 feet; minimum rod size, 3/8 inch.
 - 4. NPS 1-1/2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
 - 5. NPS 2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
 - 6. NPS 2-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
 - 7. NPS 3 and Larger: Maximum span, 10 feet; minimum rod size, 3/8 inch.
- F. Support vertical runs at roof, at each floor, and at 10-foot intervals between floors.

3.5 PIPE JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
- D. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8/A5.8M.

- E. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
 - 1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.
 - 2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.
- F. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.
- G. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.6 TERMINAL EQUIPMENT CONNECTIONS

- A. Sizes for supply and return piping connections shall be the same as or larger than equipment connections.
- B. Install control valves in accessible locations close to connected equipment.
- C. Install bypass piping with globe valve around control valve. If parallel control valves are installed, only one bypass is required.
- D. Install ports for pressure gages and thermometers at coil inlet and outlet connections. Comply with requirements in Section 230519 "Meters and Gages for HVAC Piping."

3.7 CHEMICAL TREATMENT

- A. Perform an analysis of makeup water to determine type and quantities of chemical treatment needed to keep system free of scale, corrosion, and fouling, and to sustain the following water characteristics:
 - 1. pH: 9.0 to 10.5.
 - 2. "P" Alkalinity: 100 to 500 ppm.
 - 3. Boron: 100 to 200 ppm.
 - 4. Chemical Oxygen Demand: Maximum of 100 ppm. Revise this value if closed system contains glycol.
 - 5. Corrosion Inhibitor:
 - a. Molybdate: 200 to 300 ppm.
 - 6. Soluble Copper: Maximum of 0.20 ppm.
 - 7. Tolyriazole Copper and Yellow Metal Corrosion Inhibitor: Minimum of 10 ppm.
 - 8. Total Suspended Solids: Maximum of 10 ppm.
 - 9. Ammonia: Maximum of 20 ppm.
 - 10. Free Caustic Alkalinity: Maximum of 20 ppm.
 - 11. Microbiological Limits:

- a. Total Aerobic Plate Count: Maximum of 1000 organisms/mL.
 - b. Total Anaerobic Plate Count: Maximum of 100 organisms/mL.
 - c. Nitrate Reducers: 100 organisms/mL.
 - d. Sulfate Reducers: Maximum of zero organisms/mL.
 - e. Iron Bacteria: Maximum of zero organisms/mL.
- B. Install bypass chemical feeders in each hydronic system where indicated.
1. Install in upright position with top of funnel not more than 48 inches above the floor.
 2. Install feeder in minimum NPS 3/4 bypass line, from main with full-size, full-port, ball valve in the main between bypass connections.
 3. Install NPS 3/4 pipe from chemical feeder drain to nearest equipment drain and include a full-size, full-port, ball valve.
- C. Fill system with fresh water and add liquid alkaline compound with emulsifying agents and detergents to remove grease and petroleum products from piping. Circulate solution for a minimum of 24 hours, drain, clean strainer screens, and refill with fresh water.
- D. Add initial chemical treatment and maintain water quality in ranges noted above for the first year of operation.
- E. Fill systems that have antifreeze or glycol solutions with the following concentrations:
1. Hot-Water Heating Piping: Minimum of percent propylene glycol.

3.8 FIELD QUALITY CONTROL

- A. Prepare hydronic piping according to ASME B31.9 and as follows:
1. Leave joints, including welds, uninsulated and exposed for examination during test.
 2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
 3. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
 4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
 5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.
- B. Perform the following tests on hydronic piping:
1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
 2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.
 3. Isolate expansion tanks and determine that hydronic system is full of water.
 4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to

pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times the "SE" value in Appendix A in ASME B31.9, "Building Services Piping."

5. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
 6. Prepare written report of testing.
- C. Perform the following before operating the system:
1. Open manual valves fully.
 2. Inspect pumps for proper rotation.
 3. Set makeup pressure-reducing valves for required system pressure.
 4. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
 5. Set temperature controls so all coils are calling for full flow.
 6. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.
 7. Verify lubrication of motors and bearings.

END OF SECTION 232113

SECTION 232116
HYDRONIC PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes special-duty valves and specialties for the following:
 - 1. Hot-water heating piping.
 - 2. Condensate-drain piping.
 - 3. Safety-valve-inlet and -outlet piping.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of the following:
 - 1. Valves: Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves and automatic flow-control valves.
 - 2. Air-control devices.
 - 3. Hydronic specialties.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For air-control devices, hydronic specialties, and special-duty valves to include in emergency, operation, and maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Differential Pressure Meter: For each type of balancing valve and automatic flow control valve, include flowmeter, probes, hoses, flow charts, and carrying case.

1.6 QUALITY ASSURANCE

- A. Pipe Welding: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code: Section IX.
 - 1. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature unless otherwise indicated:
 - 1. Hot-Water Heating Piping
 - 2. Condensate-Drain Piping
 - 3. Safety-Valve-Inlet and -Outlet Piping: Equal to the pressure of the piping system to which it is attached.

2.2 VALVES

- A. Gate, Check, and Ball Valves: Comply with requirements specified in Section 230523.12 "Ball Valves for HVAC Piping," and Section 230523.14 "Check Valves for HVAC Piping."
- B. Bronze, Calibrated-Orifice, Balancing Valves:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Armstrong Pumps, Inc.
 - b. Bell & Gossett; a Xylem brand.
 - c. Griswold Controls.
 - 2. Body: Bronze, ball or plug type with calibrated orifice or venturi.
 - 3. Ball: Brass or stainless steel.
 - 4. Plug: Resin.
 - 5. Seat: PTFE.
 - 6. End Connections: Threaded or socket.
 - 7. Pressure Gage Connections: Integral seals for portable differential pressure meter.
 - 8. Handle Style: Lever, with memory stop to retain set position.
 - 9. CWP Rating: Minimum 125 psig.
 - 10. Maximum Operating Temperature: 250 deg F.
- C. Diaphragm-Operated, Pressure-Reducing Valves: ASME labeled.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Apollo Valves; Conbraco Industries, Inc.
 - b. Bell & Gossett; a Xylem brand.
 - c. Watts; a Watts Water Technologies company.
 - 2. Body: Bronze or brass.
 - 3. Disc: Glass and carbon-filled PTFE.
 - 4. Seat: Brass.
 - 5. Stem Seals: EPDM O-rings.

6. Diaphragm: EPT.
7. Low inlet-pressure check valve.
8. Inlet Strainer: , removable without system shutdown.
9. Valve Seat and Stem: Noncorrosive.
10. Valve Size, Capacity, and Operating Pressure: Selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.

D. Diaphragm-Operated Safety Valves: ASME labeled.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Apollo Valves; Conbraco Industries, Inc.
 - b. Bell & Gossett; a Xylem brand.
 - c. Watts; a Watts Water Technologies company.
2. Body: Bronze or brass.
3. Disc: Glass and carbon-filled PTFE.
4. Seat: Brass.
5. Stem Seals: EPDM O-rings.
6. Diaphragm: EPT.
7. Wetted, Internal Work Parts: Brass and rubber.
8. Inlet Strainer: , removable without system shutdown.
9. Valve Seat and Stem: Noncorrosive.
10. Valve Size, Capacity, and Operating Pressure: Comply with ASME Boiler and Pressure Vessel Code: Section IV, and selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.

E. Automatic Flow-Control Valves:

1. Body: Brass.
2. Piston and Spring Assembly: Corrosion resistant, tamper proof, self-cleaning, and removable.
3. Combination Assemblies: Include bronze or brass-alloy ball valve.
4. Identification Tag: Marked with zone identification, valve number, and flow rate.
5. Size: Same as pipe in which installed.
6. Performance: Maintain constant flow, plus or minus 5 percent over system pressure fluctuations.
7. Minimum CWP Rating: 175 psig.
8. Maximum Operating Temperature: 200 deg F.

2.3 AIR-CONTROL DEVICES

A. Manual Air Vents:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Apollo Valves; Conbraco Industries, Inc.
 - b. Armstrong Pumps, Inc.

- c. Bell & Gossett; a Xylem brand.
 2. Body: Bronze.
 3. Internal Parts: Nonferrous.
 4. Operator: Screwdriver or thumbscrew.
 5. Inlet Connection: NPS 1/2.
 6. Discharge Connection: NPS 1/8.
 7. CWP Rating: 150 psig.
 8. Maximum Operating Temperature: 225 deg F.
- B. Automatic Air Vents:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. AMTROL, Inc.
 - b. Armstrong Pumps, Inc.
 - c. Bell & Gossett; a Xylem brand.
 2. Body: Bronze.
 3. Internal Parts: Nonferrous.
 4. Operator: Noncorrosive metal float.
 5. Inlet Connection: NPS 1/2.
 6. Discharge Connection: NPS 1/4.
 7. CWP Rating: 150 psig.
 8. Maximum Operating Temperature: 240 deg F.
- C. Expansion Tanks:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Armstrong Pumps, Inc.
 - b. Bell & Gossett; a Xylem brand.
 - c. Flo Fab Inc.
 2. Tank: Welded steel, rated for 125-psig working pressure and 375 deg F maximum operating temperature, with taps in bottom of tank for tank fitting and taps in end of tank for gage glass. Tanks shall be factory tested after taps are fabricated and shall be labeled according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
 3. Air-Control Tank Fitting: Cast-iron body, copper-plated tube, brass vent tube plug, and stainless-steel ball check, 100-gal. unit only; sized for compression-tank diameter. Provide tank fittings for 125-psig working pressure and 250 deg F maximum operating temperature.
 4. Tank Drain Fitting: Brass body, nonferrous internal parts; 125-psig working pressure and 240 deg F maximum operating temperature; constructed to admit air to compression tank, drain water, and close off system.
 5. Gage Glass: Full height with dual manual shutoff valves, 3/4-inch- diameter gage glass, and slotted-metal glass guard.
- D. Diaphragm-Type Expansion Tanks:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Armstrong Pumps, Inc.
 - b. Bell & Gossett; a Xylem brand.
 - c. Flo Fab Inc.
2. Tank: Welded steel, rated for 125-psig working pressure and 375 deg F maximum operating temperature. Factory test after taps are fabricated and supports installed and are labeled according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
3. Diaphragm: Securely sealed into tank to separate air charge from system water to maintain required expansion capacity.
4. Air-Charge Fittings: Schrader valve, stainless steel with EPDM seats.

E. In-Line Air Separators:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Armstrong Products, Inc.
 - b. Bell & Gossett; a Xylem brand.
 - c. Spirotherm, Inc.
2. Tank: One-piece cast iron with an integral weir constructed to decelerate system flow to maximize air separation.
3. Maximum Working Pressure: Up to 175 psig.
4. Maximum Operating Temperature: Up to 300 deg F.

2.4 HYDRONIC PIPING SPECIALTIES

A. Y-Pattern Strainers:

1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.
2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.
3. Strainer Screen: Stainless-steel, 20-mesh strainer, or perforated stainless-steel basket.
4. CWP Rating: 125 psig .

B. Stainless-Steel Bellow, Flexible Connectors:

1. Body: Stainless-steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket.
2. End Connections: Threaded or flanged to match equipment connected.
3. Performance: Capable of 3/4-inch misalignment.
4. CWP Rating: 150 psig.
5. Maximum Operating Temperature: 250 deg F.

C. Spherical, Rubber, Flexible Connectors:

1. Body: Fiber-reinforced rubber body.

2. End Connections: Steel flanges drilled to align with Classes 150 and 300 steel flanges.
 3. Performance: Capable of misalignment.
 4. CWP Rating: 150 psig.
 5. Maximum Operating Temperature: 250 deg F.
- D. Expansion Fittings: Comply with requirements in Section 230516 "Expansion Fittings and Loops for HVAC Piping. "

PART 3 - EXECUTION

3.1 VALVE APPLICATIONS

- A. Install shutoff-duty valves at each branch connection to supply mains and at supply connection to each piece of equipment.
- B. Install throttling-duty or calibrated-orifice, balancing valves at each branch connection to return main.
- C. Install calibrated-orifice, balancing valves in the return pipe of each heating or cooling terminal.
- D. Install check valves at each pump discharge and elsewhere as required to control flow direction.
- E. Install safety valves at hot-water generators and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install drip-pan elbow on safety-valve outlet and pipe without valves to the outdoors; pipe drain to nearest floor drain or as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.
- F. Install pressure-reducing valves at makeup-water connection to regulate system fill pressure.

3.2 HYDRONIC SPECIALTIES INSTALLATION

- A. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.
- B. Install automatic air vents at high points of system piping in mechanical equipment rooms only. Install manual vents at heat-transfer coils and elsewhere as required for air venting.
- C. Install piping from boiler air outlet, air separator to expansion tank with a 2 percent upward slope toward tank.
- D. Install in-line air separators in pump suction. Install drain valve on air separators NPS 2 and larger.
- E. Install expansion tanks above the air separator. Install tank fitting in tank bottom and charge tank. Use manual vent for initial fill to establish proper water level in tank.
 1. Install tank fittings that are shipped loose.

2. Support tank from floor or structure above with sufficient strength to carry weight of tank, piping connections, fittings, plus tank full of water. Do not overload building components and structural members.
- F. Install expansion tanks on the floor. Vent and purge air from hydronic system, and ensure that tank is properly charged with air to suit system Project requirements.

END OF SECTION 232116

SECTION 232123
HYDRONIC PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Close-coupled, in-line centrifugal pumps.
 - 2. Wet-rotor pumps.
 - 3. Automatic condensate pump units.

1.3 DEFINITIONS

- A. Buna-N: Nitrile rubber.
- B. EPT: Ethylene propylene terpolymer.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of pump. Include certified performance curves and rated capacities, operating characteristics, furnished specialties, final impeller dimensions, and accessories for each type of product indicated. Indicate pump's operating point on curves.
- B. Shop Drawings: For each pump.
 - 1. Show pump layout and connections.
 - 2. Include setting drawings with templates for installing foundation and anchor bolts and other anchorages.
 - 3. Include diagrams for power, signal, and control wiring.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For pumps to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Mechanical Seals: One mechanical seal(s) for each pump.

PART 2 - PRODUCTS

2.1 CLOSE-COUPLED, IN-LINE CENTRIFUGAL PUMPS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. Armstrong Pumps, Inc.
 - 2. Grundfos Pumps Corporation.
 - 3. ITT Corporation.
 - 4. PACO Pumps; Grundfos Pumps Corporation, USA.
- B. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, close-coupled, in-line pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted horizontally or vertically.
- C. Pump Construction:
 - 1. Casing: Radially split, cast iron, with threaded gage tappings at inlet and outlet, replaceable bronze wear rings, and threaded companion-flange connections.
 - 2. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. For constant-speed pumps, trim impeller to match specified performance.
 - 3. Pump Shaft: Steel, with copper-alloy shaft sleeve.
 - 4. Seal: Mechanical seal consisting of carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N bellows and gasket. Include water slinger on shaft between motor and seal.
 - 5. Seal: Packing seal consisting of stuffing box with a minimum of four rings of graphite-impregnated braided yarn with bronze lantern ring between center two graphite rings, and bronze packing gland.
 - 6. Pump Bearings: Permanently lubricated ball bearings.
- D. Motor: ECM.
 - 1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
 - 2. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
 - a. Enclosure: Totally enclosed, fan cooled.
 - b. Enclosure Materials: Cast iron.
 - c. Motor Bearings: Permanently lubricated ball bearings.
 - d. Efficiency: Premium efficient.
 - e. Service Factor: Insert value.

E. Capacities and Characteristics:

1. See Mechanical Schedules

2.2 WET-ROTOR PUMPS

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

1. Armstrong Pumps, Inc.
2. Grundfos Pumps Corporation.
3. ITT Corporation.

B. Description: Factory-assembled and -tested, wet-rotor pump.

C. Pump Construction:

1. Body: Cast iron.
2. Impeller: Polypropylene.
3. Pump Shaft: Ceramic.
4. Bearings. Double-sintered carbon.

D. Motor: ECM.

1. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
 - a. Efficiency: Premium efficient.

E. Capacities and Characteristics:

1. See Mechanical Schedules

2.3 AUTOMATIC CONDENSATE PUMP UNITS

A. Description: Packaged units with corrosion-resistant pump, plastic tank with cover, and automatic controls. Include factory- or field-installed check valve and a 72-inch-minimum, electrical power cord with plug.

B. Capacities and Characteristics:

1. See Mechanical Schedules

2.4 PUMP SPECIALTY FITTINGS

A. Triple-Duty Valve:

1. Angle or straight pattern.

2. 175-psig pressure rating, cast-iron body, pump-discharge fitting.
3. Drain plug and bronze-fitted shutoff, balancing, and check valve features.
4. Brass gage ports with integral check valve and orifice for flow measurement.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine equipment foundations and anchor-bolt locations for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for piping systems to verify actual locations of piping connections before pump installation.
- C. Examine foundations and inertia bases for suitable conditions where pumps are to be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PUMP INSTALLATION

- A. Install pumps to provide access for periodic maintenance including removing motors, impellers, couplings, and accessories.
- B. Independently support pumps and piping; so the weight of piping is not supported by pumps, and weight of pumps is not supported by piping.
- C. Automatic Condensate Pump Units: Install units for collecting condensate and extend to open drain.
- D. Equipment Mounting:
 1. Comply with requirements for vibration isolation and seismic control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
- E. Equipment Mounting: Install in-line pumps with continuous-thread hanger rods and spring hangers of size required to support weight of in-line pumps.
 1. Comply with requirements for seismic-restraint devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
 2. Comply with requirements for hangers and supports specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

3.3 CONNECTIONS

- A. Comply with requirements for piping specified in Section 232113 "Hydronic Piping." Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where installing piping adjacent to pump, allow space for service and maintenance.
- C. Connect piping to pumps. Install valves that are same size as piping connected to pumps.

- D. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.
- E. Install check, shutoff, and throttling valves or triple-duty valve on discharge side of pumps.
- F. Install Y-type strainer and shutoff valve on suction side of pumps.
- G. Install pressure gages on pump suction and discharge or at integral pressure-gage tapping, or install single gage with multiple-input selector valve.
- H. Install check valve and gate or ball valve on each condensate pump unit discharge.
- I. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- J. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.4 STARTUP SERVICE

- A. Perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.
 - 2. Check piping connections for tightness.
 - 3. Clean strainers on suction piping.
 - 4. Perform the following startup checks for each pump before starting:
 - a. Verify bearing lubrication.
 - b. Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
 - c. Verify that pump is rotating in the correct direction.
 - 5. Prime pump by opening suction valves and closing drains, and prepare pump for operation.
 - 6. Start motor.
 - 7. Open discharge valve slowly.

3.5 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain hydronic pumps.

END OF SECTION 232123

SECTION 233113
METAL DUCTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Single-wall rectangular ducts and fittings.
2. Single-wall round ducts and fittings.
3. Sheet metal materials.
4. Duct liner.
5. Sealants and gaskets.
6. Hangers and supports.
7. Seismic-restraint devices.

B. Related Sections:

1. Section 230593 "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
2. Section 233300 "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.3 PERFORMANCE REQUIREMENTS

- A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated in "Duct Schedule" Article.
- B. Structural Performance: Duct hangers and supports and seismic restraints shall withstand the effects of gravity and seismic loads and stresses within limits and under conditions described in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and ASCE/SEI 7. SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems."
 1. Seismic Hazard Level A: Seismic force to weight ratio, 0.48.
 2. Seismic Hazard Level B: Seismic force to weight ratio, 0.30.
 3. Seismic Hazard Level C: Seismic force to weight ratio, 0.15.
- C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of the following products:

1. Liners and adhesives.
2. Sealants and gaskets.
3. Seismic-restraint devices.

B. Shop Drawings:

1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
2. Factory- and shop-fabricated ducts and fittings.
3. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.
4. Elevation of top of ducts.
5. Dimensions of main duct runs from building grid lines.
6. Fittings.
7. Reinforcement and spacing.
8. Seam and joint construction.
9. Penetrations through fire-rated and other partitions.
10. Equipment installation based on equipment being used on Project.
11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
12. Hangers and supports, including methods for duct and building attachment, seismic restraints, and vibration isolation.

C. Delegated-Design Submittal:

1. Sheet metal thicknesses.
2. Joint and seam construction and sealing.
3. Reinforcement details and spacing.
4. Materials, fabrication, assembly, and spacing of hangers and supports.
5. Design Calculations: Calculations, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation for selecting hangers and supports and seismic restraints.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.
2. Suspended ceiling components.
3. Structural members to which duct will be attached.
4. Size and location of initial access modules for acoustical tile.
5. Penetrations of smoke barriers and fire-rated construction.
6. Items penetrating finished ceiling including the following:

- a. Lighting fixtures.
 - b. Air outlets and inlets.
 - c. Speakers.
 - d. Sprinklers.
 - e. Access panels.
 - f. Perimeter moldings.
- B. Welding certificates.
- C. Field quality-control reports.

1.6 QUALITY ASSURANCE

- A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports, AWS D1.2/D1.2M, "Structural Welding Code - Aluminum," for aluminum supports, and AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.
- B. Welding Qualifications: Qualify procedures and personnel according to the following:
- 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.
 - 2. AWS D1.2/D1.2M, "Structural Welding Code - Aluminum," for aluminum supports.
 - 3. AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.
- C. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and System Start-up."
- D. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6.4.4 - "HVAC System Construction and Insulation."

PART 2 - PRODUCTS

2.1 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.
- B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "Rectangular Duct/Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Duct/Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

- D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.2 SINGLE-WALL ROUND DUCTS AND FITTINGS

- A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.
 - 1. Manufacturer: Subject to compliance with requirements, provide products by one of the following or equal:
 - a. Ductmate Industries, Inc.
 - b. Lindab Inc.
 - c. McGill AirFlow LLC.
- B. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Round Duct Transverse Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
 - 1. Transverse Joints in Ducts Larger Than 60 Inches in Diameter: Flanged.
- C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Round Duct Longitudinal Seams," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
 - 1. Fabricate round ducts larger than 90 inches in diameter with butt-welded longitudinal seams.
 - 2. Fabricate flat-oval ducts larger than 72 inches in width (major dimension) with butt-welded longitudinal seams.
- D. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

2.3 SHEET METAL MATERIALS

- A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct

construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

- B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
 - 1. Galvanized Coating Designation: G90.
 - 2. Finishes for Surfaces Exposed to View: Mill phosphatized.
- C. Carbon-Steel Sheets: Comply with ASTM A 1008/A 1008M, with oiled, matte finish for exposed ducts.
- D. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304 or 316, as indicated in the "Duct Schedule" Article; cold rolled, annealed, sheet. Exposed surface finish shall be No. 2B, No. 2D, No. 3, or No. 4 as indicated in the "Duct Schedule" Article.
- E. Aluminum Sheets: Comply with ASTM B 209 Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.
- F. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
 - 1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.
- G. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.4 DUCT LINER

- A. Flexible Elastomeric Duct Liner: Preformed, cellular, closed-cell, sheet materials complying with ASTM C 534, Type II, Grade 1; and with NFPA 90A or NFPA 90B.
 - 1. Manufacturer: Subject to compliance with requirements, provide products by one of the following or equal:
 - a. Aeroflex USA, Inc.
 - b. Armacell LLC.
 - c. Rubatex International, LLC.
 - 2. Surface-Burning Characteristics: Maximum flame-spread index of 25 and maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
 - 3. Liner Adhesive: As recommended by insulation manufacturer and complying with NFPA 90A or NFPA 90B.
 - a. For indoor applications, adhesive shall have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- B. Shop Application of Duct Liner: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 7-11, "Flexible Duct Liner Installation."

1. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.
2. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.
3. Butt transverse joints without gaps, and coat joint with adhesive.
4. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.
5. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and dimensions of standard liner make longitudinal joints necessary.
6. Apply adhesive coating on longitudinal seams in ducts with air velocity of 2500 fpm.
7. Secure liner with mechanical fasteners 4 inches from corners and at intervals not exceeding 12 inches transversely; at 3 inches from transverse joints and at intervals not exceeding 18 inches longitudinally.
8. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:
 - a. Fan discharges.
 - b. Intervals of lined duct preceding unlined duct.
 - c. Upstream edges of transverse joints in ducts where air velocities are higher than 2500 fpm or where indicated.
9. Secure insulation between perforated sheet metal inner duct of same thickness as specified for outer shell. Use mechanical fasteners that maintain inner duct at uniform distance from outer shell without compressing insulation.
 - a. Sheet Metal Inner Duct Perforations: 3/32-inch diameter, with an overall open area of 23 percent.
10. Terminate inner ducts with buildouts attached to fire-damper sleeves, dampers, turning vane assemblies, or other devices. Fabricated buildouts (metal hat sections) or other buildout means are optional; when used, secure buildouts to duct walls with bolts, screws, rivets, or welds.

2.5 SEALANT AND GASKETS

- A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.
- B. Two-Part Tape Sealing System:
 1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.
 2. Tape Width: 4 inches.
 3. Sealant: Modified styrene acrylic.
 4. Water resistant.
 5. Mold and mildew resistant.

6. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
7. Service: Indoor and outdoor.
8. Service Temperature: Minus 40 to plus 200 deg F.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.
10. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. Water-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Solids Content: Minimum 65 percent.
3. Shore A Hardness: Minimum 20.
4. Water resistant.
5. Mold and mildew resistant.
6. VOC: Maximum 75 g/L (less water).
7. Maximum Static-Pressure Class: 10-inch wg, positive and negative.
8. Service: Indoor or outdoor.
9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

D. Solvent-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Base: Synthetic rubber resin.
3. Solvent: Toluene and heptane.
4. Solids Content: Minimum 60 percent.
5. Shore A Hardness: Minimum 60.
6. Water resistant.
7. Mold and mildew resistant.
8. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
9. VOC: Maximum 395 g/L.

E. Flanged Joint Sealant: Comply with ASTM C 920.

1. General: Single-component, acid-curing, silicone, elastomeric.
2. Type: S.
3. Grade: NS.
4. Class: 25.
5. Use: O.
6. For indoor applications, sealant shall have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

F. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

G. Round Duct Joint O-Ring Seals:

1. Seal shall provide maximum 3 cfm/100 sq. ft. at 1-inch wg and shall be rated for 10-inch wg static-pressure class, positive or negative.
2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.

3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

2.6 HANGERS AND SUPPORTS

- A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.
- B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.
- C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."
- D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.
- E. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.
- F. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.
- G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.
- H. Trapeze and Riser Supports:
 1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.
 2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.
 3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

2.7 SEISMIC-RESTRAINT DEVICES

- A. Manufacturer: Subject to compliance with requirements, provide products by one of the following or equal:
 1. Cooper B-Line, Inc.; a division of Cooper Industries.
 2. Ductmate Industries, Inc.
 3. Kinetics Noise Control, Inc.
 4. Mason Industries, Inc.
 5. Unistrut; an Atkore International company.
- B.
- C. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by an agency acceptable to authorities having jurisdiction.
 1. Structural Safety Factor: Allowable strength in tension, shear, and pullout force of components shall be at least four times the maximum seismic forces to which they will be subjected.

- D. Channel Support System: Shop- or field-fabricated support assembly made of slotted steel channels rated in tension, compression, and torsion forces and with accessories for attachment to braced component at one end and to building structure at the other end. Include matching components and corrosion-resistant coating.
- E. Restraint Cables: ASTM A 603, galvanized or ASTM A 492, stainless-steel cables with end connections made of cadmium-plated steel assemblies with brackets, swivel, and bolts designed for restraining cable service; and with an automatic-locking and clamping device or double-cable clips.
- F. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections or Reinforcing steel angle clamped to hanger rod.
- G. Mechanical Anchor Bolts: Drilled-in and stud-wedge or female-wedge type. Select anchor bolts with strength required for anchor and as tested according to ASTM E 488.

PART 3 - EXECUTION

3.1 DUCT INSTALLATION

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.
- B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.
- C. Install round ducts in maximum practical lengths.
- D. Install ducts with fewest possible joints.
- E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.
- F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.
- G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.
- H. Install ducts with a clearance of 1 inch, plus allowance for insulation thickness.
- I. Route ducts to avoid passing through transformer vaults and electrical equipment rooms and enclosures.
- J. Where ducts pass through non-fire-rated interior partitions and exterior walls and are exposed to view, cover the opening between the partition and duct or duct insulation with sheet metal

flanges of same metal thickness as the duct. Overlap openings on four sides by at least 1-1/2 inches.

- K. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Section 233300 "Air Duct Accessories" for fire and smoke dampers.
- L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "IAQ Guidelines for Occupied Buildings Under Construction," Appendix G, "Duct Cleanliness for New Construction Guidelines."

3.2 INSTALLATION OF EXPOSED DUCTWORK

- A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.
- B. Trim duct sealants flush with metal. Create a smooth and uniform exposed bead. Do not use two-part tape sealing system.
- C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.
- D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.
- E. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.3 DUCT SEALING

- A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
- B. Seal ducts to the following seal classes according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":
 - 1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
 - 2. Outdoor, Supply-Air Ducts: Seal Class A.
 - 3. Outdoor, Exhaust Ducts: Seal Class C.
 - 4. Outdoor, Return-Air Ducts: Seal Class C.
 - 5. Unconditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class B.
 - 6. Unconditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class A.
 - 7. Unconditioned Space, Exhaust Ducts: Seal Class C.
 - 8. Unconditioned Space, Return-Air Ducts: Seal Class B.
 - 9. Conditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg and Lower: Seal Class C.

10. Conditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg: Seal Class B.
11. Conditioned Space, Exhaust Ducts: Seal Class B.
12. Conditioned Space, Return-Air Ducts: Seal Class C.

3.4 HANGER AND SUPPORT INSTALLATION

- A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."
- B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.
 1. Where practical, install concrete inserts before placing concrete.
 2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
 3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches thick.
 4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.
 5. Do not use powder-actuated concrete fasteners for seismic restraints.
- C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.
- D. Hangers Exposed to View: Threaded rod and angle or channel supports.
- E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum intervals of 16 feet.
- F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.5 SEISMIC-RESTRAINT-DEVICE INSTALLATION

- A. Install ducts with hangers and braces designed to support the duct and to restrain against seismic forces required by applicable building codes. Comply with SMACNA's "Seismic Restraint Manual: Guidelines for Mechanical Systems." ASCE/SEI 7.
 1. Space lateral supports a maximum of 40 feet o.c., and longitudinal supports a maximum of 80 feet o.c.
 2. Brace a change of direction longer than 12 feet.
- B. Select seismic-restraint devices with capacities adequate to carry present and future static and seismic loads.
- C. Install cables so they do not bend across edges of adjacent equipment or building structure.

- D. Install cable restraints on ducts that are suspended with vibration isolators.
- E. Install seismic-restraint devices using methods approved by an agency acceptable to authorities having jurisdiction.
- F. Attachment to Structure: If specific attachment is not indicated, anchor bracing and restraints to structure, to flanges of beams, to upper truss chords of bar joists, or to concrete members.
- G. Drilling for and Setting Anchors:
 - 1. Identify position of reinforcing steel and other embedded items prior to drilling holes for anchors. Do not damage existing reinforcement or embedded items during drilling. Notify the Architect if reinforcing steel or other embedded items are encountered during drilling. Locate and avoid prestressed tendons, electrical and telecommunications conduit, and gas lines.
 - 2. Do not drill holes in concrete or masonry until concrete, mortar, or grout has achieved full design strength.
 - 3. Wedge Anchors: Protect threads from damage during anchor installation. Heavy-duty sleeve anchors shall be installed with sleeve fully engaged in the structural element to which anchor is to be fastened.
 - 4. Set anchors to manufacturer's recommended torque, using a torque wrench.
 - 5. Install zinc-coated steel anchors for interior applications and stainless-steel anchors for applications exposed to weather.

3.6 CONNECTIONS

- A. Make connections to equipment with flexible connectors complying with Section 233300 "Air Duct Accessories."
- B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.7 PAINTING

- A. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Section 099123 "Painting."

3.8 FIELD QUALITY CONTROL

- A. Perform tests and inspections.
- B. Leakage Tests:
 - 1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual." Submit a test report for each test.
 - 2. Test the following systems:

- a. Ducts with a Pressure Class Higher Than 3-Inch wg: Test representative duct sections totaling no less than 25 percent of total installed duct area for each designated pressure class.
 - b. Supply Ducts with a Pressure Class of 3-Inch wg or Higher: Test representative duct sections totaling no less than 50 percent of total installed duct area for each designated pressure class.
 - c. Return Ducts with a Pressure Class of 3-Inch wg or Higher: Test representative duct sections totaling no less than 50 percent of total installed duct area for each designated pressure class.
 - d. Exhaust Ducts with a Pressure Class of 3-Inch wg or Higher: Test representative duct sections totaling no less than 50 percent of total installed duct area for each designated pressure class.
 - e. Outdoor Air Ducts with a Pressure Class of 3-Inch wg or Higher: Test representative duct sections totaling no less than 50 percent of total installed duct area for each designated pressure class.
3. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
 4. Test for leaks before applying external insulation.
 5. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure.
 6. Give seven days' advance notice for testing.
- C. Duct System Cleanliness Tests:
1. Visually inspect duct system to ensure that no visible contaminants are present.
 2. Test sections of metal duct system, chosen randomly by Owner, for cleanliness according to "Vacuum Test" in NADCA ACR, "Assessment, Cleaning and Restoration of HVAC Systems."
 - a. Acceptable Cleanliness Level: Net weight of debris collected on the filter media shall not exceed 0.75 mg/100 sq. cm.
- D. Duct system will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.
- 3.9 DUCT CLEANING
- A. Clean new duct system(s) before testing, adjusting, and balancing.
 - B. Use service openings for entry and inspection.
 1. Create new openings and install access panels appropriate for duct static-pressure class if required for cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Section 233300 "Air Duct Accessories" for access panels and doors.
 2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.
 3. Remove and reinstall ceiling to gain access during the cleaning process.

C. Particulate Collection and Odor Control:

1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.
2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.

D. Clean the following components by removing surface contaminants and deposits:

1. Air outlets and inlets (registers, grilles, and diffusers).
2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.
3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.
4. Coils and related components.
5. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.
6. Supply-air ducts, dampers, actuators, and turning vanes.
7. Dedicated exhaust and ventilation components and makeup air systems.

E. Mechanical Cleaning Methodology:

1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.
2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.
3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.
4. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.
5. Clean coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.
6. Provide drainage and cleanup for wash-down procedures.
7. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents according to manufacturer's written instructions after removal of surface deposits and debris.

3.10 START UP

- A. Air Balance: Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC."

3.11 DUCT SCHEDULE

- A. Fabricate ducts with galvanized sheet steel except as otherwise indicated and as follows:
- B. Supply Ducts:
 - 1. Ducts Connected to Heat Pumps:
 - a. Pressure Class: Positive 2-inch wg.
 - b. Minimum SMACNA Seal Class: B.
 - c. SMACNA Leakage Class for Rectangular: 12.
 - d. SMACNA Leakage Class for Round: 12.
 - 2. Ducts Connected to Constant-Volume Air-Handling Units:
 - a. Pressure Class: Positive 2-inch wg or 3-inch wg see ESP on drawings.
 - b. Minimum SMACNA Seal Class: A or B (2 and 3 inch respectively).
 - c. SMACNA Leakage Class for Rectangular: 24.
 - d. SMACNA Leakage Class for Round: 24.
- C. Return Ducts:
 - 1. Ducts Connected to Heat Pumps:
 - a. Pressure Class: Positive 2-inch wg.
 - b. Minimum SMACNA Seal Class: B.
 - c. SMACNA Leakage Class for Rectangular: 12.
 - d. SMACNA Leakage Class for Round: 12.
 - 2. Ducts Connected to Constant-Volume Air-Handling Units:
 - a. Pressure Class: Positive 2-inch wg or 3-inch wg see ESP on drawings.
 - b. Minimum SMACNA Seal Class: A or B (2 and 3 inch respectively).
 - c. SMACNA Leakage Class for Rectangular: 24.
 - d. SMACNA Leakage Class for Round: 24.
- D. Exhaust Ducts:
 - 1. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air:
 - a. Pressure Class: Negative 2-inch wg.
 - b. Minimum SMACNA Seal Class: A if negative pressure, and A if positive pressure.
 - c. SMACNA Leakage Class for Rectangular: 24.
 - d. SMACNA Leakage Class for Round: 24.
- E. Outdoor-Air (Not Filtered, Heated, or Cooled) Ducts:
 - 1. Ducts Connected to Constant-Volume Air-Handling Units:
 - a. Pressure Class: Positive 2-inch wg or 3-inch wg see ESP on drawings.
 - b. Minimum SMACNA Seal Class: A or B (2 and 3 inch respectively).
 - c. SMACNA Leakage Class for Rectangular: 24.

- d. SMACNA Leakage Class for Round: 24.
- F. Intermediate Reinforcement:
- 1. Galvanized-Steel Ducts: Galvanized steel.
 - 2. Stainless-Steel Ducts:
 - a. Exposed to Airstream: Match duct material.
 - b. Not Exposed to Airstream: Match duct material.
 - 3. Aluminum Ducts: Aluminum or galvanized sheet steel coated with zinc chromate.
- G. Liner:
- 1. Supply Air Ducts: Flexible elastomeric, 1 inch thick.
 - 2. Return Air Ducts: Flexible elastomeric, 1 inch thick.
 - 3. Exhaust Air Ducts: Flexible elastomeric, 1 inch thick.
 - 4. Supply Fan Plenums: Flexible elastomeric, 1 inch thick.
- H. Elbow Configuration:
- 1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."
 - a. Velocity 1000 fpm or Lower:
 - 1) Radius Type RE 1 with minimum 0.5 radius-to-diameter ratio.
 - 2) Mitered Type RE 4 without vanes.
 - b. Velocity 1000 to 1500 fpm:
 - 1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.
 - 2) Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.
 - 3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
 - c. Velocity 1500 fpm or Higher:
 - 1) Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
 - 2) Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
 - 3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
 - 2. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "Rectangular Elbows."
 - a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.

- b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
 - c. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-3, "Vaness and Vane Runners," and Figure 4-4, "Vane Support in Elbows."
3. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "Round Duct Elbows."
- a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.
 - 1) Velocity 1000 fpm or Lower: 0.5 radius-to-diameter ratio and three segments for 90-degree elbow.
 - 2) Velocity 1000 to 1500 fpm: 1.0 radius-to-diameter ratio and four segments for 90-degree elbow.
 - 3) Velocity 1500 fpm or Higher: 1.5 radius-to-diameter ratio and five segments for 90-degree elbow.
 - 4) Radius-to Diameter Ratio: 1.5.
 - b. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.
 - c. Round Elbows, 14 Inches and Larger in Diameter: Standing seam or Welded.
- I. Branch Configuration:
- 1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connection."
 - a. Rectangular Main to Rectangular Branch: 45-degree entry.
 - b. Rectangular Main to Round Branch: Spin in.
 - 2. Round and Flat Oval: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees." Saddle taps are permitted in existing duct.
 - a. Velocity 1000 fpm or Lower: 90-degree tap.
 - b. Velocity 1000 to 1500 fpm: Conical tap.
 - c. Velocity 1500 fpm or Higher: 45-degree lateral.

END OF SECTION 233113

SECTION 233300
AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.01 GENERAL PROVISIONS

- A. Examine all Drawings and all Sections of the Specifications for requirements and provisions affecting the work of this Section.

1.02 SUMMARY

- A. Section Includes:
 - 1. Manual volume dampers.
 - 2. Control dampers.
 - 3. Fire dampers.
 - 4. Counter-balanced backdraft damper.
 - 5. Flange connectors.
 - 6. Turning vanes.
 - 7. Remote damper operators.
 - 8. Duct-mounted access doors.
 - 9. Flexible connectors.
 - 10. Flexible ducts.
 - 11. Duct accessory hardware.

1.03 RELATED WORK

- A. Section 233113 "Metal Ducts"

1.04 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. For duct silencers, include pressure drop and dynamic insertion loss data. Include breakout noise calculations for high transmission loss casings.
- B. Shop Drawings: For duct accessories. Include plans, elevations, sections, details and attachments to other work.
 - 1. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:
 - a. Special fittings.
 - b. Manual volume damper installations.
 - c. Control-damper installations.

- d. Fire-damper, smoke-damper, combination fire- and smoke-damper, ceiling, and corridor damper installations, including sleeves; and duct-mounted access doors and remote damper operators.
- e. Duct security bars.
- f. Wiring Diagrams: For power, signal, and control wiring.

1.05 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which ceiling-mounted access panels and access doors required for access to duct accessories are shown and coordinated with each other, using input from Installers of the items involved.
- B. Source quality-control reports.

1.06 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

1.07 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. Fusible Links: Furnish quantity equal to 10 percent of amount installed.

PART 2 - PRODUCTS

2.01 ASSEMBLY DESCRIPTION

- A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."
- B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

2.02 MATERIALS

- A. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
 - 1. Galvanized Coating Designation: G90.
 - 2. Exposed-Surface Finish: Mill phosphatized.

- B. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304, and having a No. 2 finish for concealed ducts
- C. Aluminum Sheets: Comply with ASTM B 209, Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.
- D. Extruded Aluminum: Comply with ASTM B 221, Alloy 6063, Temper T6.
- E. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.
- F. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.03 MANUAL VOLUME DAMPERS

- A. Standard, Steel, Manual Volume Dampers:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Nailor Industries Inc.
 - b. Ruskin Company.
 - c. Vent Products Co., Inc.
 - 2. Standard leakage rating, with linkage outside airstream.
 - 3. Suitable for horizontal or vertical applications.
 - 4. Frames:
 - a. Frame: Hat-shaped, 0.094-inch-thick, galvanized sheet steel.
 - b. Mitered and welded corners.
 - c. Flanges for attaching to walls and flangeless frames for installing in ducts.
 - 5. Blades:
 - a. Multiple or single blade.
 - b. Parallel- or opposed-blade design.
 - c. Stiffen damper blades for stability.
 - d. Galvanized-steel, 0.064 inch thick.
 - 6. Blade Axles: Galvanized steel.
 - 7. Bearings:
 - a. Stainless-steel sleeve.
 - b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
 - 8. Tie Bars and Brackets: Galvanized steel.
- B. Standard, Aluminum, Manual Volume Dampers:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

- a. Nailor Industries Inc.
 - b. Ruskin Company.
 - c. Vent Products Co., Inc.
2. Standard leakage rating, with linkage outside airstream.
 3. Suitable for horizontal or vertical applications.
 4. Frames: Hat-shaped, 0.10-inch-thick, aluminum sheet channels; frames with flanges for attaching to walls and flangeless frames for installing in ducts.
 5. Blades:
 - a. Multiple or single blade.
 - b. Parallel- or opposed-blade design.
 - c. Stiffen damper blades for stability.
 - d. Roll-Formed Aluminum Blades: 0.10-inch-thick aluminum sheet.
 - e. Extruded-Aluminum Blades: 0.050-inch-thick extruded aluminum.
 6. Blade Axles: Galvanized steel.
 7. Bearings:
 - a. Stainless-steel sleeve.
 - b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
 8. Tie Bars and Brackets: Aluminum.
- C. Low-Leakage, Steel, Manual Volume Dampers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. McGill AirFlow LLC.
 - b. Nailor Industries Inc.
 - c. Ruskin Company.
 2. Comply with AMCA 500-D testing for damper rating.
 3. Low-leakage rating, with linkage outside airstream, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.
 4. Suitable for horizontal or vertical applications.
 5. Frames:
 - a. Hat, U or Angle shaped.
 - b. 0.094-inch-thick, galvanized sheet steel.
 - c. Mitered and welded corners.
 - d. Flanges for attaching to walls and flangeless frames for installing in ducts.
 6. Blades:
 - a. Multiple or single blade.
 - b. Parallel- or opposed-blade design.
 - c. Stiffen damper blades for stability.
 - d. Galvanized, roll-formed steel, 0.064 inch thick.

7. Blade Axles: Galvanized steel.
 8. Bearings:
 - a. Stainless-steel sleeve.
 - b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
 9. Blade Seals: Neoprene.
 10. Jamb Seals: Cambered aluminum.
 11. Tie Bars and Brackets: Galvanized steel or Aluminum.
 12. Accessories:
 - a. Include locking device to hold single-blade dampers in a fixed position without vibration.
- D. Low-Leakage, Aluminum, Manual Volume Dampers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. McGill AirFlow LLC.
 - b. Nailor Industries Inc.
 - c. Ruskin Company.
 2. Comply with AMCA 500-D testing for damper rating.
 3. Low-leakage rating, with linkage outside airstream, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.
 4. Suitable for horizontal or vertical applications.
 5. Frames: Hat, U or Angle-shaped, 0.10-inch-thick, aluminum sheet channels; frames with flanges for attaching to walls and flangeless frames for installing in ducts.
 6. Blades:
 - a. Multiple or single blade.
 - b. Parallel- or opposed-blade design.
 - c. Roll-Formed Aluminum Blades: 0.10-inch-thick aluminum sheet.
 - d. Extruded-Aluminum Blades: 0.050-inch-thick extruded aluminum.
 7. Blade Axles: Galvanized steel.
 8. Bearings:
 - a. Stainless-steel sleeve.
 - b. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
 9. Blade Seals: Neoprene.
 10. Jamb Seals: Cambered stainless steel or aluminum.
 11. Tie Bars and Brackets: Galvanized steel or Aluminum.
 12. Accessories:
 - a. Include locking device to hold single-blade dampers in a fixed position without vibration.

- E. Jackshaft:
 - 1. Size: 0.5-inch diameter.
 - 2. Material: Galvanized-steel pipe rotating within pipe-bearing assembly mounted on supports at each mullion and at each end of multiple-damper assemblies.
 - 3. Length and Number of Mountings: As required to connect linkage of each damper in multiple-damper assembly.
- F. Damper Hardware:
 - 1. Zinc-plated, die-cast core with dial and handle made of 3/32-inch-thick zinc-plated steel, and a 3/4-inch hexagon locking nut.
 - 2. Include center hole to suit damper operating-rod size.
 - 3. Include elevated platform for insulated duct mounting.

2.04 CONTROL DAMPERS

- 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Greenheck Fan Corporation.
 - b. McGill AirFlow LLC.
 - c. Nailor Industries Inc.
 - d. Ruskin Company.
- B. Low-leakage rating, with linkage outside airstream, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.
- C. Frames:
 - 1. Hat U or Angle shaped.
 - 2. 0.094-inch-thick, galvanized sheet steel.
 - 3. Mitered and welded corners.
- D. Blades:
 - 1. Multiple blade with maximum blade width of 6 inches.
 - 2. Parallel- and opposed-blade design. See drawings. For outdoor air shut off dampers shall be parallel blade. For modulating control/two position service, blades shall be opposed type.
 - 3. Galvanized-steel or Aluminum.
 - 4. 0.064 inch thick single skin or 0.0747-inch-thick dual skin.
 - 5. Blade Edging: Closed-cell neoprene.
 - 6. Blade Edging: Inflatable seal blade edging, or replaceable rubber seals.
- E. Blade Axles: 1/2-inch-diameter; galvanized steel; blade-linkage hardware of zinc-plated steel and brass; ends sealed against blade bearings.
 - 1. Operating Temperature Range: From minus 40 to plus 200 deg F.
- F. Bearings:

1. Stainless-steel sleeve.
2. Dampers in ducts with pressure classes of 3-inch wg or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
3. Thrust bearings at each end of every blade.

2.05 FIRE DAMPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Greenheck Fan Corporation.
 2. Nailor Industries Inc.
 3. Ruskin Company.
- B. Type: Static; rated and labeled according to UL 555 by an NRTL.
- C. Closing rating in ducts up to 4-inch wg static pressure class and minimum 2000-fpm velocity.
- D. Fire Rating: 2 hours.
- E. Frame: Curtain type with blades outside airstream except when located behind grille where blades may be inside airstream; fabricated with roll-formed, 0.034-inch-thick galvanized steel; with mitered and interlocking corners.
- F. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.
 1. Minimum Thickness: 0.138 inch or 0.39 inch thick, as indicated, and of length to suit application.
 2. Exception: Omit sleeve where damper-frame width permits direct attachment of perimeter mounting angles on each side of wall or floor; thickness of damper frame must comply with sleeve requirements.
- G. Mounting Orientation: Vertical or horizontal as indicated.
- H. Blades: Roll-formed, interlocking, 0.024-inch-thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch-thick, galvanized-steel blade connectors.
- I. Horizontal Dampers: Include blade lock and stainless-steel closure spring.
- J. Heat-Responsive Device: Replaceable, 165 deg F rated, fusible links.
- K. Heat-Responsive Device: Resettable or replaceable link and switch package, factory installed, 165 deg F rated.

2.06 COUNTER-BALANCED BACKDRAFT DAMPERS

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

- 2. Nailor.
- 3. Vent Products.

B. Description: Frame shall be extruded aluminum channel. Blades shall be galvanized sheet steel with extruded vinyl blade edge seals mechanically locked into blade edge. Adhesive or clip on type seals shall be unacceptable. Blades shall include field adjustable, zinc plated steel counter balance weights to allow pressure relief between 0.01 and 0.05 inches w.g. Bearings shall be dustproof ball type for low pressure operation. Linkage shall be 1/2-inch wide tie-bar connected to Type 316 stainless steel pivot pins. Dampers shall be designed for maximum 3500 fpm spot velocities and minimum 4 inches w.g. back pressure.

2.07 FLANGE CONNECTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Ductmate Industries, Inc.
 - 2. Hardcast, Inc.
 - 3. Ward Industries, Inc.
- B. Description: Add-on or roll-formed, factory-fabricated, slide-on transverse flange connectors, gaskets, and components.
- C. Material: Galvanized steel.
- D. Gage and Shape: Match connecting ductwork.

2.08 TURNING VANES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Ductmate Industries, Inc.
 - 2. METALAIRE, Inc.
 - 3. SEMCO Incorporated.
- B. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
 - 1. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.
- C. Manufactured Turning Vanes for Nonmetal Ducts: Fabricate curved blades of resin-bonded fiberglass with acrylic polymer coating; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.
- D. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 4-3, "Vanes and Vane Runners," and 4-4, "Vane Support in Elbows."
- E. Vane Construction: Double wall.

- F. Vane Construction: Single wall for ducts up to 48 inches wide and double wall for larger dimensions.

2.09 REMOTE DAMPER OPERATORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Ruskin Inc.
 - 2. United Enertech Inc.
- B. Description: Electronic Zone Pulse volumetric control damper which interfaces with a hand-held damper motor control. The handheld device is equipped with a 9 volt power supply that operates the damper motor via an RJ11 cable that terminates at the diffuser/register/grille.
- C. Cable: none
- D. Mounting: Terminal device mounted. See manufacturer's literature for installation instructions.
- E. Damper
 - 1. Frame shall be 20ga galvanized steel, 6"
 - 2. Blade shall be equal in gage to frame and like materials
 - 3. Axles shall be minimum 3/8" square shaft
 - 4. Bearings shall be molded Lexan or equal
 - 5. Maximum static pressure shall be 2"
 - 6. Velocity shall not exceed 2000 fpm
 - 7. Actuator shall be gear drive, fail in place motor
 - 8. Power requirements
 - a. 9 Volt DC, Powered through handheld remote control. Provide a minimum of (4) four for project

2.10 DUCT-MOUNTED ACCESS DOORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Ductmate Industries, Inc.
 - 2. Greenheck Fan Corporation.
 - 3. McGill AirFlow LLC.
 - 4. Nailor Industries Inc.
- B. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 7-2, "Duct Access Doors and Panels," and 7-3, "Access Doors - Round Duct."
 - 1. Door:
 - a. Double wall, rectangular.

- b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.
 - c. Vision panel.
 - d. Hinges and Latches: 1-by-1-inchbutt or piano hinge and cam latches.
 - e. Fabricate doors airtight and suitable for duct pressure class.
2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.
3. Number of Hinges and Locks:
- a. Access Doors Less Than 12 Inches Square: No hinges and two sash locks.
 - b. Access Doors up to 18 Inches Square: Continuous and two sash locks.
 - c. Access Doors up to 24 by 48 Inches Continuous and two compression latches with outside and inside handles.
 - d. Access Doors Larger Than 24 by 48 Inches Continuous and two compression latches with outside and inside handles.

2.11 FLEXIBLE CONNECTORS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
- 1. Ductmate Industries, Inc.
 - 2. Duro Dyne Inc.
 - 3. Ventfabrics, Inc.
- B. Materials: Flame-retardant or noncombustible fabrics.
- C. Coatings and Adhesives: Comply with UL 181, Class 1.
- D. Metal-Edged Connectors: Factory fabricated with a fabric strip 5-3/4 inches wide attached to two strips of 2-3/4-inch-wide, 0.028-inch-thick, galvanized sheet steel or 0.032-inch-thick aluminum sheets. Provide metal compatible with connected ducts.
- E. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.
- 1. Minimum Weight: 26 oz./sq. yd..
 - 2. Tensile Strength: 480 lbf/inch in the warp and 360 lbf/inch in the filling.
 - 3. Service Temperature: Minus 40 to plus 200 deg F.
- F. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.
- 1. Minimum Weight: 24 oz./sq. yd..
 - 2. Tensile Strength: 530 lbf/inch in the warp and 440 lbf/inch in the filling.
 - 3. Service Temperature: Minus 50 to plus 250 deg F.

2.12 FLEXIBLE DUCTS

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

1. Flexmaster U.S.A., Inc.
 2. Flex-Tek Group.
 3. McGill AirFlow LLC.
- B. Noninsulated, Flexible Duct: UL 181, Class 1, 2-ply vinyl film supported by helically wound, spring-steel wire.
1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.
 2. Maximum Air Velocity: 4000 fpm.
 3. Temperature Range: Minus 10 to plus 160 deg F.
 4. Insulation R-value: Comply with ASHRAE/IESNA 90.1.
- C. Insulated, Flexible Duct: UL 181, Class 1, black polymer film supported by helically wound, spring-steel wire; fibrous-glass insulation; polyethylene vapor-barrier film.
1. Pressure Rating: 4-inch wg positive and 0.5-inch wg negative.
 2. Maximum Air Velocity: 4000 fpm.
 3. Temperature Range: Minus 20 to plus 175 deg F.
 4. Insulation R-Value: Comply with ASHRAE/IESNA 90.1.
- D. Flexible Duct Connectors:
1. Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action in sizes 3 through 18 inches, to suit duct size.
 2. Non-Clamp Connectors: Adhesive plus sheet metal screws.

2.13 DUCT ACCESSORY HARDWARE

- A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.
- B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 - EXECUTION

3.01 INSTALLATION

- A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.
- B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.
- C. Install control dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.

- D. Install volume dampers at points on supply, return, and exhaust systems where branches extend from larger ducts. Where dampers are installed in ducts having duct liner, install dampers with hat channels of same depth as liner, and terminate liner with nosing at hat channel.
 - 1. Install steel volume dampers in steel ducts.
 - 2. Install aluminum volume dampers in aluminum ducts.
- E. Set dampers to fully open position before testing, adjusting, and balancing.
- F. Install test holes at fan inlets and outlets and elsewhere as indicated.
- G. Install fire dampers according to UL listing.
- H. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:
 - 1. On both sides of duct coils.
 - 2. Upstream and downstream from duct filters.
 - 3. At outdoor-air intakes and mixed-air plenums.
 - 4. At drain pans and seals.
 - 5. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.
 - 6. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke dampers having fusible links shall be pressure relief access doors and shall be outward operation for access doors installed upstream from dampers and inward operation for access doors installed downstream from dampers.
 - 7. At each change in direction and at maximum 50-foot spacing.
 - 8. Upstream and downstream from turning vanes.
 - 9. Upstream or downstream from duct silencers.
 - 10. Control devices requiring inspection.
 - 11. Elsewhere as indicated.
- I. Install access doors with swing against duct static pressure.
- J. Access Door Sizes:
 - 1. One-Hand or Inspection Access: 8 by 5 inches.
 - 2. Two-Hand Access: 12 by 6 inches.
 - 3. Head and Hand Access: 18 by 10 inches.
 - 4. Head and Shoulders Access: 21 by 14 inches.
 - 5. Body Access: 25 by 14 inches.
 - 6. Body plus Ladder Access: 25 by 17 inches.
- K. Label access doors according to Section 230553 "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.
- L. Install flexible connectors to connect ducts to equipment.
- M. For fans developing static pressures of 5-inch wg and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.

- N. Connect terminal units to supply ducts directly or with maximum 12-inch lengths of flexible duct. Do not use flexible ducts to change directions.
- O. Connect diffusers or light troffer boots to ducts with maximum 60-inch lengths of flexible duct clamped or strapped in place.
- P. Connect flexible ducts to metal ducts with draw bands.
- Q. Install duct test holes where required for testing and balancing purposes.
- R. Install thrust limits at centerline of thrust, symmetrical on both sides of equipment. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch movement during start and stop of fans.

3.02 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Operate dampers to verify full range of movement.
2. Inspect locations of access doors and verify that purpose of access door can be performed.
3. Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.
4. Inspect turning vanes for proper and secure installation.
5. Operate remote damper operators to verify full range of movement of operator and damper.

END OF SECTION 233300

SECTION 233713
DIFFUSERS, REGISTERS, AND GRILLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Rectangular and square ceiling diffusers.
 - 2. Louver face diffusers.
- B. Related Sections:
 - 1. Section 101010 "Miscellaneous Specialties" for fixed and adjustable louvers and wall vents, whether or not they are connected to ducts.
 - 2. Section 233300 "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated, include the following:
 - 1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.
 - 2. Diffuser, Register, and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.
- B. Samples for Initial Selection: For diffusers, registers, and grilles with factory-applied color finishes.
- C. Samples for Verification: For diffusers, registers, and grilles, in manufacturer's standard sizes to verify color selected.

1.4 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:
 - 1. Ceiling suspension assembly members.
 - 2. Method of attaching hangers to building structure.
 - 3. Size and location of initial access modules for acoustical tile.

4. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.
 5. Duct access panels.
- B. Source quality-control reports.

PART 2 - PRODUCTS

2.1 CEILING DIFFUSERS

A. Rectangular and Square Ceiling Diffusers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Krueger.
 - b. Nailor Industries Inc.
 - c. Price Industries.
 - d. Titus.
2. Devices shall be specifically designed for constant-air-volume flows.
3. Material: Aluminum.
4. Finish: Baked enamel, white.
5. Face Size: 24 by 24 inches.
6. Face Style: Plaque.
7. Mounting: Surface or T-bar.
8. Pattern: Adjustable.
9. Accessories:
 - a. Equalizing grid.
 - b. Plaster ring.
 - c. Safety chain.
 - d. Wire guard.
 - e. Sectorizing baffles.
 - f. Operating rod extension.

B. Louver Face Diffuser:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Krueger.
 - b. Nailor Industries Inc.
 - c. Price Industries.
 - d. Titus.
2. Devices shall be specifically designed for constant-air-volume flows.
3. Material: Aluminum.
4. Finish: Baked enamel, white.

5. Face Size:
6. Mounting: Surface or T-bar.
7. Pattern: Adjustable core style.
8. Accessories:
 - a. Square to round neck adaptor.
 - b. Throw reducing vanes.
 - c. Equalizing grid.
 - d. Plaster ring.
 - e. Safety chain.

2.2 SOURCE QUALITY CONTROL

- A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install diffusers, registers, and grilles level and plumb.
- B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.
- C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.3 ADJUSTING

- A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

END OF SECTION 233713

SECTION 235100
BREECHINGS, CHIMNEYS, AND STACKS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Listed single double-wall vents chimneys.

1.3 ACTION SUBMITTALS

- A. Product Data: For the following:
 - 1. Type B and BW vents.
 - 2. Guy wires and connectors.
 - 3. Listed single double-wall vents chimneys.
- B. Shop Drawings: For vents, and stacks. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, methods of field assembly, components, hangers and seismic restraints, and location and size of each field connection.
 - 2. For installed products indicated to comply with design loads, include calculations required for selecting seismic restraints and structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS

- A. Welding certificates.
- B. Manufacturer Seismic Qualification Certification: Submit certification that factory-fabricated breeching, chimneys, and stacks; accessories; and components will withstand seismic forces defined in Section 230548 "Vibration and Seismic Controls for HVAC." Include the following:
 - 1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
 - a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

- b. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
 - 2. Dimensioned Outline Drawings of Breeching, Chimneys, and Stacks: Identify center of gravity and locate and describe mounting and anchorage provisions.
 - 3. Detailed description of anchorage devices on which the certification is based and their installation requirements.
- C. Warranty: Special warranty specified in this Section.

1.5 QUALITY ASSURANCE

- A. Source Limitations: Obtain listed system components through one source from a single manufacturer.
- B. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code--Steel," for hangers and supports and AWS D9.1/D9.1M, "Sheet Metal Welding Code," for shop and field welding of joints and seams in vents, breechings, and stacks.
- C. Certified Sizing Calculations: Manufacturer shall certify venting system sizing calculations.

1.6 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

1.7 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of venting system that fail in materials or workmanship within specified warranty period. Failures include, but are not limited to, structural failures caused by expansion and contraction.
 - 1. Warranty Period: 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 LISTED TYPE B AND BW VENTS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. FAMCO.
 - 2. Heat-Fab, Inc.
 - 3. Metal-Fab, Inc.

- B. Description: Double-wall metal vents tested according to UL 441 and rated for 480 deg F continuously for Type B, or 550 deg F continuously for Type BW; with neutral or negative flue pressure complying with NFPA 211.
- C. Construction: Inner shell and outer jacket separated by at least a 1/4-inch airspace.
- D. Inner Shell: ASTM B 209, Type 3105 aluminum or ASTM A 666, Type 430 stainless steel.
- E. Outer Jacket: Galvanized or Aluminized steel.
- F. Accessories: Tees, elbows, increasers, draft-hood connectors, terminations, adjustable roof flashings, storm collars, support assemblies, thimbles, firestop spacers, and fasteners; fabricated from similar materials and designs as vent-pipe straight sections; all listed for same assembly.
 - 1. Termination: Stack cap designed to exclude minimum 90 percent of rainfall.
 - 2. Termination: Round chimney top designed to exclude minimum 98 percent of rainfall.
 - 3. Termination: Exit cone with drain section incorporated into riser.
 - 4. Termination: Antibackdraft.
 - 5. Termination:

2.2 LISTED TYPE L VENTS

- A. Description: Double-wall metal vents tested according to UL 641 and rated for 570 deg F continuously, or 1700 deg F for 10 minutes; with neutral or negative flue pressure complying with NFPA 211.
- B. Construction: Inner shell and outer jacket separated by at least a 2-inch filled with high-temperature, ceramic-fiber insulation.
- C. Inner Shell: ASTM A 666, AL-29 4c stainless steel.
- D. Outer Jacket: Galvanized , aluminized or Stainless steel.
- E. Accessories: Tees, elbows, increasers, draft-hood connectors, terminations, adjustable roof flashings, storm collars, support assemblies, thimbles, firestop spacers, and fasteners; fabricated from similar materials and designs as vent-pipe straight sections; all listed for same assembly.
 - 1. Termination: Stack cap designed to exclude 90 percent of rainfall.
 - 2. Termination: Round chimney top designed to exclude 98 percent of rainfall.
 - 3. Termination: Exit cone with drain section incorporated into riser.
 - 4. Termination:

2.3 GUYING AND BRACING MATERIALS

- A. Cable: Three galvanized, stranded wires of the following thickness:
 - 1. Minimum Size: 1/4 inch in diameter.
 - 2. For ID Sizes 4 to 15 Inches: 5/16 inch.
 - 3. For ID Sizes 18 to 24 Inches: 3/8 inch.
 - 4. For ID Sizes 27 to 30 Inches: 7/16 inch.

5. For ID Sizes 33 to 36 Inches: 1/2 inch.
6. For ID Sizes 39 to 48 Inches: 9/16 inch.
7. For ID Sizes 51 to 60 Inches: 5/8 inch

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of work.
 1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATION

- A. Listed Type B and BW Vents: Vents for certified gas appliances.
- B. Listed Type L Vent: Vents for low-heat appliances.
- C. Listed Special Gas Vent: Condensing gas appliances.

3.3 INSTALLATION OF LISTED VENTS AND CHIMNEYS

- A. Locate to comply with minimum clearances from combustibles and minimum termination heights according to product listing or NFPA 211, whichever is most stringent.
- B. Seal between sections of positive-pressure vents and grease exhaust ducts according to manufacturer's written installation instructions, using sealants recommended by manufacturer.
- C. Support vents at intervals recommended by manufacturer to support weight of vents and all accessories, without exceeding appliance loading.
- D. Slope breechings down in direction of appliance, with condensate drain connection at lowest point piped to nearest drain.
- E. Lap joints in direction of flow.
- F. Connect base section to foundation using anchor lugs of size and number recommended by manufacturer.
- G. Join sections with acid-resistant joint cement to provide continuous joint and smooth interior finish.
- H. Erect stacks plumb to finished tolerance of no more than 1 inch out of plumb from top to bottom.

- 3.4 INSTALLATION OF UNLISTED, FIELD-FABRICATED BREECHINGS AND CHIMNEYS
- A. Suspend breechings and chimneys independent of their appliance connections.
 - B. Install, support, and restrain according to seismic requirements.
 - C. Align breechings at connections, with smooth internal surface and a maximum 1/8-inch misalignment tolerance.
 - D. Slope breechings down in direction of appliance, with condensate drain connection at lowest point piped to nearest drain.
 - E. Lap joints in direction of flow.
 - F. Support breechings and chimneys from building structure with bolts, concrete inserts, steel expansion anchors, welded studs, C-clamps, or beam clamps according to manufacturer's written instructions.
- 3.5 CLEANING
- A. After completing system installation, including outlet fittings and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finishes.
 - B. Clean breechings internally, during and after installation, to remove dust and debris. Clean external surfaces to remove welding slag and mill film. Grind welds smooth and apply touchup finish to match factory or shop finish.
 - C. Provide temporary closures at ends of breechings, chimneys, and stacks that are not completed or connected to equipment.

END OF SECTION 235100

SECTION 235216
CONDENSING BOILERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes packaged, factory-fabricated and -assembled, gas-fired, high efficiency boilers, trim, and accessories for generating hot water.

1.3 ACTION SUBMITTALS

- A. Product Data: Include performance data, operating characteristics, furnished specialties, and accessories.
- B. Shop Drawings: For boilers, boiler trim, and accessories. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Design calculations and vibration isolation base details, signed and sealed by a qualified professional engineer.
 - a. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
 - b. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails and equipment mounting frames.
 - 2. Include diagrams for power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Source quality-control reports.
- B. Field quality-control reports.
- C. Warranty: Special warranty specified in this Section.
- D. Other Informational Submittals:
 - 1. ASME Stamp Certification and Report: Submit "A," "S," or "PP" stamp certificate of authorization, as required by authorities having jurisdiction, and document hydrostatic testing of piping external to boiler.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: Provide (3) installation, operation and maintenance manuals for boilers.

1.6 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- B. ASME Compliance: Fabricate and label boilers to comply with ASME Boiler and Pressure Vessel Code.
- C. ASHRAE/IESNA 90.1 Compliance: Boilers shall have minimum efficiency according to "Gas and Oil Fired Boilers - Minimum Efficiency Requirements."
- D. UL Compliance: Test boilers for compliance with UL 795, "Commercial-Industrial Gas Heating Equipment." Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.

1.7 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.

1.8 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of boilers that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period for Fire-Tube Condensing Boilers:
 - a. Heat Exchanger: Ten years from date of Substantial Completion.
 - b. Parts: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 FIRE-TUBE CONDENSING BOILERS

- A. Manufacturers: Subject to compliance with requirements, provide products by the following:
 - 1. Buderus.
 - 2. Peerless.
 - 3. Lochinvar.

- B. Description: Factory-fabricated, -assembled, and -tested, fire-tube condensing boiler with heat exchanger sealed pressure tight, built on a steel base; including insulated jacket; flue-gas vent; combustion-air intake connections; water supply, return, and condensate drain connections; and controls. Water heating service only.
- C. Heat Exchanger: Nonferrous, corrosion-resistant combustion chamber.
- D. Pressure Vessel: Carbon steel with welded heads and tube connections.
- E. Burner: Natural gas, forced draft, design to operate between 4" to 13" w.c.
- F. Blower: Centrifugal fan to operate during each burner firing sequence and to prepurge and postpurge the combustion chamber.
 - 1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
- G. Gas Train: Combination gas valve with manual shutoff and pressure regulator.
- H. Ignition: Spark ignition with 100 percent main-valve shutoff with electronic flame supervision.
- I. Casing:
 - 1. Jacket: Sheet metal, with snap-in or interlocking closures.
 - 2. Control Compartment Enclosures: NEMA 250, Type 1A.
 - 3. Finish: Powder-coated protective finish.
 - 4. Insulation: Minimum 2-inch-thick, mineral-fiber insulation surrounding the heat exchanger.
 - 5. Combustion-Air Connections: Inlet and vent duct collars.
 - 6. Mounting base to secure boiler.
- J. Characteristics and Capacities:
 - 1. See drawings schedules.
 - 2. Heating Medium: Hot Water
 - 3. Maximum Allowable Working Pressure: 80 psig
 - 4. Safety Relief Valve Setting: 75 psig
 - 5. Entering-Water Temperature: 160 deg. F
 - 6. Leaving-Water Temperature: 180 deg. F

2.2 TRIM

- A. Include devices sized to comply with ANSI B31.9, "Building Services Piping."
- B. Aquastat Controllers: Operating, firing rate, and high limit.
- C. Safety Relief Valve: ASME rated.
- D. Pressure and Temperature Gage: Minimum 3-1/2-inch-diameter, combination water-pressure and -temperature gage. Gages shall have operating-pressure and -temperature ranges so normal operating range is about 50 percent of full range.

- E. Boiler Air Vent: Automatic.
- F. Drain Valve: Minimum NPS 3/4 hose-end gate valve.
- G. Circulation Pump: Non-overloading, in-line pump with split-capacitor motor having thermal-overload protection and lubricated bearings; designed to operate at specified boiler pressures and temperatures.

2.3 CONTROLS

- A. Refer to Section 230923 "Direct Digital Control (DDC) System for HVAC."
- B. Boiler operating controls shall include the following devices and features:
 - 1. Control transformer.
 - 2. Set-Point Adjust: Set points shall be adjustable.
 - 3. Operating Pressure Control: Factory wired and mounted to cycle burner.
 - 4. Low-Water Cutoff and Pump Control: Cycle feedwater pump(s) for makeup water control.
 - 5. Sequence of Operation: Electric, factory-fabricated and field-installed panel to control burner firing rate to maintain space temperature in response to thermostat with heat anticipator located in heated space.
 - 6. Sequence of Operation: Electric, factory-fabricated and field-installed panel to control burner firing rate to reset supply-water temperature inversely with outside-air temperature. At 40deg F outside-air temperature, set supply-water temperature at 180deg F; at 60 deg F outside-air temperature, set supply-water temperature at 160 deg F. Reset schedule shall be fully adjustable by the end user/operator.
 - a. Include automatic, alternating-firing sequence for multiple boilers to ensure maximum system efficiency throughout the load range and to provide equal runtime for boilers.
- C. Burner Operating Controls: To maintain safe operating conditions, burner safety controls limit burner operation.
 - 1. High Cutoff: Manual reset stops burner if operating conditions rise above maximum boiler design temperature and pressure.
 - 2. Low-Water Cutoff Switch: Electronic probe shall prevent burner operation on low water. Cutoff switch shall be automatic-reset type.
 - 3. Blocked Inlet Safety Switch: Manual-reset pressure switch field mounted on boiler combustion-air inlet.
 - 4. Audible Alarm: Factory mounted on control panel with silence switch; shall sound alarm for above conditions.
- D. Building Automation System Interface: Factory install hardware and software to enable building automation system to monitor, control, and display boiler status and alarms.
 - 1. Hardwired Points:
 - a. Monitoring: On/off status, common trouble alarm.

- b. Control: On/off operation, hot water supply temperature set-point adjustment.
 - c. See controls drawings for further information.
2. A communication interface with building automation system shall enable building automation system operator to remotely control and monitor the boiler from an operator workstation. Control features available, and monitoring points displayed, locally at boiler control panel shall be available through building automation system.

2.4 ELECTRICAL POWER

- A. Controllers, Electrical Devices, and Wiring: Electrical devices and connections are specified in electrical Sections.
- B. Single-Point Field Power Connection: Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to boiler.
 - 1. Coordinate and see Division 26 for power wiring and disconnects.

2.5 VENTING KITS

- A. Vertical Concentric Vent Kit: Complete system, ASTM A 959, Type 29-4C stainless steel, pipe, vent terminal, inlet air coupling thimble, indoor plate, vent adapter, condensate trap and neutralization tank, and sealant.

2.6 SOURCE QUALITY CONTROL

- A. Burner and Hydrostatic Test: Factory adjust burner to eliminate excess oxygen, carbon dioxide, oxides of nitrogen emissions, and carbon monoxide in flue gas and to achieve combustion efficiency; perform hydrostatic test.
- B. Test and inspect factory-assembled boilers, before shipping, according to ASME Boiler and Pressure Vessel Code.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Before boiler installation, examine roughing-in for concrete equipment bases, anchor-bolt sizes and locations, and piping and electrical connections to verify actual locations, sizes, and other conditions affecting boiler performance, maintenance, and operations.
 - 1. Final boiler locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.
- B. Examine mechanical spaces for suitable conditions where boilers will be installed.

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

3.2 BOILER INSTALLATION

A. Equipment Mounting:

1. Install boilers on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
2. Comply with requirements for vibration isolation and seismic control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."

- B. Install gas-fired boilers according to NFPA 54.

- C. Assemble and install boiler trim.

- D. Install electrical devices furnished with boiler but not specified to be factory mounted.

- E. Install control wiring to field-mounted electrical devices.

3.3 CONNECTIONS

- A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

- B. Install piping adjacent to boiler to allow service and maintenance.

- C. Install piping from equipment drain connection to nearest floor drain. Piping shall be at least full size of connection. Provide an isolation valve if required.

- D. Connect piping to boilers, except safety relief valve connections, with flexible connectors of materials suitable for service. Flexible connectors and their installation are specified in Section 232116 Hydronic Piping Specialties."

- E. Connect gas piping to boiler gas-train inlet with union. Piping shall be at least full size of gas train connection. Provide a reducer if required.

- F. Connect hot-water piping to supply- and return-boiler tappings with shutoff valve and union or flange at each connection.

- G. Connect steam and condensate piping to supply-, return-, and blowdown-boiler tappings with shutoff valve and union or flange at each connection.

- H. Install piping from safety relief valves to nearest floor drain.

- I. Install piping from safety valves to drip-pan elbow and to nearest floor drain.

J. Boiler Venting:

1. Install flue venting kit and combustion-air intake.

- 2. Connect full size to boiler connections. Comply with requirements in Section 235100 "Breechings, Chimneys, and Stacks."
- K. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- L. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 - 1. Perform installation and startup checks according to manufacturer's written instructions.
 - 2. Leak Test: Hydrostatic test. Repair leaks and retest until no leaks exist.
 - 3. Operational Test: Start units to confirm proper motor rotation and unit operation. Adjust air-fuel ratio and combustion.
 - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - a. Check and adjust initial operating set points and high- and low-limit safety set points of fuel supply, water level and water temperature.
 - b. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
- B. Remove and replace malfunctioning units and retest as specified above.
- C. Prepare test and inspection reports.
- D. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other than normal occupancy hours for this purpose.

3.5 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain boilers.
- B. Comply with the requirements of Section 230593 "Testing, Adjusting and Balancing for HVAC" for testing, adjusting and balancing procedures.

END OF SECTION 235216

SECTION 237313
AIR-HANDLING UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Constant-air-volume, multizone air-handling units.

1.3 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design vibration isolation and seismic-restraint details, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Structural Performance: Casing panels shall be self-supporting and capable of withstanding 133 percent of internal static pressures indicated, without panel joints exceeding a deflection of L/100 where "L" is the unsupported span length within completed casings.
- C. Seismic Performance: Air-handling units shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
 - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

1.4 ACTION SUBMITTALS

- A. Product Data: For each air-handling unit indicated.
 - 1. Unit dimensions and weight.
 - 2. Cabinet material, metal thickness, finishes, insulation, and accessories.
 - 3. Fans:
 - a. Certified fan-performance curves with system operating conditions indicated.
 - b. Certified fan-sound power ratings.
 - c. Fan construction and accessories.
 - d. Motor ratings, electrical characteristics, and motor accessories.
 - 4. Certified coil-performance ratings with system operating conditions indicated.
 - 5. Dampers, including housings, linkages, and operators.

6. Filters with performance characteristics.

B. Delegated-Design Submittal: For vibration isolation and seismic restraints indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
2. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Mechanical-room layout and relationships between components and adjacent structural and mechanical elements.
2. Support location, type, and weight.
3. Field measurements.

B. Seismic Qualification Certificates: For air-handling units, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Source quality-control reports.

D. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: Provide (3) Installation, Operation and Maintenance for air-handling units.

1.7 QUALITY ASSURANCE

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

B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of air-handling units and components.

- C. ARI Certification: Air-handling units and their components shall be factory tested according to ARI 430, "Central-Station Air-Handling Units," and shall be listed and labeled by ARI.
- D. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- E. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."
- F. Comply with NFPA 70.

1.8 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.
- B. Coordinate sizes and locations of structural-steel support members, if any, with actual equipment provided.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Carrier Corporation; a member of the United Technologies Corporation Family.
 - 2. Eviro-tec, Johnson Controls
 - 3. VTS

2.2 GENERAL

- A. General:
 - 1. Factory assembled air-handling unit that is modular in design and construction. Unit shall consist of a fan and coil section with factory-installed direct expansion coil, heating coil section, filter section, combination filter/mixing box (flat arrangement), and access section(s) as indicated on the equipment schedules.

2.3 UNIT CASINGS

- A. Unit panels shall be constructed of G60 galvanized steel and shall be capable of withstanding 125-hour salt spray test per ASTM Standard B117. All casing panels shall be removable for easy access to the unit. All panels shall be gasketed to ensure a tight seal.
- B. Single wall unit panels shall be 1-in. nominal thickness using matt-faced fiberglass insulation with a nominal density of not less than 1.5-lbs/ft³.
- C. Insulation shall be secured to casing with water based adhesive, and weld pins where necessary, corresponding to 25/50-flame spread/smoke developed.

- D. Casing Coating: Powder-baked enamel.
- E. Sealing: Seal all joints with water-resistant sealant.
- F. Base Rail: Unit mounted base rail shall be a minimum of 4” in height and constructed of galvanized steel, structurally capable of supporting unit on floor or by ceiling suspension.
- G. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- H. Access Panels and Doors:
 - 1. Panel and Door Fabrication: Formed and reinforced, single- or double-wall and insulated panels of same materials and thicknesses as casing.
 - 2. Inspection and Access Panels:
 - a. Fasteners: Two or more camlock type for panel lift-out operation. Arrangement shall allow panels to be opened against air-pressure differential.
 - b. Gasket: Neoprene, applied around entire perimeters of panel frames.
 - c. Size: Large enough to allow inspection and maintenance of air-handling unit's internal components.
 - 3. Access Doors:
 - a. Hinges: A minimum of two ball-bearing hinges or stainless-steel piano hinge and two wedge-lever-type latches, operable from inside and outside. Arrange doors to be opened against air-pressure differential.
 - b. Gasket: Neoprene, applied around entire perimeters of panel frames.
 - 4. Locations and Applications:
 - a. Fan Section: Doors.
 - b. Access Section: Doors.
 - c. Coil Section: Inspection and access panel.
 - d. Filter/Mixing Box Section: Doors.
- I. Condensate Drain Pans:
 - 1. Fabricated with one percent slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) to direct water toward drain connection.
 - a. Length: Extend drain pan downstream from leaving face to comply with ASHRAE 62.1.
 - b. Depth: A minimum of 2 inches deep.
 - 2. Double-wall, stainless-steel sheet with space between walls filled with foam insulation and moisture-tight seal.
 - 3. Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on one end of pan.
 - a. Minimum Connection Size: NPS 1.
 - 4. Pan-Top Surface Coating: Asphaltic waterproofing compound.

- J. Air Handling Unit Mounting Frame: Formed galvanized-steel channel or structural channel supports, designed for low deflection, welded with integral lifting lugs.
 - 1. Seismic Fabrication Requirements: Fabricate mounting base and attachment to air-handling unit sections, accessories, and components with reinforcement strong enough to withstand seismic forces defined in Section 230548 "Vibration and Seismic Controls for HVAC" when air-handling unit frame is anchored to building structure.

2.4 FAN, DRIVE, AND MOTOR SECTION

- A. Fan sections shall be constructed of G60 steel and shall have a formed channel base for integral mounting of fan, motor, and casing panels. Fan housing, wheel, shaft, and bearings shall be rigidly secured to the base unit.
- B. Each unit shall have one fan wheel and housing only.
- C. Fan and Drive Assemblies: Statically and dynamically balanced and designed for continuous operation at maximum-rated fan speed and motor horsepower.
 - 1. Shafts: Designed for continuous operation at maximum-rated fan speed and motor horsepower, and with field-adjustable alignment.
 - a. Turned, ground, and polished hot-rolled steel with keyway. Ship with a protective coating of lubricating oil.
 - b. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.
 - 2. Fan drive shall be designed for a minimum of 1.15 service factor and shall be factory mounted and aligned.
- D. Forward-Curved, Centrifugal Fan Wheels: Inlet flange, backplate, and shallow blades with inlet and tip curved forward in direction of airflow and mechanically fastened to flange and backplate; cast-steel hub swaged to backplate and fastened to shaft with set screws.
- E. Fan Shaft Bearings:
 - 1. Fan bearings shall be self-aligning, non-regreasable (permanent) ball bearing type selected for an average life (L50) of 100,000 hours at design operation conditions, per ANSI Code B3.15.
- F. Belt Drives: Factory mounted, with adjustable alignment and belt tensioning, and with 1.5 service factor based on fan motor.
 - 1. Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
 - 2. Motor Pulleys: Adjustable pitch for use with 5-hp motors and smaller; Select pulley size so pitch adjustment is at the middle of adjustment range at fan design conditions.
 - 3. Belts: Oil resistant, nonsparking, and nonstatic; in matched sets for multiple-belt drives.
 - 4. Belt Guards: Comply with requirements specified by OSHA and fabricate according to SMACNA's "HVAC Duct Construction Standards"; 0.1046-inch-thick, 3/4-inch diamond-mesh wire screen, welded to steel angle frame; prime coated.

- G. Dampers: Heavy-duty steel assembly with channel frame and sealed ball bearings, and parallel blades constructed of two plates formed around and welded to shaft, with blades linked out of air stream to single control lever.
- H. Internal Vibration Isolation and Seismic Control: Fans shall be factory mounted with manufacturer's standard vibration isolation mounting devices having a minimum static deflection of 1 inch.
 - 1. Seismic Fabrication Requirements: Fabricate fan section, internal mounting frame and attachment to fans, fan housings, motors, casings, accessories, and other fan section components with reinforcement strong enough to withstand seismic forces defined in Section 230548 "Vibration and Seismic Controls for HVAC" when fan-mounting frame and air-handling-unit mounting frame are anchored to building structure.
- I. Motor: Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements.
 - 1. Enclosure Type: Totally enclosed, fan cooled.
 - 2. NEMA Premium (TM) efficient motors as defined in NEMA MG 1.
 - 3. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
 - 4. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.
 - 5. Mount unit-mounted disconnect switches on exterior of unit.

2.5 COIL SECTION

- A. General Requirements for Coil Section:
 - 1. All coils shall have aluminum plate fins mechanically bonded to 1/2-in. OD seamless copper tubes by mechanical expansion.
 - 2. Coils shall be factory leak tested at 450-psig air pressure under water in an illuminated test tank.
 - 3. Copper tubes shall be either 0.016" or 0.025" copper tube wall thickness.
 - 4. Coils shall have G60 galvanized steel or stainless steel casings with copper headers and sweat connections.
 - 5. Comply with ARI 410.
 - 6. Fabricate coil section to allow removal and replacement of coil for maintenance and to allow in-place access for service and maintenance of coil(s).
 - 7. For multizone units, provide air deflectors and air baffles to balance airflow across coils.
 - 8. Coils shall not act as structural component of unit.
 - 9. Seismic Fabrication Requirements: Fabricate coil section, internal mounting frame and attachment to coils, and other coil section components with reinforcement strong enough to withstand seismic forces defined in Section 230548 "Vibration and Seismic Controls for HVAC" when coil-mounting frame and air-handling-unit mounting frame are anchored to building structure.

- B. Direct-Expansion (DX) Coils: Pressure-type brass distributors with solder-type connections. Coils shall be designed and tested in accordance with ANSI/ASHRAE 15.
- C. Hot Water Coils: Working pressure of 300-psig at 200° F. No turbulence-promoting devices will be permitted inside the tubes. Headers shall have vent connections.

2.6 AIR FILTRATION SECTION

A. General Requirements for Air Filtration Section:

1. Each filter section shall be designed and constructed to house the type of filter specified on the equipment schedule.
2. Flat filter sections shall accept 2-in. disposable, 30% (MERV-7) pleated filters of standard sizes. Sections shall include side access slide rails. Flat filter section shall be arranged with minimum depth in direction of airflow.
3. Comply with NFPA 90A.
4. Provide minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
5. Provide filter holding frames arranged for flat orientation, with access doors on both sides of unit. Filters shall be removable from one side.

2.7 DAMPERS

A. General Requirements for Dampers: Leakage rate, according to AMCA 500, "Laboratory Methods for Testing Dampers for Rating," shall not exceed 5 percent of air quantity at 2000-fpm face velocity through damper and 4-inch wg pressure differential.

B. Electronic Damper Operators:

1. Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.
2. Electronic damper position indicator shall have visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.
3. Operator Motors:
 - a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors.
 - b. Size to operate with sufficient reserve power to provide smooth modulating action or two-position action.
 - c. Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.
4. Nonspring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf.
5. Spring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running and breakaway torque of 150 in. x lbf.
6. Size dampers for running torque calculated as follows:
 - a. Parallel-Blade Damper with Edge Seals: 7 inch-lb/sq. ft. of damper.
 - b. Parallel-Blade Damper without Edge Seals: 4 inch-lb/sq. ft. of damper.

- c. Dampers with 2- to 3-Inch wg of Pressure Drop or Face Velocities of 1000 to 2500 fpm: Increase running torque by 1.5.
 - d. Dampers with 3- to 4-Inch wg of Pressure Drop or Face Velocities of 2500 to 3000 fpm: Increase running torque by 2.0.
7. Coupling: V-bolt and V-shaped, toothed cradle.
 8. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
 9. Fail-Safe Operation: Mechanical, spring-return mechanism with external, manual gear release on nonspring-return actuators.
 10. Power Requirements (Two-Position Spring Return): 24-V ac.
 11. Power Requirements (Modulating): Maximum 10 VA at 24-V ac or 8 W at 24-V dc.
 12. Proportional Signal: 2- to 10-V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.
 13. Temperature Rating: Minus 22 to plus 122 deg F.
 14. Run Time: 12 seconds open, 5 seconds closed.
- C. Outdoor- and Return-Air Mixing Dampers: Parallel-blade, galvanized-steel, aluminum, or extruded-aluminum dampers mechanically fastened to steel operating rod in reinforced cabinet. Connect operating rods with common linkage and interconnect linkages so dampers operate simultaneously.
- D. Combination Filter and Mixing Section:
1. Cabinet support members shall hold 2-inch-thick, pleated, flat, permanent or throwaway filters.
 2. Multiple-blade, air-mixer assembly shall mix air to prevent stratification, located immediately downstream of mixing box.

2.8 ELECTRONIC AIR MEASURING STATION

- A. Comply with requirements for an electronic air measuring station as specified in Section 23 "Electronic Air Measuring Stations."

2.9 CAPACITIES AND CHARACTERISTICS

- A. See Mechanical Schedules

2.10 SOURCE QUALITY CONTROL

- A. Fan Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Fans shall bear AMCA-certified sound ratings seal.
- B. Fan Performance Rating: Factory test fan performance for airflow, pressure, power, air density, rotation speed, and efficiency. Rate performance according to AMCA 210, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating."
- C. Water Coils: Factory tested to 300 psig according to ARI 410 and ASHRAE 33.
- D. Refrigerant Coils: Factory tested to 450 psig according to ARI 410 and ASHRAE 33.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine casing insulation materials and filter media before air-handling unit installation. Reject insulation materials and filter media that are wet, moisture damaged, or mold damaged.
- C. Examine roughing-in for hydronic piping systems and electrical services to verify actual locations of connections before installation.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Equipment Mounting:
 - 1. Install air-handling units on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
 - 2. Comply with requirements for vibration isolation and seismic control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
- B. Arrange installation of units to provide access space around air-handling units for service and maintenance.
- C. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing, with new, clean filters.
- D. Install filter-gage, static-pressure taps upstream and downstream of filters. Mount filter gages on outside of filter housing or filter plenum in accessible position. Provide filter gages on filter banks, installed with separate static-pressure taps upstream and downstream of filters.

3.3 CONNECTIONS

- A. Comply with requirements for piping specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to air-handling unit to allow service and maintenance.
- C. Connect piping to air-handling units mounted on vibration isolators with flexible connectors.
- D. Connect condensate drain pans using NPS 1-1/4, ASTM B 88, Type M copper tubing. Extend to nearest equipment or floor drain. Construct deep trap at connection to drain pan and install cleanouts at changes in direction.
- E. Hot- -Water Piping: Comply with applicable requirements in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties." Install shutoff valve and union or flange at

each coil supply connection. Install balancing valve and union or flange at each coil return connection.

- F. Refrigerant Piping: Installation shall comply with the manufacturer's guidelines and recommendations.
- G. Connect duct to air-handling units with flexible connections. Comply with requirements in Section 233300 "Air Duct Accessories."

3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- B. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- C. Tests and Inspections:
 - 1. Leak Test: After installation, fill water coils with water, and test coils and connections for leaks.
 - 2. Charge refrigerant coils with refrigerant and test for leaks.
 - 3. Fan Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Air-handling unit or components will be considered defective if unit or components do not pass tests and inspections.
- E. Prepare test and inspection reports.

3.5 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.
 - 2. Verify that shipping, blocking, and bracing are removed.
 - 3. Verify that unit is secure on mountings and supporting devices and that connections to piping, ducts, and electrical systems are complete. Verify that proper thermal-overload protection is installed in motors, controllers, and switches.
 - 4. Verify proper motor rotation direction, free fan wheel rotation, and smooth bearing operations. Reconnect fan drive system, align belts, and install belt guards.
 - 5. Verify that bearings, pulleys, belts, and other moving parts are lubricated with factory-recommended lubricants.
 - 6. Verify that outdoor- and return-air mixing dampers open and close, and maintain minimum outdoor-air setting.
 - 7. Comb coil fins for parallel orientation.

8. Install new, clean filters.
9. Verify that manual and automatic volume control and fire and smoke dampers in connected duct systems are in fully open position.

B. Starting procedures for air-handling units include the following:

1. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated rpm. Replace fan and motor pulleys as required to achieve design conditions.
2. Measure and record motor electrical values for voltage and amperage.
3. Manually operate dampers from fully closed to fully open position and record fan performance.

3.6 ADJUSTING

- A. Adjust damper linkages for proper damper operation.
- B. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC" for air-handling system testing, adjusting, and balancing.

3.7 CLEANING

- A. After completing system installation and testing, adjusting, and balancing air-handling unit and air-distribution systems and after completing startup service, clean air-handling units internally to remove foreign material and construction dirt and dust. Clean fan wheels, cabinets, dampers, coils, and filter housings, and install new, clean filters.

3.8 DEMONSTRATION

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

END OF SECTION 237313

SECTION 237339
HEATING AND VENTILATION UNIT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Constant-air-volume, single-zone air-handling units.

1.3 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Design vibration isolation and seismic-restraint details, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Structural Performance: Casing panels shall be self-supporting and capable of withstanding 133 percent of internal static pressures indicated, without panel joints exceeding a deflection of L/100 where "L" is the unsupported span length within completed casings.
- C. Seismic Performance: Air-handling units shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
 - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

1.4 ACTION SUBMITTALS

- A. Product Data: For each air-handling unit indicated.
 - 1. Unit dimensions and weight.
 - 2. Cabinet material, metal thickness, finishes, insulation, and accessories.
 - 3. Fans:
 - a. Certified fan-performance curves with system operating conditions indicated.
 - b. Certified fan-sound power ratings.
 - c. Fan construction and accessories.
 - d. Motor ratings, electrical characteristics, and motor accessories.

4. Certified coil-performance ratings with system operating conditions indicated.
5. Dampers, including housings, linkages, and operators.
6. Filters with performance characteristics.

B. Delegated-Design Submittal: For vibration isolation and seismic restraints indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include adjustable motor bases, rails, and frames for equipment mounting.
2. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Mechanical-room layout and relationships between components and adjacent structural and mechanical elements.
2. Support location, type, and weight.
3. Field measurements.

B. Seismic Qualification Certificates: For air-handling units, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

C. Source quality-control reports.

D. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: Provide (3) Installation, Operation and Maintenance for air-handling units.

1.7 QUALITY ASSURANCE

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

- B. NFPA Compliance: Comply with NFPA 90A for design, fabrication, and installation of air-handling units and components.
- C. ARI Certification: Air-handling units and their components shall be factory tested according to ARI 430, "Central-Station Air-Handling Units," and shall be listed and labeled by ARI.
- D. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- E. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."
- F. Comply with NFPA 70.

1.8 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided.
- B. Coordinate sizes and locations of structural-steel support members, if any, with actual equipment provided.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Carrier Corporation; a member of the United Technologies Corporation Family.
 - 2. Eviro-tec, Johnson Controls
 - 3. YORK International Corporation.

2.2 GENERAL

- A. General:
 - 1. Factory assembled air-handling unit that is modular in design and construction. Unit shall consist of a fan and coil section with factory-installed heating coil section, filter section, inlet plenum with filter (flat arrangement), and access section(s) as indicated on the equipment schedules.

2.3 UNIT CASINGS

- A. Unit panels shall be constructed of G60 galvanized steel and shall be capable of withstanding 125-hour salt spray test per ASTM Standard B117. All casing panels shall be removable for easy access to the unit. All panels shall be gasketed to ensure a tight seal.

- B. Single wall unit panels shall be 1-in. nominal thickness using matt-faced fiberglass insulation with a nominal density of not less than 1.5-lbs/ft³.
- C. Insulation shall be secured to casing with water based adhesive, and weld pins where necessary, corresponding to 25/50-flame spread/smoke developed.
- D. Casing Coating: Powder-baked enamel.
- E. Sealing: Seal all joints with water-resistant sealant.
- F. Base Rail: Unit mounted base rail shall be a minimum of 4" in height and constructed of galvanized steel, structurally capable of supporting unit on floor or by ceiling suspension.
- G. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- H. Access Panels and Doors:
 - 1. Panel and Door Fabrication: Formed and reinforced, single- or double-wall and insulated panels of same materials and thicknesses as casing.
 - 2. Inspection and Access Panels:
 - a. Fasteners: Two or more camlock type for panel lift-out operation. Arrangement shall allow panels to be opened against air-pressure differential.
 - b. Gasket: Neoprene, applied around entire perimeters of panel frames.
 - c. Size: Large enough to allow inspection and maintenance of air-handling unit's internal components.
 - 3. Access Doors:
 - a. Hinges: A minimum of two ball-bearing hinges or stainless-steel piano hinge and two wedge-lever-type latches, operable from inside and outside. Arrange doors to be opened against air-pressure differential.
 - b. Gasket: Neoprene, applied around entire perimeters of panel frames.
 - 4. Locations and Applications:
 - a. Fan Section: Doors.
 - b. Access Section: Doors.
 - c. Coil Section: Inspection and access panel.
 - d. Filter/Mixing Box Section: Doors.
- I. Air Handling Unit Mounting Frame: Formed galvanized-steel channel or structural channel supports, designed for low deflection, welded with integral lifting lugs.
 - 1. Seismic Fabrication Requirements: Fabricate mounting base and attachment to air-handling unit sections, accessories, and components with reinforcement strong enough to withstand seismic forces defined in Section 230548 "Vibration and Seismic Controls for HVAC" when air-handling unit frame is anchored to building structure.

2.4 FAN, DRIVE, AND MOTOR SECTION

- A. Fan sections shall be constructed of G60 steel and shall have a formed channel base for integral mounting of fan, motor, and casing panels. Fan housing, wheel, shaft, and bearings shall be rigidly secured to the base unit.
- B. Each unit shall have one fan wheel and housing only.
- C. Fan and Drive Assemblies: Statically and dynamically balanced and designed for continuous operation at maximum-rated fan speed and motor horsepower.
 - 1. Shafts: Designed for continuous operation at maximum-rated fan speed and motor horsepower, and with field-adjustable alignment.
 - a. Turned, ground, and polished hot-rolled steel with keyway. Ship with a protective coating of lubricating oil.
 - b. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.
 - 2. Fan drive shall be designed for a minimum of 1.15 service factor and shall be factory mounted and aligned.
- D. Forward-Curved, Centrifugal Fan Wheels: Inlet flange, backplate, and shallow blades with inlet and tip curved forward in direction of airflow and mechanically fastened to flange and backplate; cast-steel hub swaged to backplate and fastened to shaft with set screws.
- E. Fan Shaft Bearings:
 - 1. Fan bearings shall be self-aligning, non-regreasable (permanent) ball bearing type selected for an average life (L50) of 100,000 hours at design operation conditions, per ANSI Code B3.15.
- F. Belt Drives: Factory mounted, with adjustable alignment and belt tensioning, and with 1.5 service factor based on fan motor.
 - 1. Pulleys: Cast iron or cast steel with split, tapered bushing; dynamically balanced at factory.
 - 2. Motor Pulleys: Adjustable pitch for use with 5-hp motors and smaller; Select pulley size so pitch adjustment is at the middle of adjustment range at fan design conditions.
 - 3. Belts: Oil resistant, nonsparking, and nonstatic; in matched sets for multiple-belt drives.
 - 4. Belt Guards: Comply with requirements specified by OSHA and fabricate according to SMACNA's "HVAC Duct Construction Standards"; 0.1046-inch-thick, 3/4-inch diamond-mesh wire screen, welded to steel angle frame; prime coated.
- G. Dampers: Heavy-duty steel assembly with channel frame and sealed ball bearings, and parallel blades constructed of two plates formed around and welded to shaft, with blades linked out of air stream to single control lever.
- H. Internal Vibration Isolation and Seismic Control: Fans shall be factory mounted with manufacturer's standard vibration isolation mounting devices having a minimum static deflection of 1 inch.

1. Seismic Fabrication Requirements: Fabricate fan section, internal mounting frame and attachment to fans, fan housings, motors, casings, accessories, and other fan section components with reinforcement strong enough to withstand seismic forces defined in Section 230548 "Vibration and Seismic Controls for HVAC" when fan-mounting frame and air-handling-unit mounting frame are anchored to building structure.

- I. Motor: Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements.

1. Enclosure Type: Totally enclosed, fan cooled.
2. NEMA Premium (TM) efficient motors as defined in NEMA MG 1.
3. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
4. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.
5. Mount unit-mounted disconnect switches on exterior of unit.

2.5 COIL SECTION

- A. General Requirements for Coil Section:

1. All coils shall have aluminum plate fins mechanically bonded to 1/2-in. OD seamless copper tubes by mechanical expansion.
2. Coils shall be factory leak tested at 450-psig air pressure under water in an illuminated test tank.
3. Copper tubes shall be either 0.016" or 0.025" copper tube wall thickness.
4. Coils shall have stainless steel casings with copper headers and sweat connections.
5. Comply with ARI 410.
6. Fabricate coil section to allow removal and replacement of coil for maintenance and to allow in-place access for service and maintenance of coil(s).
7. For multizone units, provide air deflectors and air baffles to balance airflow across coils.
8. Coils shall not act as structural component of unit.
9. Seismic Fabrication Requirements: Fabricate coil section, internal mounting frame and attachment to coils, and other coil section components with reinforcement strong enough to withstand seismic forces defined in Section 230548 "Vibration and Seismic Controls for HVAC" when coil-mounting frame and air-handling-unit mounting frame are anchored to building structure.

- B. Hot Water Coils: Working pressure of 300-psig at 200° F. No turbulence-promoting devices will be permitted inside the tubes. Headers shall have vent connections.

2.6 AIR FILTRATION SECTION

A. General Requirements for Air Filtration Section:

1. Each filter section shall be designed and constructed to house the type of filter specified on the equipment schedule.
2. Flat filter sections shall accept 2-in. disposable, 30% (MERV-7) pleated filters of standard sizes. Sections shall include side access slide rails. Flat filter section shall be arranged with minimum depth in direction of airflow.
3. Comply with NFPA 90A.
4. Provide minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
5. Provide filter holding frames arranged for flat orientation, with access doors on both sides of unit. Filters shall be removable from one side.

2.7 DAMPERS

A. General Requirements for Dampers: Leakage rate, according to AMCA 500, "Laboratory Methods for Testing Dampers for Rating," shall not exceed 5 percent of air quantity at 2000-fpm face velocity through damper and 4-inch wg pressure differential.

B. Electronic Damper Operators:

1. Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.
2. Electronic damper position indicator shall have visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.
3. Operator Motors:
 - a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors.
 - b. Size to operate with sufficient reserve power to provide smooth modulating action or two-position action.
 - c. Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.
4. Nonspring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf.
5. Spring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running and breakaway torque of 150 in. x lbf.
6. Size dampers for running torque calculated as follows:
 - a. Parallel-Blade Damper with Edge Seals: 7 inch-lb/sq. ft. of damper.
 - b. Parallel-Blade Damper without Edge Seals: 4 inch-lb/sq. ft. of damper.
 - c. Dampers with 2- to 3-Inch wg of Pressure Drop or Face Velocities of 1000 to 2500 fpm: Increase running torque by 1.5.

- d. Dampers with 3- to 4-Inch wg of Pressure Drop or Face Velocities of 2500 to 3000 fpm: Increase running torque by 2.0.
 - 7. Coupling: V-bolt and V-shaped, toothed cradle.
 - 8. Overload Protection: Electronic overload or digital rotation-sensing circuitry.
 - 9. Fail-Safe Operation: Mechanical, spring-return mechanism with external, manual gear release on nonspring-return actuators.
 - 10. Power Requirements (Two-Position Spring Return): 24-V ac.
 - 11. Power Requirements (Modulating): Maximum 10 VA at 24-V ac or 8 W at 24-V dc.
 - 12. Proportional Signal: 2- to 10-V dc or 4 to 20 mA, and 2- to 10-V dc position feedback signal.
 - 13. Temperature Rating: Minus 22 to plus 122 deg F.
 - 14. Run Time: 12 seconds open, 5 seconds closed.
- C. Outdoor Dampers: Parallel-blade, galvanized-steel, aluminum, or extruded-aluminum dampers mechanically fastened to steel operating rod in reinforced cabinet.
- D. Inlet Plenum with Filter Section:
- 1. Cabinet support members shall hold 2-inch-thick, pleated, flat, permanent or throwaway filters.
- 2.8 ELECTRONIC AIR MEASURING STATION
- A. Comply with requirements for an electronic air measuring station as specified in Section 23 "Electronic Air Measuring Stations."
- 2.9 CAPACITIES AND CHARACTERISTICS
- A. See Mechanical Schedules
- 2.10 SOURCE QUALITY CONTROL
- A. Fan Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Fans shall bear AMCA-certified sound ratings seal.
 - B. Fan Performance Rating: Factory test fan performance for airflow, pressure, power, air density, rotation speed, and efficiency. Rate performance according to AMCA 210, "Laboratory Methods of Testing Fans for Aerodynamic Performance Rating."
 - C. Water Coils: Factory tested to 300 psig according to ARI 410 and ASHRAE 33.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine casing insulation materials and filter media before air-handling unit installation. Reject insulation materials and filter media that are wet, moisture damaged, or mold damaged.
- C. Examine roughing-in for hydronic piping systems and electrical services to verify actual locations of connections before installation.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Equipment Mounting:
 - 1. Install air-handling units on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
 - 2. Comply with requirements for vibration isolation and seismic control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
- B. Arrange installation of units to provide access space around air-handling units for service and maintenance.
- C. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing, with new, clean filters.
- D. Install filter-gage, static-pressure taps upstream and downstream of filters. Mount filter gages on outside of filter housing or filter plenum in accessible position. Provide filter gages on filter banks, installed with separate static-pressure taps upstream and downstream of filters.

3.3 CONNECTIONS

- A. Comply with requirements for piping specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to air-handling unit to allow service and maintenance.
- C. Connect piping to air-handling units mounted on vibration isolators with flexible connectors.
- D. Hot-Water Piping: Comply with applicable requirements in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties." Install shutoff valve and union or flange at each coil supply connection. Install balancing valve and union or flange at each coil return connection.

- E. Connect duct to air-handling units with flexible connections. Comply with requirements in Section 233300 "Air Duct Accessories."

3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- B. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- C. Tests and Inspections:
 - 1. Leak Test: After installation, fill water coils with water, and test coils and connections for leaks.
 - 2. Fan Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Air-handling unit or components will be considered defective if unit or components do not pass tests and inspections.
- E. Prepare test and inspection reports.

3.5 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
 - 1. Complete installation and startup checks according to manufacturer's written instructions.
 - 2. Verify that shipping, blocking, and bracing are removed.
 - 3. Verify that unit is secure on mountings and supporting devices and that connections to piping, ducts, and electrical systems are complete. Verify that proper thermal-overload protection is installed in motors, controllers, and switches.
 - 4. Verify proper motor rotation direction, free fan wheel rotation, and smooth bearing operations. Reconnect fan drive system, align belts, and install belt guards.
 - 5. Verify that bearings, pulleys, belts, and other moving parts are lubricated with factory-recommended lubricants.
 - 6. Verify that outdoor- and return-air mixing dampers open and close, and maintain minimum outdoor-air setting.
 - 7. Comb coil fins for parallel orientation.
 - 8. Install new, clean filters.
 - 9. Verify that manual and automatic volume control and fire and smoke dampers in connected duct systems are in fully open position.

- B. Starting procedures for air-handling units include the following:
 - 1. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated rpm. Replace fan and motor pulleys as required to achieve design conditions.
 - 2. Measure and record motor electrical values for voltage and amperage.
 - 3. Manually operate dampers from fully closed to fully open position and record fan performance.

3.6 ADJUSTING

- A. Adjust damper linkages for proper damper operation.
- B. Comply with requirements in Section 230593 "Testing, Adjusting, and Balancing for HVAC" for air-handling system testing, adjusting, and balancing.

3.7 CLEANING

- A. After completing system installation and testing, adjusting, and balancing air-handling unit and air-distribution systems and after completing startup service, clean air-handling units internally to remove foreign material and construction dirt and dust. Clean fan wheels, cabinets, dampers, coils, and filter housings, and install new, clean filters.

3.8 DEMONSTRATION

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

END OF SECTION 237339

SECTION 238123
COMPUTER-ROOM AIR-CONDITIONERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section Includes:
 - 1. Ceiling-mounted computer-room air conditioners.

1.3 DEFINITION

- A. DDC: Direct digital control.

1.4 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Computer-room air conditioners shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
 - 1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."

1.5 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
- B. Shop Drawings: For computer-room air conditioners. Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 2. Wiring Diagrams: For power, signal, and control wiring.
- C. Color Samples: For unit cabinet, discharge grille, and exterior louver and for each color and texture specified.

1.6 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Plans, elevations, and other details, drawn to scale, using input from Installers of the items involved.
- B. Seismic Qualification Certificates: For computer-room air conditioners, 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. Field quality-control reports.
- D. Warranty: Sample of special warranty.

1.7 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For computer-room air conditioners to include in emergency, operation, and maintenance manuals.

1.8 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. Fan Belts: One set(s) for each belt-driven fan.
 - 2. Filters: One set(s) of filters for each unit.

1.9 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ASHRAE Compliance:
 - 1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."
 - 2. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 4 - "Outdoor Air Quality," Section 5 - "Systems and Equipment," Section 6 - "Ventilation Rate Procedures," and Section 7 - "Construction and Startup."
- C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1.
- D. ASME Compliance: Fabricate and label water-cooled condenser shell to comply with ASME Boiler and Pressure Vessel Code: Section VIII, "Pressure Vessels," Division 1.

1.10 COORDINATION

- A. Coordinate layout and installation of computer-room air conditioners and suspension system with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.
- B. Coordinate installation of computer-room air conditioners with computer-room access flooring Installer.
- C. Coordinate sizes and locations of concrete bases with actual equipment provided.
- D. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

1.11 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of computer-room air conditioners that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period for Compressors: Manufacturer's standard, but not less than five years from date of Substantial Completion.
 - 2. Warranty Period for Control Boards: Manufacturer's standard, but not less than three years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 CEILING-MOUNTED UNITS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Compu-Aire, Inc.
 - 2. Data Aire Inc.
 - 3. Liebert; a brand of Emerson Electric Co.
- B. Description: Self-contained, factory assembled, prewired, and prepiped; consisting of cabinet, fan, filters, and controls; for horizontal ceiling mounting to fit T-bar ceiling opening of 24 by 48 inches.
- C. Cabinet: Galvanized steel with baked-enamel finish, insulated with 1/2-inch-thick duct liner.
 - 1. Integral factory-supplied supply and return grille to fit ceiling grid kit of 24 by 48 inches, with filter.
 - 2. Finish of Interior Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- D. Supply-Air Fan: Forward curved, centrifugal, and directly driven by two-speed motor.

E. Refrigeration System:

1. Compressor: Hermetic, with oil strainer, internal motor overload protection, resilient suspension system, and crankcase heater.
2. Refrigeration Circuit: Low-pressure switch, manual-reset high-pressure switch, thermal-expansion valve with external equalizer, sight glass with moisture indicator, service shutoff valves, charging valves, and charge of refrigerant.
3. Refrigerant: R-407C or R-410A.
4. Refrigerant Evaporator Coil: Direct-expansion coil of seamless copper tubes expanded into aluminum fins.
 - a. Mount coil assembly over stainless-steel drain pan complying with ASHRAE 62.1 and having a condensate pump unit with integral float switch, pump-motor assembly, and condensate reservoir.
5. Remote Air-Cooled Refrigerant Condenser: Integral, copper-tube aluminum-fin coil with propeller fan, direct driven.
6. Split system shall have suction- and liquid-line compatible fittings and refrigerant piping for field interconnection.

F. Electric-Resistance Heating Coil: Finned-tube electric elements with contactor, dehumidification relay, and high-temperature-limit switches.

G. Filter: 1-inch-thick, disposable, glass-fiber media.

1. Merv (ASHRAE 52.2): 8.

H. Disconnect Switch: Nonautomatic, molded-case circuit breaker with handle accessible when panel is closed and capable of preventing access until switched to off position.

I. Control System: Unit-mounted panel with main fan contactor, compressor contactor, compressor start capacitor, control transformer with circuit breaker, solid-state temperature- and humidity-control modules, humidity contactor, time-delay relay, heating contactor, and high-temperature thermostat. Provide solid-state, wall-mounted control panel with start-stop switch, adjustable humidity set point, and adjustable temperature set point.

2.2 FAN MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Section 230513 "Common Motor Requirements for HVAC Equipment."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.

2.3 EXAMINATION

- A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for hydronic piping systems to verify actual locations of piping connections before equipment installation.
- C. Examine walls, floors, and roofs for suitable conditions where computer-room air conditioners will be installed.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

2.4 INSTALLATION

- A. Install computer-room air conditioners level and plumb, maintaining manufacturer's recommended clearances. Install according to ARI Guideline B.
- B. Suspended Computer-Room Air Conditioners: Install using continuous-thread hanger rods and spring hangers of size required to support weight of computer-room air conditioner.
 - 1. Comply with requirements for vibration isolation devices specified in Section 230548 "Vibration and Seismic Controls for HVAC." Fabricate brackets or supports as required.
 - 2. Comply with requirements for hangers and supports specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."
- C. Air-Cooled Refrigerant Condenser Mounting: Install using elastomeric mounts. Comply with requirements for vibration isolation devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
 - 1. Minimum Deflection: 1 inch.

2.5 CONNECTIONS

- A. Piping installation requirements are specified in other heating, ventilating, and air-conditioning Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to machine to allow service and maintenance.
- C. Water and Drainage Connections: Comply with applicable requirements in Section 221116 "Domestic Water Piping." Provide adequate connections for water-cooled units, condensate drain, and humidifier flushing system.
- D. Refrigerant Piping: Comply with manufacturer's requirements. Provide shutoff valves and piping.

2.6 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- B. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- C. Tests and Inspections:
 - 1. Inspect for and remove shipping bolts, blocks, and tie-down straps.
 - 2. After installing computer-room air conditioners and after electrical circuitry has been energized, test for compliance with requirements.
 - 3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Computer-room air conditioners will be considered defective if they do not pass tests and inspections.
- E. Prepare test and inspection reports.
- F. After startup service and performance test, change filters and flush humidifier.

2.7 ADJUSTING

- A. Adjust initial temperature and humidity set points.
- B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
- C. Occupancy Adjustments: When requested within 1 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

2.8 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain computer-room air conditioners.

END OF SECTION 238123

SECTION 238126
SPLIT-SYSTEM AIR-CONDITIONERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes split-system air-conditioning units consisting of separate evaporator-fan and compressor-condenser components.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.
- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 2. Wiring Diagrams: For power, signal, and control wiring.
- C. Samples for Initial Selection: For units with factory-applied color finishes.

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.
- B. Warranty: Sample of special warranty.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For split-system air-conditioning units to include in emergency, operation, and maintenance manuals.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Filters: One set(s) for each air-handling unit.
 - 2. Gaskets: One set(s) for each access door.
 - 3. Fan Belts: One set(s) for each air-handling unit fan.

1.7 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ASHRAE Compliance:
 - 1. Fabricate and label refrigeration system to comply with ASHRAE 15, "Safety Standard for Refrigeration Systems."
- C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1.

1.8 COORDINATION

- A. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork are specified in Section 033000 "Cast-in-Place Concrete."
- B. Coordinate sizes and locations of roof curbs, equipment supports, and roof penetrations with actual equipment provided.

1.9 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period:
 - a. For Compressor: Five year(s) from date of Substantial Completion.
 - b. For Parts: Five year(s) from date of Substantial Completion.
 - c. For Labor: One year(s) from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. LG Electronics U.S.A, Inc.
 2. Mitsubishi Electric & Electronics USA, Inc.
 3. YORK; a Johnson Controls company.

2.2 INDOOR UNITS (5 TONS OR LESS)

A. Concealed Evaporator-Fan Components:

1. Chassis: Galvanized steel with flanged edges, removable panels for servicing, and insulation on back of panel.
2. Insulation: Faced, glass-fiber duct liner.
3. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with ARI 206/110.
4. Water Coil: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch; leak tested to 300 psig underwater; with a two-position control valve.
5. Fan: Forward-curved, double-width wheel of galvanized steel; directly connected to motor.
6. Fan Motors:
 - a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Section 230513 "Common Motor Requirements for HVAC Equipment."
 - b. Multitapped, multispeed with internal thermal protection and permanent lubrication.
 - c. Wiring Terminations: Connect motor to chassis wiring with plug connection.
7. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
8. Air Filtration Section:
 - a. General Requirements for Air Filtration Section:
 - 1) Comply with NFPA 90A.
 - 2) Minimum Arrestance: 30% or MERV 6
 - 3) Filter-Holding Frames: Arranged for flat, with access doors on both sides of unit. Filters shall be removable from one side
 - 4) Factory-fabricated, flat-panel disposable type.
 - 5) Thickness: 2 inches
 - 6) Media: Interlaced glass fibers sprayed with nonflammable adhesive and antimicrobial agent.

9. Frame: Galvanized steel, with metal grid on outlet side, steel rod grid on inlet side, and hinged; with pull and retaining handles.
10. Condensate Drain Pans:
 - a. Fabricated with one percent slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and humidifiers, and to direct water toward drain connection.
 - 1) Length: Extend drain pan downstream from leaving face to comply with ASHRAE 62.1.
 - 2) Depth: A minimum of 2 inches deep.
 - b. Single-wall, stainless-steel sheet.
 - c. Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on one end of pan.
 - 1) Minimum Connection Size: NPS 1.

2.3 UNITS (5 TONS OR LESS)

A. Air-Cooled, Compressor-Condenser Components:

1. Casing: Steel, finished with baked enamel in color selected by Architect, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.
2. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation device. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.
 - a. Compressor Type: Scroll.
 - b. Two-speed compressor motor with manual-reset high-pressure switch and automatic-reset low-pressure switch.
 - c. Refrigerant Charge: R-410A.
 - d. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and liquid subcooler. Comply with ARI 206/110.
3. Fan: Aluminum-propeller type, directly connected to motor.
4. Motor: Permanently lubricated, with integral thermal-overload protection.
5. Low Ambient Kit: Permits operation down to 45 deg F.
6. Mounting Base: Polyethylene.

2.4 ACCESSORIES

- A. Control equipment and sequence of operation are specified in Section 230923 "Direct Digital Control (DDC) System for HVAC."
- B. Automatic-reset timer to prevent rapid cycling of compressor.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install units level and plumb.
- B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.
- C. Equipment Mounting:
 - 1. Install ground-mounted, compressor-condenser components on cast-in-place concrete equipment base(s). Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
 - 2. Install ground-mounted, compressor-condenser components on polyethylene mounting base.
 - 3. Comply with requirements for vibration isolation and seismic control devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
- D. Install and connect precharged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

3.2 CONNECTIONS

- A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where piping is installed adjacent to unit, allow space for service and maintenance of unit.
- C. Duct Connections: Duct installation requirements are specified in Section 233113 "Metal Ducts." Drawings indicate the general arrangement of ducts. Connect supply and return ducts to split-system air-conditioning units with flexible duct connectors. Flexible duct connectors are specified in Section 233300 "Air Duct Accessories."

3.3 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- B. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- C. Tests and Inspections:
 - 1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

D. Remove and replace malfunctioning units and retest as specified above.

E. Prepare test and inspection reports.

3.4 STARTUP SERVICE

A. Perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.

3.5 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain units.

END OF SECTION 238126

SECTION 238239.16
PROPELLER UNIT HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes propeller unit heaters with hot-water coils.

1.3 DEFINITIONS

- A. CWP: Cold working pressure.
- B. PTFE: Polytetrafluoroethylene plastic.
- C. TFE: Tetrafluoroethylene plastic.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include rated capacities, operating characteristics, furnished specialties, and accessories.
- B. Shop Drawings:
 - 1. Include plans, elevations, sections, and details.
 - 2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 3. Include location and size of each field connection.
 - 4. Include details of anchorages and attachments to structure and to supported equipment.
 - 5. Include equipment schedules to indicate rated capacities, operating characteristics, furnished specialties, and accessories.
 - 6. Indicate location and arrangement of piping valves and specialties.
 - 7. Indicate location and arrangement of integral controls.
 - 8. Wiring Diagrams: Power, signal, and control wiring.

1.5 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings: Floor plans, reflected ceiling plans, and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
 - 1. Suspended ceiling components.
 - 2. Structural members to which propeller unit heaters will be attached.
 - 3. Method of attaching hangers to building structure.
 - 4. Size and location of initial access modules for acoustical tile.
 - 5. Items penetrating finished ceiling, including the following:
 - a. Lighting fixtures.
 - b. Air outlets and inlets.
 - c. Speakers.
 - d. Sprinklers.
 - e. Access panels.

- B. Seismic Qualification Certificates: Submit certification that propeller unit heaters, accessories, and components will withstand seismic forces defined in Section 230548 "Vibration and Seismic Controls for HVAC." Include the following:
 - 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. Include detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

- C. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For propeller unit heaters to include in emergency, operation, and maintenance manuals.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. Airtherm; a Mestek company.
 - 2. Modine.
 - 3. Trane.

2.2 DESCRIPTION

- A. Assembly including casing, coil, fan, and motor in horizontal discharge configuration with adjustable discharge louvers.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with UL 2021.
- D. Comply with UL 823.

2.3 PERFORMANCE REQUIREMENTS

- A. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- B. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."
- C. Seismic Performance: Propeller unit heaters shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
 - 1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified."

2.4 HOUSINGS

- A. Finish: Manufacturer's standard baked enamel applied to factory-assembled and -tested propeller unit heaters before shipping.
- B. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- C. Discharge Louver: Adjustable horizontal air deflectors.

2.5 COILS

- A. General Coil Requirements: Test and rate hot-water propeller unit-heater coils according to ASHRAE 33.
- B. Hot-Water Coil: Copper tube, minimum 0.025-inch wall thickness, with mechanically bonded aluminum fins spaced no closer than 0.1 inch and rated for a minimum working pressure of 150 psig and a maximum entering-water temperature of 325 deg F, with manual air vent. Test for leaks to 200 psig underwater.
- C. Electric-Resistance Heating Coil: Nickel-chromium heating wire, free from expansion noise and 60-Hz hum, embedded in magnesium oxide refractory and sealed in steel or corrosion-resistant

metallic sheath with fins no closer than 0.16 inch . Element ends shall be enclosed in terminal box. Fin surface temperature shall not exceed 550 deg F at any point during normal operation.

1. Circuit Protection: One-time fuses in terminal box for overcurrent protection and limit controls for high-temperature protection of heaters.
2. Wiring Terminations: Stainless-steel or corrosion-resistant material.

2.6 FAN AND MOTOR

- A. Fan: Propeller type with aluminum wheel directly mounted on motor shaft in the fan venturi.
- B. Motor: Permanently lubricated, designed for continuous duty.

2.7 CONTROLS

- A. Control Devices:
 1. Unit-mounted thermostat.
 2. Thermostat shall be concealed or in accessible by end user.

2.8 CAPACITIES AND CHARACTERISTICS

- A. See equipment schedule for unit heater capacities and accessories

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to receive propeller unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for piping and electrical connections to verify actual locations before unit-heater installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install propeller unit heaters to comply with NFPA 90A.
- B. Install propeller unit heaters level and plumb.

- C. Suspend propeller unit heaters from structure with all-thread hanger rods and spring hangers. Hanger rods and attachments to structure are specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment." Vibration hangers are specified in Section 230548 "Vibration and Seismic Controls for HVAC."

3.3 CONNECTIONS

- A. Piping installation requirements are specified in Section 232113 "Hydronic Piping," an Section 232116 "Hydronic Piping Specialties." Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Install piping adjacent to machine to allow service and maintenance.
- C. Connect piping to propeller unit heater's factory, hot-water piping package. Install the piping package if shipped loose.
- D. Comply with safety requirements in UL 1995.
- E. Unless otherwise indicated, install union and gate or ball valve on supply-water connection and union and calibrated balancing valve on return-water connection of propeller unit heater. Hydronic specialties are specified in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties."
- F. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- G. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
 - 1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
 - 2. Operate electric heating elements through each stage to verify proper operation and electrical connections.
 - 3. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.
- B. Units will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports.

3.5 ADJUSTING

- A. Adjust initial temperature set points.

3.6 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain propeller unit heaters.

END OF SECTION 238239.16

SECTION 260519
LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Building wires and cables rated 600 V and less.
 - 2. Connectors, splices, and terminations rated 600 V and less.

1.2 ACTION SUBMITTALS

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

1.3 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. Alpha Wire Company.
 - 2. General Cable Technologies Corporation.
 - 3. Southwire Company.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Conductor and Cable Marking: Comply with wire and cable marking according to UL's "Wire and Cable Marking and Application Guide."
- D. Comply with UL 1277, UL 1685, and NFPA 70 for Type TC-ER cable used in VFC circuits.
- E. Conductors: Copper, complying with NEMA WC 70/ICEA S-95-658.
 - 1. Conductor Insulation: Comply with NEMA WC 70/ICEA S-95-658 for Type THHN/THWN-2 (for branch circuits) and Type XHHW-2 (for panel feeders).

- F. Cable: Comply with NEMA WC 70/ICEA S-95-658 for metal-clad cable, Type MC with ground wire.

2.2 CONNECTORS AND SPLICES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 1. 3M Electrical Products.
 2. AFC Cable Systems; a part of Atkore International.
 3. Hubbell Power Systems, Inc.
 4. O-Z/Gedney; a brand of Emerson Industrial Automation.
 5. Thomas & Betts Corporation, A Member of the ABB Group.
- B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated; listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

- A. Feeders: Copper. All wire shall be stranded.
- B. Branch Circuits: Copper. All wire shall be stranded.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

- A. Service Entrance: Type XHHW-2, single conductors in raceway.
- B. Exposed Feeders: Type XHHW-2, single conductors in raceway.
- C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspace: Type XHHW-2, single conductors in raceway.
- D. Exposed Branch Circuits, Including in Crawlspace: Type THHN/THWN-2, single conductors in raceway.
- E. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Metal-clad cable, Type MC.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

- A. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.

- B. Complete raceway installation between conductor and cable termination points according to Section 260533 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.
- C. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
- D. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.
- E. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.
- F. Support cables according to Section 260529 "Hangers and Supports for Electrical Systems."

3.4 CONNECTIONS

- A. Tighten electrical connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A-486B.
- B. Make splices, terminations, and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.
- C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack.

3.5 IDENTIFICATION

- A. Identify and color-code conductors and cables according to Section 260553 "Identification for Electrical Systems."
- B. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

3.6 FIRESTOPPING

- A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Section 078413 "Penetration Firestopping."

3.7 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:

1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors for compliance with requirements.
 2. Perform each of the following visual and electrical tests:
 - a. Inspect exposed sections of conductor and cable for physical damage and correct connection according to the single-line diagram.
 - b. Test bolted connections for high resistance using one of the following:
 - 1) A low-resistance ohmmeter.
 - 2) Calibrated torque wrench.
 - 3) Thermographic survey.
 - c. Inspect compression applied connectors for correct cable match and indentation.
 - d. Inspect for correct identification.
 - e. Inspect cable jacket and condition.
 - f. Insulation-resistance test on each conductor with respect to ground and adjacent conductors. Apply a potential of 500-V dc for 300-V rated cable and 1000-V dc for 600-V rated cable for a one-minute duration.
 - g. Continuity test on each conductor and cable.
 - h. Uniform resistance of parallel conductors.
- B. Cables will be considered defective if they do not pass tests and inspections.
- C. Prepare test and inspection reports to record the following:
1. Procedures used.
 2. Results that comply with requirements.
 3. Results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

END OF SECTION 260519

SECTION 260526
GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes grounding and bonding systems and equipment.
- B. Section includes grounding and bonding systems and equipment, plus the following special applications:
 - 1. Underground distribution grounding.

1.2 ACTION SUBMITTALS

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

1.3 QUALITY ASSURANCE

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. Burndy; Part of Hubbell Electrical Systems.
 - 2. ERICO International Corporation.
 - 3. Harger Lightning & Grounding.
 - 4. O-Z/Gedney; a brand of Emerson Industrial Automation.
 - 5. Thomas & Betts Corporation, A Member of the ABB Group.

2.2 SYSTEM DESCRIPTION

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

- B. Comply with UL 467 for grounding and bonding materials and equipment.

2.3 CONDUCTORS

- A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.
- B. Bare Copper Conductors:
 - 1. Solid Conductors: ASTM B 3.
 - 2. Stranded Conductors: ASTM B 8.
 - 3. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch in diameter.
 - 4. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
- C. Grounding Bus: Predrilled rectangular bars of annealed copper, 1/4 by 4 inches in cross section, with 9/32-inch holes spaced 1-1/8 inches apart. Stand-off insulators for mounting shall comply with UL 891 for use in switchboards, 600 V and shall be Lexan or PVC, impulse tested at 5000 V.
- D. Grounding electrode conductors shall be stranded cable and be sized in accordance with Table 250.66 of the National Electrical Code.
- E. Equipment Grounding Conductors: Insulated with green-colored insulation.
- F. Isolated Ground Conductors: Insulated with green-colored insulation with yellow strip. On feeders with isolated ground, use colored tape, alternating bands of green and yellow tape to provide a minimum of three bands of green and two bands of yellow.
- G. Grounding Electrode Conductors: Stranded cable.
- H. Underground Conductors: Bare, tinned, stranded, unless otherwise indicated.

2.4 CONNECTORS

- A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction for applications in which used and for specific types, sizes, and combinations of conductors and other items connected.
- B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy.
- C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.
- D. Bus-Bar Connectors: Mechanical type, cast silicon bronze, solderless compression-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.

2.5 GROUNDING ELECTRODES

- A. Ground Rods: Copper-clad steel; 3/4 inch by 10 feet.

PART 3 - EXECUTION

3.1 APPLICATIONS

- A. Conductors: All conductors shall be stranded.
- B. Underground Grounding Conductors: Install bare copper conductor, No. 4/0 AWG minimum.
 - 1. Bury at least 24 inches below grade.
- C. Grounding Bus: Install in electrical equipment rooms, in rooms housing service equipment, and elsewhere as indicated.
 - 1. Install bus horizontally, on insulated spacers 2 inches minimum from wall, 6 inches above finished floor unless otherwise indicated.
- D. Conductor Terminations and Connections:
 - 1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
 - 2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.

3.2 GROUNDING AT THE SERVICE

- A. Equipment grounding conductors and grounding electrode conductors shall be connected to the ground bus. Install a main bonding jumper between the neutral and ground buses.

3.3 GROUNDING SEPARATELY DERIVED SYSTEMS

- A. Generator: Install grounding electrodes at the generator location. The electrode shall be connected to the equipment grounding conductor and to the frame of the generator.

3.4 EQUIPMENT GROUNDING

- A. Install insulated equipment grounding conductors with all feeders and branch circuits.
- B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:
 - 1. Feeders and branch circuits.
 - 2. Lighting circuits.
 - 3. Receptacle circuits.
 - 4. Single-phase motor and appliance branch circuits.
 - 5. Three-phase motor and appliance branch circuits.
 - 6. Flexible raceway runs.
 - 7. Metal-clad cable runs.

- C. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.
- D. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.

3.5 INSTALLATION

- A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.
- B. Ground Rods: Drive rods until tops are 2 inches below finished floor or final grade unless otherwise indicated.
 - 1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.
 - 2. For grounding electrode system, install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.
- C. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.
 - 1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
 - 2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
 - 3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.
- D. Grounding and Bonding for Piping:
 - 1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use a bolted clamp connector or bolt a lug-type connector to a pipe flange by using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.
 - 2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.
 - 3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.
- E. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install bonding jumper to bond across flexible duct connections to achieve continuity.

3.6 FIELD QUALITY CONTROL

- A. Tests and Inspections:
 - 1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.
 - 2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.
 - 3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, and at individual ground rods. Make tests at ground rods before any conductors are connected.
 - a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.
 - b. Perform tests by fall-of-potential method according to IEEE 81.
 - 4. Prepare dimensioned Drawings locating each ground rod and ground-rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results.
- B. Grounding system will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.
- D. Report measured ground resistances that exceed 5 Ohms.
- E. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Engineer promptly and include recommendations to reduce ground resistance.

END OF SECTION 260526

SECTION 260529
HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Hangers and supports for electrical equipment and systems.
 - 2. Construction requirements for concrete bases.

1.2 DEFINITIONS

- A. EMT: Electrical metallic tubing.
- B. RMC: Rigid metal conduit.

1.3 PERFORMANCE REQUIREMENTS

- A. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.
- B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.
- C. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

1.4 ACTION SUBMITTALS

- A. Product Data: For the following:
 - 1. Steel slotted support systems.
 - 2. Trapeze hangers. Include Product Data for components.
 - 3. Equipment supports.

1.5 QUALITY ASSURANCE

- A. Comply with NFPA 70.

1.6 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified together with concrete Specifications.

PART 2 - PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

- A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Allied Tube & Conduit; a part of Atkore International.
 - b. B-line, an Eaton business.
 - c. ERICO International Corporation.
 - d. Thomas & Betts Corporation, A Member of the ABB Group.
 - e. Unistrut; Part of Atkore International.
 - 2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
 - 3. Channel Dimensions: Selected for applicable load criteria.
 - 4. Fittings and Accessories: Products of channel and angle manufacturer and designed for use with those items.
 - 5. Rated Strength: Selected to suit applicable load criteria.
- B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.
- C. Conduit and Cable Support Devices: Steel and malleable-iron hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.
- D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.
- E. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.
- F. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:
 - 1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

- 1) Hilti, Inc.
- 2) ITW Ramset/Red Head; Illinois Tool Works, Inc.
- 3) MKT Fastening, LLC.
- 4) Simpson Strong-Tie Co., Inc.
2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
 - a. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1) B-line, an Eaton business.
 - 2) Empire Tool and Manufacturing Co., Inc.
 - 3) Hilti, Inc.
 - 4) ITW Ramset/Red Head; Illinois Tool Works, Inc.
 - 5) MKT Fastening, LLC.
 3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
 4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
 5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
 6. Toggle Bolts: All-steel springhead type.
 7. Hanger Rods: Threaded steel.

2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

- A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

PART 3 - EXECUTION

3.1 APPLICATION

- A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.
- B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch in diameter.
- C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.
 1. Secure raceways and cables to these supports with single-bolt conduit clamps using spring friction action for retention in support channel.

- D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.
- B. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb.
- C. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
 - 1. To Wood: Fasten with lag screws or through bolts.
 - 2. To New Concrete: Bolt to concrete inserts.
 - 3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
 - 4. To Existing Concrete: Expansion anchor fasteners.
 - 5. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.
 - 6. To Steel: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69.
 - 7. To Light Steel: Sheet metal screws.
 - 8. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate by means that meet seismic-restraint strength and anchorage requirements.
- D. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

- A. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.
- B. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 CONCRETE BASES

- A. Construct concrete bases of dimensions indicated but not less than 4 inches larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.
- B. Use 3000-psi 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Section 033000 "Cast-in-Place Concrete."
- C. Anchor equipment to concrete base.
 - 1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
 - 2. Install anchor bolts to elevations required for proper attachment to supported equipment.
 - 3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.5 PAINTING

- A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.
 - 1. Apply paint by brush or spray to provide minimum dry film thickness of .
- B. Touchup: Provide cleaning and touchup painting of affected field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.
- C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION 260529

SECTION 260533
RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Metal conduits, tubing, and fittings.
 - 2. Nonmetal conduits, tubing, and fittings.
 - 3. Metal wireways and auxiliary gutters.
 - 4. Boxes, enclosures, and cabinets.

1.2 ACTION SUBMITTALS

- A. Product Data: For surface raceways, wireways and fittings, hinged-cover enclosures, and cabinets.
- B. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

PART 2 - PRODUCTS

2.1 METAL CONDUITS, TUBING, AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. AFC Cable Systems; a part of Atkore International.
 - 2. Allied Tube & Conduit; a part of Atkore International.
 - 3. Calconduit.
 - 4. O-Z/Gedney; a brand of Emerson Industrial Automation.
 - 5. Southwire Company.
 - 6. Thomas & Betts Corporation, A Member of the ABB Group.
- B. Listing and Labeling: Metal conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. GRC: Comply with ANSI C80.1 and UL 6.
- D. EMT: Comply with ANSI C80.3 and UL 797.
- E. FMC: Comply with UL 1; zinc-coated steel.
- F. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.

- G. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.
 - 1. Fittings for EMT:
 - a. Material: Steel.
 - b. Type: compression.
 - 2. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.
- H. Joint Compound for GRC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 NONMETALLIC CONDUITS, TUBING, AND FITTINGS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. AFC Cable Systems; a part of Atkore International.
 - 2. CANTEX INC.
 - 3. Condux International, Inc.
 - 4. Thomas & Betts Corporation, A Member of the ABB Group.
- B. Listing and Labeling: Nonmetallic conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.
- D. Fittings for RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.
- E. Solvents and Adhesives: As recommended by conduit manufacturer.

2.3 METAL WIREWAYS AND AUXILIARY GUTTERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. B-line, an Eaton business.
 - 2. Hoffman; a brand of Pentair Equipment Protection.
 - 3. MonoSystems, Inc.
 - 4. Square D.
- B. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 1 (indoors), NEMA 4 (outdoors) unless otherwise indicated, and sized according to NFPA 70.
 - 1. Metal wireways installed outdoors shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

- C. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.
- D. Wireway Covers: Hinged type unless otherwise indicated.
- E. Finish: Manufacturer's standard enamel finish.

2.4 BOXES, ENCLOSURES, AND CABINETS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. Crouse-Hinds, an Eaton business.
 - 2. EGS/Appleton Electric.
 - 3. Hoffman; a brand of Pentair Equipment Protection.
 - 4. Hubbell Incorporated.
 - 5. O-Z/Gedney; a brand of Emerson Industrial Automation.
 - 6. RACO; Hubbell.
- B. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.
- C. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.
- D. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.
- E. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 lb. Outlet boxes designed for attachment of luminaires weighing more than 50 lb shall be listed and marked for the maximum allowable weight.
- F. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.
- G. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, galvanized, cast iron with gasketed cover.
- H. Box extensions used to accommodate new building finishes shall be of same material as recessed box.
- I. Device Box Dimensions: 4 inches square by 2-1/8 inches deep.
- J. Gangable boxes are prohibited.
- K. Hinged-Cover Enclosures: Comply with UL 50 and NEMA 250, Type 1 or Type 3R with continuous-hinge cover with flush latch unless otherwise indicated.
 - 1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
 - 2. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

- L. Cabinets:
 - 1. NEMA 250, Type 1 or Type 3R galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
 - 2. Hinged door in front cover with flush latch and concealed hinge.
 - 3. Key latch to match panelboards.
 - 4. Metal barriers to separate wiring of different systems and voltage.
 - 5. Accessory feet where required for freestanding equipment.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

- A. Outdoors: Apply raceway products as specified below unless otherwise indicated:
 - 1. Exposed Conduit: GRC.
 - 2. Concealed Conduit, Aboveground: GRC.
 - 3. Underground Conduit: RNC, Type EPC-40-PVC.
 - 4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.
 - 5. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.
- B. Indoors: Apply raceway products as specified below unless otherwise indicated:
 - 1. Exposed, Not Subject to Physical Damage: EMT.
 - 2. Exposed, Not Subject to Severe Physical Damage: EMT.
 - 3. Exposed and Subject to Severe Physical Damage: GRC.
 - 4. Concealed in Ceilings and Interior Walls and Partitions: MC Cable.
 - 5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
 - 6. Damp or Wet Locations: GRC.
 - 7. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 3R stainless steel in damp or wet locations.
- C. Minimum Raceway Size: 3/4-inch trade size.
- D. Raceway Fittings: Compatible with raceways and suitable for use and location.
 - 1. Rigid Steel Conduit: Use threaded rigid steel conduit fittings unless otherwise indicated. Comply with NEMA FB 2.10.
 - 2. EMT: Use compression, steel fittings. Comply with NEMA FB 2.10.
 - 3. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.
- E. Do not install nonmetallic conduit where ambient temperature exceeds 120 deg F.

3.2 INSTALLATION

- A. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum conduits. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.
- B. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.
- C. Complete raceway installation before starting conductor installation.
- D. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for hangers and supports.
- E. Arrange stub-ups so curved portions of bends are not visible above finished slab.
- F. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches of changes in direction.
- G. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.
- H. Support conduit within 12 inches of enclosures to which attached.
- I. Raceways Embedded in Slabs:
 - 1. Run conduit larger than 1-inch trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure raceways to reinforcement at maximum 10-foot intervals.
 - 2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
 - 3. Arrange raceways to keep a minimum of 2 inches of concrete cover in all directions.
 - 4. Do not embed threadless fittings in concrete unless specifically approved by Engineer for each specific location.
 - 5. Change from EPC-40-PVC to GRC before rising above floor.
- J. Stub-ups to Above Recessed Ceilings:
 - 1. Use EMT for raceways.
 - 2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.
- K. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.
- L. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.

- M. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch trade size and insulated throat metal bushings on 1-1/2-inch trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.
- N. Install raceways square to the enclosure and terminate at enclosures with locknuts. Install locknuts hand tight plus 1/4 turn more.
- O. Do not rely on locknuts to penetrate nonconductive coatings on enclosures. Remove coatings in the locknut area prior to assembling conduit to enclosure to assure a continuous ground path.
- P. Cut conduit perpendicular to the length. For conduits 2-inch trade size and larger, use roll cutter or a guide to make cut straight and perpendicular to the length.
- Q. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire. Cap underground raceways designated as spare above grade alongside raceways in use.
- R. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:
 - 1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
 - 2. Where an underground service raceway enters a building or structure.
 - 3. Where otherwise required by NFPA 70.
- S. Comply with manufacturer's written instructions for solvent welding RNC and fittings.
- T. Expansion-Joint Fittings:
 - 1. Install in each run of aboveground RMC and EMT conduit that is located where environmental temperature change may exceed 100 deg F and that has straight-run length that exceeds 100 feet.
 - 2. Install type and quantity of fittings that accommodate temperature change listed for each of the following locations:
 - a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F temperature change.
 - b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F temperature change.
 - c. Indoor Spaces Connected with Outdoors without Physical Separation: 125 deg F temperature change.
 - d. Attics: 135 deg F temperature change.
 - 3. Install expansion fittings at all locations where conduits cross building or structure expansion joints.
 - 4. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at time of installation. Install conduit supports to allow for expansion movement.

- U. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72 inches of flexible conduit for recessed and semirecessed luminaires, equipment subject to vibration, noise transmission, or movement; and for transformers and motors.
 - 1. Use LFMC in damp or wet locations subject to severe physical damage.
 - 2. Use LFMC in damp or wet locations not subject to severe physical damage.
- V. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.
- W. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between box and cover plate or supported equipment and box.
- X. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.
- Y. Locate boxes so that cover or plate will not span different building finishes.
- Z. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.
- AA. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

3.3 INSTALLATION OF UNDERGROUND CONDUIT

- A. Direct-Buried Conduit:
 - 1. Excavate trench bottom to provide firm and uniform support for conduit.
 - 2. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction.
 - 3. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through floor.
 - a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete for a minimum of 12 inches on each side of the coupling.
 - b. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60 inches from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.
 - 4. Underground Warning Tape: Comply with requirements in Section 260553 "Identification for Electrical Systems."

3.4 FIRESTOPPING

- A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.5 PROTECTION

- A. Protect coatings, finishes, and cabinets from damage and deterioration.
 - 1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
 - 2. Repair damage to coatings or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION 260533

SECTION 260553
IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Identification for raceways.
 - 2. Identification of power and control cables.
 - 3. Identification for conductors.
 - 4. Underground-line warning tape.
 - 5. Warning labels and signs.
 - 6. Instruction signs.
 - 7. Equipment identification labels.
 - 8. Miscellaneous identification products.

1.2 ACTION SUBMITTALS

- A. Product Data: For each electrical identification product indicated.

1.3 QUALITY ASSURANCE

- A. Comply with ANSI A13.1 and IEEE C2.
- B. Comply with NFPA 70.
- C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.
- D. Comply with ANSI Z535.4 for safety signs and labels.
- E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

1.4 COORDINATION

- A. Coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual; and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.
- B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.
- C. Coordinate installation of identifying devices with location of access panels and doors.

- D. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 POWER AND CONTROL RACEWAY IDENTIFICATION MATERIALS

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway size.
- B. Colors for Raceways Carrying Circuits at 600 V or Less:
 - 1. Black letters on an orange field.
 - 2. Legend: Indicate voltage and system or service type.
- C. Vinyl Labels for Raceways Carrying Circuits at 600 V or Less: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing ends of legend label.
- D. Snap-Around Labels for Raceways Carrying Circuits at 600 V or Less: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

2.2 METAL-CLAD CABLE IDENTIFICATION MATERIALS

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each cable size.
- B. Colors for Cables Carrying Circuits at 600 V and Less:
 - 1. Black letters on an orange field.
 - 2. Legend: Indicate voltage and system or service type.
- C. Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing ends of legend label.
- D. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; 2 inches wide; compounded for outdoor use.

2.3 POWER AND CONTROL CABLE IDENTIFICATION MATERIALS

- A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each cable size.
- B. Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound clear adhesive tape for securing ends of legend label.

- C. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of cable it identifies and to stay in place by gripping action.

2.4 CONDUCTOR IDENTIFICATION MATERIALS

- A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils thick by 1 to 2 inches wide.
- B. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of conductor it identifies and to stay in place by gripping action.

2.5 UNDERGROUND-LINE WARNING TAPE

- A. Tape:
 - 1. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical utility lines.
 - 2. Printing on tape shall be permanent and shall not be damaged by burial operations.
 - 3. Tape material and ink shall be chemically inert, and not subject to degrading when exposed to acids, alkalis, and other destructive substances commonly found in soils.
- B. Color and Printing:
 - 1. Comply with ANSI Z535.1 through ANSI Z535.5.
 - 2. Inscriptions for Red-Colored Tapes: ELECTRIC LINE, HIGH VOLTAGE,.
- C. Tag: Type ID:
 - 1. Detectable three-layer laminate, consisting of a printed pigmented polyolefin film, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core, bright-colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.
 - 2. Overall Thickness: 5 mils.
 - 3. Foil Core Thickness: 0.35 mil.
 - 4. Weight: 28 lb/1000 sq. ft..
 - 5. 3-Inch Tensile According to ASTM D 882: 70 lbf, and 4600 psi.

2.6 WARNING LABELS AND SIGNS

- A. Comply with NFPA 70 and 29 CFR 1910.145.
- B. Baked-Enamel Warning Signs:
 - 1. Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application.
 - 2. 1/4-inch grommets in corners for mounting.
 - 3. Nominal size, 7 by 10 inches.
- C. Metal-Backed, Butyrate Warning Signs:

1. Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch galvanized-steel backing; and with colors, legend, and size required for application.
 2. 1/4-inch grommets in corners for mounting.
 3. Nominal size, 10 by 14 inches.
- D. Warning label and sign shall include, but are not limited to, the following legends:
1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."

2.7 INSTRUCTION SIGNS

- A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch thick for signs up to 20 sq. inches and 1/8 inch thick for larger sizes.
1. Engraved legend with black letters on white face.
 2. Punched or drilled for mechanical fasteners.
 3. Framed with mitered acrylic molding and arranged for attachment at applicable equipment.
- B. Adhesive Film Label: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch.
- C. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch. Overlay shall provide a weatherproof and UV-resistant seal for label.

2.8 EQUIPMENT IDENTIFICATION LABELS

- A. Adhesive Film Label: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch.
- B. Adhesive Film Label with Clear Protective Overlay: Machine printed, in black, by thermal transfer or equivalent process. Minimum letter height shall be 3/8 inch. Overlay shall provide a weatherproof and UV-resistant seal for label.
- C. Self-Adhesive, Engraved, Laminated Acrylic or Melamine Label: Adhesive backed, with white letters on a dark-gray background. Minimum letter height shall be 3/8 inch.
- D. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. White letters on a dark-gray background. Minimum letter height shall be 3/8 inch.
- E. Stenciled Legend: In nonfading, waterproof, black ink or paint. Minimum letter height shall be 1 inch.

2.9 CABLE TIES

- A. General-Purpose Cable Ties: Fungus inert, self-extinguishing, one piece, self-locking, Type 6/6 nylon.

1. Minimum Width: 3/16 inch.
 2. Tensile Strength at 73 deg F, According to ASTM D 638: 12,000 psi.
 3. Temperature Range: Minus 40 to plus 185 deg F.
 4. Color: Black except where used for color-coding.
- B. UV-Stabilized Cable Ties: Fungus inert, designed for continuous exposure to exterior sunlight, self-extinguishing, one piece, self-locking, Type 6/6 nylon.
1. Minimum Width: 3/16 inch.
 2. Tensile Strength at 73 deg F, According to ASTM D 638: 12,000 psi.
 3. Temperature Range: Minus 40 to plus 185 deg F.
 4. Color: Black.

2.10 MISCELLANEOUS IDENTIFICATION PRODUCTS

- A. Paint: Comply with requirements in painting Sections for paint materials and application requirements. Select paint system applicable for surface material and location (exterior or interior).
- B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Verify identity of each item before installing identification products.
- B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.
- C. Apply identification devices to surfaces that require finish after completing finish work.
- D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.
- E. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.
- F. Attach plastic raceway and cable labels that are not self-adhesive type with clear vinyl tape with adhesive appropriate to the location and substrate.
- G. System Identification Color-Coding Bands for Raceways and Cables: Each color-coding band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot maximum intervals in straight runs, and at 25-foot maximum intervals in congested areas.
- H. Cable Ties: For attaching tags. Use general-purpose type, except as listed below:
1. Outdoors: UV-stabilized nylon.

2. In Spaces Handling Environmental Air: Plenum rated.
- I. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches below finished grade. Use multiple tapes where width of multiple lines installed in a common trench exceeds 16 inches overall.
- J. Painted Identification: Comply with requirements in painting Sections for surface preparation and paint application.

3.2 IDENTIFICATION SCHEDULE

- A. Accessible Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive vinyl labels with the wiring system legend and system voltage. System legends shall be as follows:
 1. Emergency Power.
 2. Power.
- B. Power-Circuit Conductor Identification, 600 V or Less: For conductors in pull and junction boxes, use color-coding conductor tape to identify the phase.
 1. Color-Coding for Phase and Voltage Level Identification, 600 V or Less: Use colors listed below for ungrounded service feeder and branch-circuit conductors.
 - a. Color shall be factory applied.
 - b. Colors for 208/120-V Circuits:
 - 1) Phase A: Black.
 - 2) Phase B: Red.
 - 3) Phase C: Blue.
 - c. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.
- C. Install instructional sign including the color-code for grounded and ungrounded conductors using adhesive-film-type labels.
- D. Control-Circuit Conductor Identification: For conductors and cables in pull and junction boxes, use self-adhesive, self-laminating polyester labels with the conductor or cable designation, origin, and destination.
- E. Control-Circuit Conductor Termination Identification: For identification at terminations provide self-adhesive, self-laminating polyester labels with the conductor designation.
- F. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.
 1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
 2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.

3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual.
- G. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.
1. Limit use of underground-line warning tape to direct-buried cables.
 2. Install underground-line warning tape for both direct-buried cables and cables in raceway.
- H. Warning Labels for Indoor Cabinets, Boxes, and Enclosures for Power and Lighting: Self-adhesive warning labels.
1. Comply with 29 CFR 1910.145.
 2. Identify system voltage with black letters on an orange background.
 3. Apply to exterior of door, cover, or other access.
 4. For equipment with multiple power or control sources, apply to door or cover of equipment including, but not limited to, the following:
 - a. Power transfer switches.
 - b. Controls with external control power connections.
- I. Operating Instruction Signs: Install instruction signs to facilitate proper operation and maintenance of electrical systems and items to which they connect. Install instruction signs with approved legend where instructions are needed for system or equipment operation.
- J. Emergency Operating Instruction Signs: Install instruction signs with white legend on a red background with minimum 3/8-inch- high letters for emergency instructions at equipment used for power transfer.
- K. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.
1. Labeling Instructions:
 - a. Indoor Equipment: Engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 1/2-inch- high letters on 1-1/2-inch- high label; where two lines of text are required, use labels 2 inches high.
 - b. Outdoor Equipment: Engraved, laminated acrylic or melamine label.
 - c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.
 - d. Unless provided with self-adhesive means of attachment, fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.
 2. Equipment to Be Labeled:
 - a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be engraved, laminated acrylic or melamine label.
 - b. Enclosures and electrical cabinets.
 - c. Access doors and panels for concealed electrical items.

- d. Emergency system boxes and enclosures.
- e. Enclosed switches.
- f. Enclosed circuit breakers.
- g. Enclosed controllers.
- h. Power transfer equipment.
- i. Contactors.
- j. Remote-controlled switches, dimmer modules, and control devices.
- k. Power-generating units.
- l. Monitoring and control equipment.

END OF SECTION 260553

SECTION 260573
OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes computer-based, overcurrent protective device coordination studies to determine overcurrent protective devices and to determine overcurrent protective device settings for selective tripping.

1.2 DEFINITIONS

- A. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.
- B. One-Line Diagram: A diagram which shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein.
- C. Protective Device: A device that senses when an abnormal current flow exists and then removes the affected portion from the system.
- D. SCCR: Short-circuit current rating.
- E. Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.

1.3 ACTION SUBMITTALS

- A. Product Data: For computer software program to be used for studies.
- B. Other Action Submittals: Submit the following after the approval of system protective devices submittals. Submittals may be in digital form.
 - 1. Coordination-study input data, including completed computer program input data sheets.
 - 2. Study and equipment evaluation reports.
 - 3. Overcurrent protective device coordination study report; signed, dated, and sealed by a qualified professional engineer.
 - a. Submit study report for action prior to receiving final approval of the distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Engineer for preliminary submittal of sufficient study data to ensure that the selection of devices and associated characteristics is satisfactory.

1.4 QUALITY ASSURANCE

- A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are unacceptable.
- B. Coordination Study Specialist Qualifications: Professional engineer in charge of performing the study and documenting recommendations, licensed in the state where Project is located. All elements of the study shall be performed under the direct supervision and control of this professional engineer.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. ESA Inc.
 - 2. Power Analytics, Corporation.
 - 3. SKM Systems Analysis, Inc.
- B. Comply with IEEE 242 and IEEE 399.
- C. Analytical features of device coordination study computer software program shall have the capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.
- D. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices and shall demonstrate selective coordination by computer-generated, time-current coordination plots.
 - 1. Optional Features:
 - a. Arcing faults.
 - b. Simultaneous faults.
 - c. Explicit negative sequence.
 - d. Mutual coupling in zero sequence.

2.2 PROTECTIVE DEVICE COORDINATION STUDY REPORT CONTENTS

- A. Executive summary.
- B. Study descriptions, purpose, basis and scope. Include case descriptions, definition of terms and guide for interpretation of the computer printout.
- C. One-line diagram, showing the following:
 - 1. Protective device designations and ampere ratings.
 - 2. Cable size and lengths.
 - 3. Transformer kilovolt ampere (kVA) and voltage ratings.
 - 4. Motor and generator designations and kVA ratings.

5. Panelboard designations.
- D. Study Input Data. Obtain available fault current information for the utility service from the power company for use in the study.
- E. Short-Circuit Study:
1. Low-Voltage Fault Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
 - a. Voltage.
 - b. Calculated fault-current magnitude and angle.
 - c. Fault-point X/R ratio.
 - d. Equivalent impedance.
 2. Momentary Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
 - a. Voltage.
 - b. Calculated symmetrical fault-current magnitude and angle.
 - c. Fault-point X/R ratio.
 - d. Calculated asymmetrical fault currents:
 - 1) Based on fault-point X/R ratio.
 - 2) Based on calculated symmetrical value multiplied by 1.6.
 - 3) Based on calculated symmetrical value multiplied by 2.7.
 3. Interrupting Duty Report: Three-phase and unbalanced fault calculations, showing the following for each overcurrent device location:
 - a. Voltage.
 - b. Calculated symmetrical fault-current magnitude and angle.
 - c. Fault-point X/R ratio.
 - d. No AC Decrement (NACD) ratio.
 - e. Equivalent impedance.
 - f. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a symmetrical basis.
 - g. Multiplying factors for 2-, 3-, 5-, and 8-cycle circuit breakers rated on a total basis.
- F. Protective Device Coordination Study:
1. Report recommended settings of protective devices, ready to be applied in the field. Use manufacturer's data sheets for recording the recommended setting of overcurrent protective devices when available.
 - a. Phase and Ground Relays:
 - 1) Device tag.
 - 2) Relay current transformer ratio and tap, time dial, and instantaneous pickup value.
 - 3) Recommendations on improved relaying systems, if applicable.
 - b. Circuit Breakers:
 - 1) Adjustable pickups and time delays (long time, short time, ground).
 - 2) Adjustable time-current characteristic.
 - 3) Adjustable instantaneous pickup.
 - 4) Recommendations on improved trip systems, if applicable.
 - c. Fuses: Show current rating, voltage, and class.
- G. Time-Current Coordination Curves: Determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation

exists between devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:

1. Device tag and title, one-line diagram with legend identifying the portion of the system covered.
2. Terminate device characteristic curves at a point reflecting maximum symmetrical or asymmetrical fault current to which the device is exposed.
3. Identify the device associated with each curve by manufacturer type, function, and, if applicable, tap, time delay, and instantaneous settings recommended.
4. Plot the following listed characteristic curves, as applicable:
 - a. Power utility's overcurrent protective device.
 - b. Low-voltage fuses including manufacturer's minimum melt, total clearing, tolerance, and damage bands.
 - c. Low-voltage equipment circuit-breaker trip devices, including manufacturer's tolerance bands.
 - d. Transformer full-load current, magnetizing inrush current, and ANSI through-fault protection curves.
 - e. Cables and conductors damage curves.
 - f. Ground-fault protective devices.
 - g. Motor-starting characteristics and motor damage points.
 - h. Generator short-circuit decrement curve and generator damage point.
 - i. The largest feeder circuit breaker in each panelboard.
5. Series rating on equipment allows the application of two series interrupting devices for a condition where the available fault current is greater than the interrupting rating of the downstream equipment. Both devices share in the interruption of the fault and selectivity is sacrificed at high fault levels. Maintain selectivity for tripping currents caused by overloads.
6. Provide adequate time margins between device characteristics such that selective operation is achieved.
7. Comments and recommendations for system improvements.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance. Devices to be coordinated are indicated on Drawings.
 1. Proceed with coordination study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to coordination study may not be used in study.

3.2 PROTECTIVE DEVICE COORDINATION STUDY

- A. Comply with IEEE 242 for calculating short-circuit currents and determining coordination time intervals.
- B. Comply with IEEE 399 for general study procedures.

- C. The study shall be based on the device characteristics supplied by device manufacturer.
- D. The extent of the electrical power system to be studied is indicated on Drawings.
- E. Begin analysis at the service, extending down to the largest branch circuit overcurrent protective device in each panel.
- F. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Study all cases of system-switching configurations and alternate operations that could result in maximum fault conditions.
- G. Transformer Primary Overcurrent Protective Devices:
 - 1. Device shall not operate in response to the following:
 - a. Inrush current when first energized.
 - b. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.
 - c. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.
 - 2. Device settings shall protect transformers according to IEEE C57.12.00, for fault currents.
- H. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and protection recommendations in IEEE 242. Demonstrate that equipment withstands the maximum short-circuit current for a time equivalent to the tripping time of the primary relay protection or total clearing time of the fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.
- I. Generator Protection: Select protection according to manufacturer's written recommendations and to IEEE 242.
- J. The calculations shall include the ac fault-current decay from induction motors, synchronous motors, and asynchronous generators and shall apply to low- and medium-voltage, three-phase ac systems. The calculations shall also account for the fault-current dc decrement, to address the asymmetrical requirements of the interrupting equipment.
 - 1. For grounded systems, provide a bolted line-to-ground fault-current study for areas as defined for the three-phase bolted fault short-circuit study.
- K. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault and single line-to-ground fault at each of the following:
 - 1. Electric utility's supply termination point.
 - 2. Standby generators and automatic transfer switches.
 - 3. Branch circuit panelboards.
- L. Protective Device Evaluation:
 - 1. Evaluate equipment and protective devices and compare to short-circuit ratings.
 - 2. Adequacy of panelboard bus bars to withstand short-circuit stresses.
 - 3. Any application of series-rated devices shall be recertified, complying with requirements in NFPA 70.

3.3 POWER SYSTEM DATA

- A. Obtain all data necessary for the conduct of the overcurrent protective device study.
1. Verify completeness of data supplied in the one-line diagram on Drawings. Call discrepancies to the attention of Architect.
 2. For new equipment, use characteristics submitted under the provisions of action submittals and information submittals for this Project.
 3. For existing equipment, whether or not relocated obtain required electrical distribution system data by field investigation and surveys, conducted by qualified technicians and engineers. The qualifications of technicians and engineers shall be qualified as defined by NFPA 70E.
- B. Gather and tabulate the following input data to support coordination study. The list below is a guide. Comply with recommendations in IEEE 241 and IEEE 551 for the amount of detail required to be acquired in the field. Field data gathering shall be under the direct supervision and control of the engineer in charge of performing the study, and shall be by the engineer or its representative who holds NETA ETT Level III certification or NICET Electrical Power Testing Level III certification.
1. Product Data for overcurrent protective devices specified in other Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
 2. Electrical power utility impedance at the service.
 3. Power sources and ties.
 4. Short-circuit current at each system bus, three phase and line-to-ground.
 5. Full-load current of all loads.
 6. Voltage level at each bus.
 7. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in percent, and phase shift.
 8. For reactors, provide manufacturer and model designation, voltage rating, and impedance.
 9. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip and available range of settings, SCCR, current rating, and breaker settings.
 10. Generator short-circuit current contribution data, including short-circuit reactance, rated kVA, rated voltage, and X/R ratio.
 11. Motor horsepower and NEMA MG 1 code letter designation.
 12. Low-voltage cable sizes, lengths, number, conductor material, and conduit material (magnetic or nonmagnetic).
 13. Data sheets to supplement electrical distribution system diagram, cross-referenced with tag numbers on diagram, showing the following:
 - a. Transformer characteristics, including primary protective device, magnetic inrush current, and overload capability.
 - b. Generator thermal-damage curve.
 - c. Ratings, types, and settings of utility company's overcurrent protective devices.
 - d. Special overcurrent protective device settings or types stipulated by utility company.
 - e. Time-current-characteristic curves of devices indicated to be coordinated.

- f. Manufacturer, frame size, interrupting rating in amperes rms symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.
- g. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.
- h. Panelboard ampacity, and SCCR in amperes rms symmetrical.

3.4 FIELD ADJUSTING

- A. Adjust relay and protective device settings according to the recommended settings provided by the coordination study. Field adjustments shall be completed by the engineering service division of the equipment manufacturer under the Startup and Acceptance Testing contract portion.
- B. Make minor modifications to equipment as required to accomplish compliance with short-circuit and protective device coordination studies.
- C. Testing and adjusting shall be by a full-time employee of the Field Adjusting Agency, who holds NETA ETT Level III certification or NICET Electrical Power Testing Level III certification.
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters. Perform NETA tests and inspections for all adjustable overcurrent protective devices.

END OF SECTION 260573

SECTION 260574
OVERCURRENT PROTECTIVE DEVICE ARC-FLASH STUDY

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes a computer-based, arc-flash study to determine the arc-flash hazard distance and the incident energy to which personnel could be exposed during work on or near electrical equipment.

1.2 DEFINITIONS

- A. Existing to Remain: Existing items of construction that are not to be removed and that are not otherwise indicated to be removed, removed and salvaged, or removed and reinstalled.
- B. One-Line Diagram: A diagram which shows, by means of single lines and graphic symbols, the course of an electric circuit or system of circuits and the component devices or parts used therein.
- C. Protective Device: A device that senses when an abnormal current flow exists and then removes the affected portion from the system.
- D. SCCR: Short-circuit current rating.
- E. Service: The conductors and equipment for delivering electric energy from the serving utility to the wiring system of the premises served.

1.3 ACTION SUBMITTALS

- A. Product Data: For computer software program to be used for studies.
- B. Other Action Submittals: Submit the following submittals after the approval of system protective devices submittals. Submittals shall be in digital form.
 - 1. Arc-flash study input data, including completed computer program input data sheets.
 - 2. Arc-flash study report; signed, dated, and sealed by a qualified professional engineer.
 - a. Submit study report for action prior to receiving final approval of the distribution equipment submittals. If formal completion of studies will cause delay in equipment manufacturing, obtain approval from Engineer for preliminary submittal of sufficient study data to ensure that the selection of devices and associated characteristics is satisfactory.

1.4 CLOSEOUT SUBMITTALS

- A. Maintenance procedures according to requirements in NFPA 70E shall be provided in the equipment manuals.
- B. Operation and Maintenance Procedures: Provide maintenance procedures for use by Owner's personnel that comply with requirements in NFPA 70E.

1.5 QUALITY ASSURANCE

- A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are unacceptable.
- B. Arc-Flash Study Specialist Qualifications: Professional engineer in charge of performing the study, analyzing the arc flash, and documenting recommendations, licensed in the state where Project is located. All elements of the study shall be performed under the direct supervision and control of this professional engineer.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - 1. ESA Inc.
 - 2. Power Analytics, Corporation.
 - 3. SKM Systems Analysis, Inc.
- B. Comply with IEEE 1584 and NFPA 70E.
- C. Analytical features of device coordination study computer software program shall have the capability to calculate "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.

2.2 SHORT-CIRCUIT STUDY REPORT CONTENT

- A. As specified in Section 26 05 73 – Overcurrent Protective Device Coordination Study

2.3 ARC-FLASH STUDY REPORT CONTENT

- A. Incident Energy and Flash Protection Boundary Calculations:
 - 1. Arcing fault magnitude.
 - 2. Protective device clearing time.
 - 3. Duration of arc.
 - 4. Arc-flash boundary.
 - 5. Working distance.

6. Incident energy.
 7. Hazard risk category.
 8. Recommendations for arc-flash energy reduction.
- B. Fault study input data, case descriptions, and fault-current calculations including a definition of terms and guide for interpretation of the computer printout.

2.4 ARC-FLASH WARNING LABELS

- A. Comply with requirements in Section 260553 "Identification for Electrical Systems." Produce a thermal transfer label of high-adhesion polyester for each work location included in the analysis.
- B. The label shall have an orange header with the wording, "WARNING, ARC-FLASH HAZARD," and shall include the following information taken directly from the arc-flash hazard analysis:
1. Location designation.
 2. Nominal voltage.
 3. Flash protection boundary.
 4. Hazard risk category.
 5. Incident energy.
 6. Working distance.
 7. Engineering report number, revision number, and issue date.
- C. Labels shall be machine printed, with no field-applied markings.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine Project overcurrent protective device submittals. Proceed with arc-flash study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to arc-flash study may not be used in study.

3.2 SHORT-CIRCUIT STUDY

- A. Perform study following the general study procedures contained in IEEE 399.
- B. Calculate short-circuit currents according to IEEE 551.
- C. Base study on the device characteristics supplied by device manufacturer.
- D. The extent of the electrical power system to be studied is indicated on Drawings.
- E. Begin analysis at the service, extending down to the disconnect switch/overcurrent protective device for each panel and piece of equipment.

- F. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Include studies of system-switching configurations and alternate operations that could result in maximum fault conditions.
- G. The calculations shall include the ac fault-current decay from induction motors, synchronous motors, and asynchronous generators and shall apply to low- and medium-voltage, three-phase ac systems.
- H. Calculate short-circuit momentary and interrupting duties for a three-phase bolted fault and single line-to-ground fault at each of the following:
 - 1. Electric utility's supply termination point.
 - 2. Standby generators and automatic transfer switches.
 - 3. Branch circuit panelboards.

3.3 ARC-FLASH HAZARD ANALYSIS

- A. Comply with NFPA 70E and its Annex D for hazard analysis study.
- B. Use the short-circuit study output and the field-verified settings of the overcurrent devices.
- C. Calculate maximum and minimum contributions of fault-current size.
 - 1. The minimum calculation shall assume that the utility contribution is at a minimum and shall assume no motor load.
 - 2. The maximum calculation shall assume a maximum contribution from the utility and shall assume motors to be operating under full-load conditions.
- D. Calculate the arc-flash protection boundary and incident energy at locations in the electrical distribution system where personnel could perform work on energized parts.
- E. Include medium- and low-voltage equipment locations, except 240-V ac and 208-V ac systems fed from transformers less than 125 kVA.
- F. Safe working distances shall be specified for calculated fault locations based on the calculated arc-flash boundary, considering incident energy of 1.2 cal/sq.cm.
- G. Incident energy calculations shall consider the accumulation of energy over time when performing arc-flash calculations on buses with multiple sources. Iterative calculations shall take into account the changing current contributions, as the sources are interrupted or decremented with time. Fault contribution from motors and generators shall be decremented as follows:
 - 1. Fault contribution from induction motors should not be considered beyond three to five cycles.
 - 2. Fault contribution from synchronous motors and generators should be decayed to match the actual decrement of each as closely as possible (e.g., contributions from permanent magnet generators will typically decay from 10 per unit to three per unit after 10 cycles).
- H. Arc-flash computation shall include both line and load side of a circuit breaker as follows:

1. When the circuit breaker is in a separate enclosure.
 2. When the line terminals of the circuit breaker are separate from the work location.
- I. Base arc-flash calculations on actual overcurrent protective device clearing time. Cap maximum clearing time at two seconds based on IEEE 1584, Section B.1.2.

3.4 POWER SYSTEM DATA

- A. Obtain all data necessary for the conduct of the arc-flash hazard analysis.
1. Verify completeness of data supplied on the one-line diagram on Drawings. Call discrepancies to the attention of Architect.
 2. For new equipment, use characteristics submitted under the provisions of action submittals and information submittals for this Project.
 3. For existing equipment, whether or not relocated, obtain required electrical distribution system data by field investigation and surveys, conducted by qualified technicians and engineers.
- B. Gather and tabulate the following input data to support coordination study. Comply with recommendations in IEEE 1584 and NFPA 70E as to the amount of detail that is required to be acquired in the field. Field data gathering shall be under the direct supervision and control of the engineer in charge of performing the study, and shall be by the engineer or its representative who holds NETA ETT Level III certification or NICET Electrical Power Testing Level III certification.
1. Product Data for overcurrent protective devices specified in other Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.
 2. Obtain electrical power utility impedance at the service.
 3. Power sources and ties.
 4. For transformers, include kVA, primary and secondary voltages, connection type, impedance, X/R ratio, taps measured in per cent, and phase shift.
 5. For reactors, provide manufacturer and model designation, voltage rating and impedance.
 6. For circuit breakers and fuses, provide manufacturer and model designation. List type of breaker, type of trip and available range of settings, SCCR, current rating, and breaker settings.
 7. Generator short-circuit current contribution data, including short-circuit reactance, rated kVA, rated voltage, and X/R ratio.
 8. For relays, provide manufacturer and model designation, current transformer ratios, potential transformer ratios, and relay settings.
 9. Busway manufacturer and model designation, current rating, impedance, lengths, and conductor material.
 10. Motor horsepower and NEMA MG 1 code letter designation.
 11. Low-voltage cable sizes, lengths, number, conductor material and conduit material (magnetic or nonmagnetic).
 12. Medium-voltage cable sizes, lengths, conductor material, and cable construction and metallic shield performance parameters.

3.5 LABELING

- A. Apply one arc-flash label for 208-V ac panelboards, transfer switch, and disconnects.

3.6 APPLICATION OF WARNING LABELS

- A. Install the arc-fault warning labels under the direct supervision and control of the Arc-Flash Study Specialist.

END OF SECTION 260574

SECTION 260923
LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Motion and Daylighting Sensor Control
2. Emergency Lighting Control

B. Related Sections:

1. Section 265100 Interior Lighting
2. Section 265600 Exterior Lighting

C. Control Intent – Control Intent includes, but is not limited to:

1. Defaults and initial calibration settings for such items as time delay, sensitivity, fade rates, etc.
2. Initial sensor and switching zones
3. Initial time switch settings
4. Emergency Lighting Control

1.2 REFERENCES

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

B. The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

1. UNDERWRITERS LABORATORIES (UL)

- a. UL 924 (2006; Reprint Oct 2009) Standard for Emergency Lighting and Power Equipment

1.3 ACTION SUBMITTALS

A. Submittals Package: Submit the shop drawings, and the product data specified below at the same time as a package.

1. Shop Drawings:
 - a. Composite Wiring Diagram
 - 1) Submit Composite Wiring Diagram and/or schematic diagram of each control circuit as proposed to be installed (standard diagram will not be accepted).
 - b. Scale Drawings
 - 1) Submit scale drawings for each area showing exact location of each sensor, room controller, and digital switch.
2. Product Data:
 - a. Submit catalog sheets and specifications. Include data for each device which:
 - 1) Indicates where sensor is proposed to be installed.
 - 2) Prove that the sensor is suitable for the proposed application.
3. Manufacturer's Instructions:
 - a. Installation Instructions:
 - 1) Submit Installation Instructions for each device which:
 - a) Indicates where sensor is proposed to be installed.
 - 2) Prove that the sensor is suitable for the proposed application.

1.4 LIGHTING CONTROL APPLICATIONS

- A. Unless relevant provisions of the applicable local Energy Codes are more stringent (except plug load control), provide a minimum application of lighting controls as follows:
 1. Provide a minimum of one room controller per room. A uniquely switched relay must be provided for each uniquely controlled lighting zone in the room.
 2. Space Control Requirements – Provide occupancy/vacancy sensors with Manual-ON functionality in all spaces except corridors, stairwells, toilet rooms, utility rooms, open plan system or other applications where hands-free operation is desirable and Automatic-ON occupancy sensors are more appropriate. Provide Manual-ON occupancy/vacancy sensors for any enclosed office, conference room, meeting room and training room. Provide occupancy/vacancy sensors with Automatic-ON functionality for all corridors, open offices, utility rooms, and toilet rooms. Provide a weatherproof rated photocell stub mounted on a conduit extending up from the roof providing control to a 20A rated lighting contactor in the mechanical room for control of the normally powered outdoor lighting. The stub mounted photocell shall be installed facing north.
 3. Task Lighting / Plug Loads – No plug load control will be required.
 4. Daylit Areas – All luminaires within 15' of windows shall be controlled separately from luminaires outside of daylit zones.

5. Daytime setpoints for total ambient illumination (combined daylight and electric light) level that initiate dimming shall be programmed to be not less than 125% of the nighttime maintained designed illumination levels.
6. Manual dimming controls shall be provided in all rooms except toilet rooms, storage rooms, and utility rooms.
7. Multiple-leveled switched daylight harvesting controls may be utilized for areas marked on drawings.
8. Provide smooth and continuous daylight dimming for areas marked on drawings. Daylighting control system may be designed to turn off electric lighting when daylight is at or above required lighting levels, only if system functions to turn lamps back on at dimmed level, rather than turning full-on prior to dimming.
9. Provide a maximum dimming speed of 13% per second. Dimming levels shall be adjusted by daylighting controls, occupancy sensor controls and manual dimming devices. Sudden light output changes are prohibited.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: Furnish 3 copies of an Operations and Maintenance Manual including product submittal information, equipment identification with serial numbers of each component, wiring diagrams, control diagrams, startup and operating procedures and instructions, emergency manuals, emergency procedures and instructions, inspection procedures, maintenance schedule, maintenance procedures and documentation, shutdown instructions, license requirements including inspection and renewal dates, performance curves, engineering data and tests, list of tools and replacement items recommended to be stored at Project for ready access, training plan, maintenance service contracts, and warranties and bonds.

1.6 QUALITY ASSURANCE

- A. Manufacturer: Minimum (10) years-experience in manufacture of lighting controls.

1.7 COORDINATION

- A. Coordinate layout and installation of lighting controls with other construction that penetrates ceilings or is supported by them, including lighting, fire alarm, HVAC equipment, fire-suppression system, and partition assemblies.

1.8 WARRANTY

- A. Provide a five (5) year complete manufacturer's warranty on all products to be free of manufacturer's defects.

1.9 MAINTENANCE

- A. Spare Parts: Provide one (1) of each product to be used for maintenance

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. The basis of design for the lighting control system is the Wattstopper Digital Lighting Management (DLM) system. Other manufacturers' systems will be considered for approval if they provide equivalent functionality.

2.2 SINGLE/DUAL RELAY WALL SWITCH OCCUPANCY SENSORS

- A. Dual technology (passive infrared and ultrasonic) wall switch occupancy/vacancy sensor. Furnish the Company's model which suits the electrical system parameters, and accommodates the square-foot coverage and wattage requirement for each area (and type of lighting) controlled.

2.3 DIGITAL WALL OR CEILING MOUNTED OCCUPANCY SENSOR SYSTEM

- A. Wall or ceiling mounted (to suit installation) dual technology digital (passive infrared and ultrasonic) occupancy sensor. Furnish the Company's system which accommodates the square-foot coverage requirements for each area controlled, utilizing room controllers, digital occupancy sensors and accessories which suit the lighting and electrical system parameters. The minimum number of sensors shall be as indicated on the contract drawings.
- B. Digital Occupancy Sensors shall provide graphic LCD display for digital calibration and electronic documentation. Features include the following:
 1. Digital calibration and pushbutton programming for the following variables:
 - a. Sensitivity – 0-100% in 10% increments
 - b. Time delay – 1-30 minutes in 1 minute increments
 - c. Test mode – Five second time delay
 - d. Detection technology – PIR, Ultrasonic or Dual B Technology activation and/or re-activation.
 - e. Walk-through mode
 - f. Load parameters including Auto/Manual-ON, blink warning, and daylight enable/disable when photosensors are included in the local lighting control network.
 2. One or two RJ-45 port(s) for connection to local lighting control network.
 3. Two-way infrared (IR) transceiver to allow remote programming through handheld commissioning tool and control by remote personal controls.
 4. Device Status LEDs including:
 - a. PIR Detection
 - b. Ultrasonic detection
 - c. Configuration mode
 - d. Load binding

5. Assignment of occupancy sensor to a specific load within the room without wiring or special tools.
 6. Manual override of controlled loads.
- C. Multiple occupancy sensors may be installed in a room by simply connecting them to the free topology local lighting control network. No additional configuration will be required.

2.4 DIGITAL WALL SWITCHES

- A. Low voltage momentary pushbutton switches in 1, 2, 3, 4, 5 and 8 button configuration. Wall switches shall include the following features:
1. Two-way infrared (IR) transceiver for use with personal and configuration remote controls.
 2. Removable buttons for field replacement with engraved buttons and/or alternate color buttons. Button replacement may be completed without removing the switch from the wall.
 3. Red configuration LED on each switch that blinks to indicate data transmission.
 4. Blue Load/Scene Status LED on each switch button with the following characteristics:
 - a. Bi-level LED
 - b. Dim locator level indicates power to switch
 - c. Bright status level indicates that load or scene is active
 5. Dimming switches shall include greater than 5 bi-level LEDs to indicate load levels using greater than 10 steps.
- B. Two RJ-45 ports for connection to local lighting control network.
- C. Multiple digital wall switches may be installed in a room by simply connecting them to the free topology local lighting control network. No additional configuration will be required to achieve multi-way switching.
- D. The following switch attributes may be changed or selected using a wireless configuration tool:
1. Load and Scene button function may be reconfigured for individual buttons (from Load to Scene, and vice versa).
 2. Individual button function may be configured to Toggle, On only or Off only.
 3. Individual scenes may be locked to prevent unauthorized change
 4. Fade Up and Fade Down times for individual scenes may be adjusted from 0 seconds to 18 hours.
 5. Ramp rate may be adjusted for each dimmer switch.

6. Switch buttons may be bound to any load on a room controller and are not load type dependent; each button may be bound to multiple loads.

2.5 CONFIGURATION TOOLS

- A. Handheld remote for room configuration provides two way infrared (IR) communications to digital devices and allows complete configuration and reconfiguration of the device / room from up to 30 feet away. Unit to have Organic LED display, simple pushbutton interface, and allow send and receive of room variables and store of occupancy sensor settings. Computer software also customizes room settings.
- B. Contractor shall provide two (2) handheld configuration tools which shall be handed to owner after start-up.

2.6 ROOM CONTROLLERS

- A. Room Controllers automatically bind the room loads to the connected devices in the space without commissioning or the use of any tools. Room Controllers shall be provided to match the room lighting load and control requirements. The controllers will be simple to install and will not have, dip switches, potentiometers or require special configuration. The control units will include the following features:
 1. Automatic room configuration to the most energy-efficient sequence of operation based upon the devices in the room.
 2. Simple replacement – Using the default automatic configuration capabilities, a room controller may be replaced with an off-the-shelf unit without requiring any configuration or setup.
 3. Device Status LEDs to indicate:
 - a. Data transmission
 - b. Device has power
 - c. Status for each load
 - d. Configuration status
 4. Quick installation features including:
 - a. Standard junction box mounting
 - b. Quick low voltage connections using standard RJ-45 patch cable
 5. Standard junction box mounting
 6. Manual override and LED indication for each load
 7. Dual voltage (120/277 VAC, 60 Hz)
 8. Zero cross circuitry for each load.

- B. On/Off Room Controllers shall include:
1. One, two or three relay configuration
 2. Efficient 150 mA switching power supply
 3. Multiple RJ-45 local lighting control network ports
 4. Discrete model listed for connection to receptacles, for occupancy-based control of plug loads within the space.
 - a. One relay configuration only
 - b. Automatic-ON/OFF configuration
- C. On/Off/Dimming enhanced Room Controllers shall include:
1. Real time current monitoring
 2. One, two or three relay configuration
 3. Efficient 250 mA switching power supply
 4. Four RJ-45 local lighting control network ports
 5. One 0-10 volt analog output per relay for control of compatible ballasts and LED drivers
 6. The following dimming attributes may be changed or selected using a wireless configuration tool:
 - a. Establish preset level for each load from 0-100%
 - b. Set high and low trim for each load
 - c. Set lamp burn in time for each load up to 100 hours
 7. Discrete model listed for connection to receptacles, for occupancy-based control of plug loads within the space.
 - a. One relay configuration only
 - b. Automatic-ON/OFF configuration

2.7 DIGITAL INDOOR PHOTSENSORS

- A. Digital photosensors work with room controllers to provide automatic switching or dimming daylight harvesting capabilities for any load type connected to a room controller. Open loop photosensors measure incoming daylight in the space, and are capable of controlling up to three lighting zones. Photosensors shall be interchangeable without the need for rewiring.
- B. Digital photosensors include the following features:
1. An internal photodiode that measures only within the visible spectrum, and has a response curve that closely matches the photopic curve. The photodiode shall not measure energy in either the ultraviolet or infrared spectrums. The photocell shall have a

sensitivity of less than 5% for any wavelengths less than 400 nanometers or greater than 700 nanometers.

2. Sensor light level range shall be from 1-10,000 footcandles (fc).
 3. The capability of switching one-third, one-half or all lighting ON and OFF, or raising or lowering lighting levels, for each controlled zone, depending on the selection of room controller(s) and load binding to room controller(s).
 4. For switching daylight harvesting, the photosensor shall provide a deadband or a separation between the "ON Setpoint" and the "OFF Setpoint" that will prevent the lights from cycling after they turn off.
 5. For dimming daylight harvesting, the photosensor shall provide the option, when the daylight contribution is sufficient, of turning lights off or dimming lights to a user-selectable minimum level.
 6. Optional programmable wall switch override to allow occupants to reduce lighting level to increase energy savings or, if permitted by system administrator, raise and lower lighting levels for a selected period of time or cycle of occupancy.
 7. Infrared (IR) transceiver for configuration and/or commissioning with a handheld configuration tool, to transmit detected light level to wireless configuration tool, and for communication with personal remote controls.
 8. Red configuration LED that blinks to indicate data transmission.
 9. Blue status LED indicates test mode, override mode and load binding.
 10. Recessed switch to turn controlled load(s) ON and OFF.
 11. One RJ-45 port for connection to local lighting control network.
 12. An adjustable head and a mounting bracket to accommodate multiple mounting methods and building materials. The photosensor may be mounted on a ceiling tile, skylight light well, suspended lighting fixture or backbox.
- C. All photosensors shall be open loop.
- D. Open loop digital photosensors include the following additional features:
1. An internal photodiode that measures light in a 60 degree angle cutting off the unwanted light from the interior of the room.
 2. Automatically establishes setpoints following calibration using a wireless configuration tool or a PC with appropriate software.
 3. A proportional control algorithm for dimming daylight harvesting with a "Setpoint" to be maintained during operation.

2.8 OUTDOOR WEATHERPROOF PHOTOCELL

- A. Photocell shall be Ripley model 6390-FAA or approved equal.
- B. Photocell shall have a minimum of 30 second sensor time delay.
- C. Photocell housing shall be constructed of high strength, UV resistant plastic.
- D. Photocell shall have an operating temperature range of -40°C to 70°C.
- E. Photocell shall be installed facing skyward, oriented towards the north.
- F. Photocell shall be ETL certified to comply with applicable requirements of U.S. Department of Transportation, Federal Aviation Administration, Advisory Circular, Specification for Obstruction Lighting Equipment, AC No. 150/5345-43E, dated 10/19/95.

2.9 EMERGENCY LIGHTING

- A. Emergency Lighting Control Unit - A UL 924A listed device that monitors a switched circuit providing normal lighting to an area. The unit provides normal ON/OFF control of emergency lighting along with the normal lighting. Upon normal power failure the emergency lighting circuit will close, forcing the emergency lighting ON until normal power is restored. Features include:
 - 1. 120/277 volts, 50/60 Hz., 20 amp ballast rating
 - 2. Push to test button
 - 3. Auxiliary contact for remote test or fire alarm system interface

2.10 LIGHTING CONTACTOR

- A. Lighting Contactors shall be of the type and maximum dimensions detailed on the contract drawings. Contacts shall be electrically held, with a 3 position (hand-off-auto) selector switch. Contactors shall be provided in a NEMA 1 enclosure. Hand-off-auto selector switch shall be mounted to the front cover of the enclosure. Enclosure shall be constructed from steel and factory painted after fabrication.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. When using wire for connections other than the local lighting control network (Cat 5e with RJ-45 connectors), provide detailed point to point wiring diagrams for every termination. Provide wire specifications and wire colors to simplify contactor termination requirements.

- B. The room controllers shall be located/mounted on the wall above the drop ceiling/plenum over the door/entry point of each room. If there are multiple doors/entry points, the room controller shall be located over the main entry point or the door closest to the panel powering the lighting.
- C. Install the work of this Section in accordance with manufacturer's printed instructions unless otherwise indicated.
- D. Calibrate all sensor time delays and sensitivity to guarantee proper detection of occupants and energy savings.
 - 1. Adjust time delay so that controlled area remains lighted for 5 minutes after occupant leaves area.
- E. Provide written or computer-generated documentation on the commissioning of the system including room by room description including:
 - 1. Sensor parameters, time delays, sensitivities, and daylighting setpoints.
 - 2. Sequence of operation, (e.g. manual ON, Auto OFF. etc.)
 - 3. Load Parameters (e.g. blink warning, etc.)
- F. Re-commissioning – After 30 days from occupancy re-calibrate all sensor time delays and sensitivities to meet the Owner's Project Requirements. Provide a detailed report to the Architect / Owner of re-commissioning activity.

3.2 FACTORY COMMISSIONING

- A. Upon completion of the installation, the system shall be commissioned by the manufacturer's factory authorized representative who will verify a complete fully functional system.
- B. The electrical contractor shall provide both the manufacturer and the electrical engineer with ten working days written notice of the system startup and adjustment date.
- C. Upon completion of the system commissioning the factory-authorized technician shall provide the proper training to the owner's personnel on the adjustment and maintenance of the system.

END OF SECTION 260923

SECTION 262416
PANELBOARDS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Distribution panelboards.
 - 2. Lighting and appliance branch-circuit panelboards.

1.2 DEFINITIONS

- A. SVR: Suppressed voltage rating.
- B. TVSS: Transient voltage surge suppressor.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of panelboard, switching and overcurrent protective device, transient voltage suppression device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.
- B. Shop Drawings: For each panelboard and related equipment.
 - 1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.
 - 2. Detail enclosure types and details for types other than NEMA 250, Type 1.
 - 3. Detail bus configuration, current, and voltage ratings.
 - 4. Short-circuit current rating of panelboards and overcurrent protective devices.
 - 5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
 - 6. Include wiring diagrams for power, signal, and control wiring.
 - 7. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit on translucent log-log graph paper; include selectable ranges for each type of overcurrent protective device.

1.4 INFORMATIONAL SUBMITTALS

- A. Field Quality-Control Reports:
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

- B. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: Furnish 3 copies of an Operations and Maintenance Manual including product submittal information, equipment identification with serial numbers of each component, wiring diagrams, control diagrams, startup and operating procedures and instructions, emergency manuals, emergency procedures and instructions, inspection procedures, maintenance schedule, maintenance procedures and documentation, shutdown instructions, license requirements including inspection and renewal dates, performance curves, engineering data and tests, list of tools and replacement items recommended to be stored at Project for ready access, training plan, maintenance service contracts, and warranties and bonds. Also include the following:
 - 1. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
 - 2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

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. Keys: Two spares for each type of panelboard cabinet lock.
 - 2. Fuses for Fused Switches: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

1.7 QUALITY ASSURANCE

- A. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with NEMA PB 1.
- D. Comply with NFPA 70.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.
- B. Handle and prepare panelboards for installation according to NECA 407 or NEMA PB 1.

1.9 PROJECT CONDITIONS

- A. Environmental Limitations:
 - 1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.
 - 2. Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - a. Ambient Temperature: Not exceeding 23 deg F to plus 104 deg F.
 - b. Altitude: Not exceeding 6600 feet.

1.10 COORDINATION

- A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PANELBOARDS

- A. Enclosures: Flush- and surface-mounted cabinets.
 - 1. Rated for environmental conditions at installed location.
 - a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
 - b. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.
 - 2. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.
 - 3. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
 - 4. Finishes:
 - a. Panels and Trim: Steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.
 - b. Back Boxes: Galvanized steel.
 - 5. Directory Card: Inside panelboard door, mounted in metal frame with transparent protective cover.
- B. Incoming Mains Location: Top or bottom. Contractor to coordinate locations.
- C. Phase, Neutral, and Ground Buses:
 - 1. Material: Hard-drawn copper, 98 percent conductivity.
 - 2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.

- D. Conductor Connectors: Suitable for use with conductor material and sizes.
 - 1. Material: Hard-drawn copper, 98 percent conductivity.
 - 2. Main and Neutral Lugs: Compression type.
 - 3. Ground Lugs and Bus-Configured Terminators: Compression type.
 - 4. Feed-Through Lugs: Compression type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
 - 5. Subfeed (Double) Lugs: Compression type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
 - 6. Gutter-Tap Lugs: Compression type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
- E. Service Equipment Label: NRTL labeled for use as service equipment for panelboards or load centers with one or more main service disconnecting and overcurrent protective devices.
- F. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.
- G. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals. Series rated devices are not permitted.

2.2 PANELBOARDS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. Eaton.
 - 2. General Electric Company.
 - 3. Schneider Electric USA, Inc.
 - 4. Siemens Industry, Inc.
- B. Panelboards: NEMA PB 1, power and feeder distribution type.
- C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.
 - 1. For doors more than 36 inches high, provide two latches, keyed alike.
- D. Mains: Circuit breaker, electronic trip.
- E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on thermal magnetic circuit breakers.
- F. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and larger: Bolt-on electronic trip, circuit breakers.

2.3 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. Eaton.
 2. General Electric Company; GE Energy Management - Electrical Distribution.
 3. Siemens Energy.
 4. Square D; by Schneider Electric.
- B. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.
1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 125 A and larger.
 2. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replaceable electronic trip; and the following field-adjustable settings:
 - a. Instantaneous trip.
 - b. Long- and short-time pickup levels.
 - c. Long- and short-time time adjustments.
 - d. Ground-fault pickup level, time delay, and $I^2 t$ response.
 3. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
 - a. Standard frame sizes, trip ratings, and number of poles.
 - b. Lugs: Compression style, suitable for number, size, trip ratings, and conductor materials.
 - c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.
 - d. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
 - e. Multipole units enclosed in a single housing or factory assembled to operate as a single unit.
 - f. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in on position.
 - g. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.

2.4 ACCESSORY COMPONENTS AND FEATURES

- A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.
- B. Portable Test Set: For testing functions of solid-state trip devices without removing from panelboard. Include relay and meter test plugs suitable for testing panelboard meters and switchboard class relays.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Receive, inspect, handle, and store panelboards according to NECA 407 or NEMA PB 1.1.

- B. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.
- C. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.
- D. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install panelboards and accessories according to NECA 407 or NEMA PB 1.1.
- B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.
- C. Mount top of trim 90 inches above finished floor unless otherwise indicated. The operating handle of the top most circuit breaker in the on position shall not be higher than 79 inches above finished floor or grade.
- D. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.
- E. Install overcurrent protective devices and controllers not already factory installed.
 - 1. Set field-adjustable, circuit-breaker trip ranges.
- F. Install filler plates in unused spaces.
- G. Stub four 1-inch empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future.
- H. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.
- I. Comply with NECA 1.

3.3 IDENTIFICATION

- A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Section 260553 "Identification for Electrical Systems."
- B. Create a directory to indicate installed circuit loads after balancing panelboard loads; incorporate Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.
- C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

- D. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.
- B. Perform tests and inspections.
 - 1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.
- C. Acceptance Testing Preparation:
 - 1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
 - 2. Test continuity of each circuit.
- D. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
 - 3. Perform the following infrared scan tests and inspections and prepare reports:
 - a. Initial Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each panelboard. Remove front panels so joints and connections are accessible to portable scanner.
- E. Panelboards will be considered defective if they do not pass tests and inspections.
- F. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.5 ADJUSTING

- A. Adjust moving parts and operable component to function smoothly, and lubricate as recommended by manufacturer.
- B. Set field-adjustable circuit-breaker trip ranges as specified in Section 260573 "Overcurrent Protective Device Coordination Study."
- C. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes.
 - 1. Measure as directed during period of normal system loading.

2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.
3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.
4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

END OF SECTION 262416

SECTION 262713
ELECTRICITY METERING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes equipment for electricity metering by utility company.

1.2 DEFINITIONS

- A. KY Pulse: Term used by the metering industry to describe a method of measuring consumption of electricity that is based on a relay opening and closing in response to the rotation of the disk in the meter.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For electricity-metering equipment.
 - 1. Dimensioned plans and sections or elevation layouts.

1.4 QUALITY ASSURANCE

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

1.5 COORDINATION

- A. Electrical Service Connections: Coordinate with utility companies and components they furnish as follows:
 - 1. Comply with requirements of utilities providing electrical power services (CMP).
 - 2. Coordinate installation and connection of utilities and services, including provision for electricity-metering components.

PART 2 - PRODUCTS

2.1 EQUIPMENT FOR ELECTRICITY METERING BY UTILITY COMPANY

- A. Meters will be furnished by utility company.
- B. Meter Sockets, Current Transfer Enclosures: Comply with requirements of electrical-power utility company (CMP).

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with equipment installation requirements in NECA 1.
- B. Install meters furnished by utility company. Install raceways and equipment according to utility company's written requirements. Provide empty conduits for metering leads and extend grounding connections as required by utility company (MP).

3.2 IDENTIFICATION

- A. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
 - 1. Series Combination Warning Label: Self-adhesive type, with text as required by NFPA 70.
 - 2. Equipment Identification Labels: Adhesive film labels with clear protective overlay.

END OF SECTION 262713

SECTION 262726
WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Receptacles, receptacles with integral GFCI, and associated device plates.
 - 2. Weather-resistant receptacles.
 - 3. Snap switches.

1.2 DEFINITIONS

- A. EMI: Electromagnetic interference.
- B. GFCI: Ground-fault circuit interrupter.
- C. Pigtail: Short lead used to connect a device to a branch-circuit conductor.
- D. RFI: Radio-frequency interference.
- E. TVSS: Transient voltage surge suppressor.
- F. UTP: Unshielded twisted pair.

1.3 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Receptacles for Owner-Furnished Equipment: Match plug configurations.
 - 2. Cord and Plug Sets: Match equipment requirements.

1.4 ACTION SUBMITTALS

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

1.5 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. Eaton (Arrow Hart).
 - 2. Hubbell Incorporated; Wiring Device-Kellems.
 - 3. Leviton Manufacturing Co., Inc.
 - 4. Pass & Seymour/Legrand (Pass & Seymour).
- B. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

2.2 GENERAL WIRING-DEVICE REQUIREMENTS

- A. Wiring Devices, Components, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NFPA 70.
- C. Devices that are manufactured for use with modular plug-in connectors may be substituted under the following conditions:
 - 1. Connectors shall comply with UL 2459 and shall be made with stranding building wire.
 - 2. Devices shall comply with the requirements in this Section.

2.3 STRAIGHT-BLADE RECEPTACLES

- A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Eaton (Arrow Hart).
 - b. Hubbell Incorporated; Wiring Device-Kellems.
 - c. Leviton Manufacturing Co., Inc.
 - d. Pass & Seymour/Legrand (Pass & Seymour).

2.4 GFCI RECEPTACLES

- A. General Description:
 - 1. Straight blade, feed or non-feed-through type.
 - 2. Comply with NEMA WD 1, NEMA WD 6, UL 498, UL 943 Class A, and FS W-C-596.
 - 3. Include indicator light that shows when the GFCI has malfunctioned and no longer provides proper GFCI protection.

- B. Duplex GFCI Convenience Receptacles, 125 V, 20 A:
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - a. Eaton (Arrow Hart).
 - b. Hubbell Incorporated; Wiring Device-Kellems.
 - c. Leviton Manufacturing Co., Inc.
 - d. Pass & Seymour/Legrand (Pass & Seymour).

2.5 TWIST-LOCKING RECEPTACLES

- A. Single Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration L5-20R, and UL 498.
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Cooper; CWL520R.
 - b. Hubbell; HBL2310.
 - c. Leviton; 2310.
 - d. Pass & Seymour; L520-R.
- B. Isolated-Ground, Single Convenience Receptacles, 125 V, 20 A:
 - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
 - a. Cooper; IGL520R.
 - b. Hubbell; IG2310.
 - c. Leviton; 2310-IG.
 - d. Pass & Seymour; IG4700.
 - 2. Description:
 - a. Comply with NEMA WD 1, NEMA WD 6 Configuration L5-20R, and UL 498.
 - b. Equipment grounding contacts shall be connected only to the green grounding screw terminal of the device and with inherent electrical isolation from mounting strap. Isolation shall be integral to receptacle construction and not dependent on removable parts.

2.6 CORD AND PLUG SETS

- A. Description:
 - 1. Match voltage and current ratings and number of conductors to requirements of equipment being connected.
 - 2. Cord: Rubber-insulated, stranded-copper conductors, with Type SOW-A jacket; with green-insulated grounding conductor and ampacity of at least 130 percent of the equipment rating.
 - 3. Plug: Nylon body and integral cable-clamping jaws. Match cord and receptacle type for connection.

2.7 TOGGLE SWITCHES

- A. Comply with NEMA WD 1, UL 20, and FS W-S-896.
- B. Switches, 120/277 V, 20 A:
 - 1. Products: Subject to compliance with requirements, provide one of the following:
 - a. Single Pole:
 - 1) Cooper; AH1221.
 - 2) Hubbell; HBL1221.
 - 3) Leviton; 1221-2.
 - 4) Pass & Seymour; CSB20AC1.
 - b. Two Pole:
 - 1) Cooper; AH1222.
 - 2) Hubbell; HBL1222.
 - 3) Leviton; 1222-2.
 - 4) Pass & Seymour; CSB20AC2.
 - c. Three Way:
 - 1) Cooper; AH1223.
 - 2) Hubbell; HBL1223.
 - 3) Leviton; 1223-2.
 - 4) Pass & Seymour; CSB20AC3.
 - d. Four Way:
 - 1) Cooper; AH1224.
 - 2) Hubbell; HBL1224.
 - 3) Leviton; 1224-2.
 - 4) Pass & Seymour; CSB20AC4.

2.8 WALL PLATES

- A. Single and combination types shall match corresponding wiring devices.
 - 1. Plate-Securing Screws: Metal with head color to match plate finish.
 - 2. Material for Finished Spaces: smooth, high impact thermoplastic.
 - 3. Material for Unfinished Spaces: Galvanized steel.
 - 4. Material for Damp Locations: Cast aluminum with spring-loaded lift cover, and listed and labeled for use in wet and damp locations.
- B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weather-resistant, die-cast aluminum with lockable cover.

2.9 FINISHES

- A. Device Color:
 - 1. Wiring Devices Connected to Normal Power System: As selected by Architect unless otherwise indicated or required by NFPA 70 or device listing.
 - 2. Wiring Devices Connected to Emergency Power System: Red.
- B. Wall Plate Color: For plastic covers, match device color.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.
- B. Coordination with Other Trades:
 - 1. Protect installed devices and their boxes. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of boxes.
 - 2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.
 - 3. Install device boxes in brick or block walls so that the cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.
 - 4. Install wiring devices after all wall preparation, including painting, is complete.
- C. Conductors:
 - 1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.
 - 2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
 - 3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
 - 4. Existing Conductors:
 - a. Cut back and pigtail, or replace all damaged conductors.
 - b. Straighten conductors that remain and remove corrosion and foreign matter.
 - c. Pigtailling existing conductors is permitted, provided the outlet box is large enough.
- D. Device Installation:
 - 1. Replace devices that have been in temporary use during construction and that were installed before building finishing operations were complete.
 - 2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.
 - 3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.
 - 4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.
 - 5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, two-thirds to three-fourths of the way around terminal screw.
 - 6. Use a torque screwdriver when a torque is recommended or required by manufacturer.
 - 7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.
 - 8. Tighten unused terminal screws on the device.
 - 9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device-mounting screws in yokes, allowing metal-to-metal contact.

- E. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.
- F. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.
- G. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

3.2 GFCI RECEPTACLES

- A. Install non-feed-through-type GFCI receptacles where protection of downstream receptacles is not required.

3.3 IDENTIFICATION

- A. Comply with Section 260553 "Identification for Electrical Systems."
- B. Identify each receptacle with panelboard identification and circuit number. Use hot, stamped, or engraved machine printing with black-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

3.4 FIELD QUALITY CONTROL

- A. Tests for Convenience Receptacles:
 - 1. Line Voltage: Acceptable range is 105 to 132 V.
 - 2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is unacceptable.
 - 3. Ground Impedance: Values of up to 2 ohms are acceptable.
 - 4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
 - 5. Using the test plug, verify that the device and its outlet box are securely mounted.
 - 6. Tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.
- B. Wiring device will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

END OF SECTION 262726

SECTION 262816
ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Fusible switches.
 - 2. Nonfusible switches.
 - 3. Enclosures.

1.2 DEFINITIONS

- A. NC: Normally closed.
- B. NO: Normally open.
- C. SPDT: Single pole, double throw.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.
 - 1. Enclosure types and details for types other than NEMA 250, Type 1.
 - 2. Current and voltage ratings.
 - 3. Short-circuit current ratings (interrupting and withstand, as appropriate).
 - 4. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
 - 5. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.
 - 1. Test procedures used.
 - 2. Test results that comply with requirements.
 - 3. Results of failed tests and corrective action taken to achieve test results that comply with requirements.

1.5 MAINTENANCE MATERIAL SUBMITTALS

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
 - 2. Fuse Pullers: Two for each size and type.

1.6 QUALITY ASSURANCE

- A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single source from single manufacturer.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- C. Comply with NFPA 70.

1.7 PROJECT CONDITIONS

- A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:
 - 1. Ambient Temperature: Not less than minus 22 deg F and not exceeding 104 deg F.
 - 2. Altitude: Not exceeding .

1.8 COORDINATION

- A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

PART 2 - PRODUCTS

2.1 FUSIBLE SWITCHES

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Eaton.
 - b. General Electric Company.
 - c. Siemens Industry, Inc.
 - d. Square D; by Schneider Electric.
- B. Type HD, Heavy Duty, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate fuses (per

manufacturers requirements), lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

- C. Accessories:
 1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
 2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
 3. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
 4. Auxiliary Contact Kit: Two NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open.
 5. Lugs: Compression type, suitable for number, size, and conductor material.
 6. Service-Rated Switches: Labeled for use as service equipment.

2.2 NONFUSIBLE SWITCHES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 1. Eaton.
 2. General Electric Company.
 3. Siemens Industry, Inc.
 4. Square D; by Schneider Electric.
- B. Type HD, Heavy Duty, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.
- C. Accessories:
 1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
 2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
 3. Auxiliary Contact Kit: Two NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open.
 4. Lugs: Compression type, suitable for number, size, and conductor material.

2.3 ENCLOSURES

- A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.
 1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.
 2. Outdoor Locations: NEMA 250, Type 3R.
 3. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.
- B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.
- C. Install fuses in fusible devices.
- D. Comply with NECA 1.

3.3 IDENTIFICATION

- A. Comply with requirements in Section 260553 "Identification for Electrical Systems."
 - 1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
 - 2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.4 FIELD QUALITY CONTROL

- A. Tests and Inspections:
 - 1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
 - 2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

3.5 ADJUSTING

- A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.
- B. Set field-adjustable circuit-breaker trip ranges as specified in Section 260573 "Overcurrent Protective Device Coordination Study."

END OF SECTION 262816

SECTION 263213
ENGINE GENERATORS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes packaged engine generators used to supply non-emergency power, with the following features:
 - 1. Diesel engine.
 - 2. Diesel fuel-oil system.
 - 3. Unit-mounted cooling system.
 - 4. Unit-mounted control and monitoring.
 - 5. Performance requirements for sensitive loads.
 - 6. Generator overcurrent and fault protection.
 - 7. Generator, exciter, and voltage regulator.
 - 8. Outdoor sound attenuated engine generator enclosure.
 - 9. Vibration isolation devices.

- B. Related Requirements:
 - 1. Section 263600 "Transfer Switches" for transfer switches including sensors and relays to initiate automatic-starting and -stopping signals for engine generators.

1.2 DEFINITIONS

- A. Operational Bandwidth: The total variation from the lowest to highest value of a parameter over the range of conditions indicated, expressed as a percentage of the nominal value of the parameter.

- B. EPS: Emergency power supply.

- C. EPSS: Emergency power supply system.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
 - 2. Include thermal damage curve for generator.
 - 3. Include time-current characteristic curves for generator protective device.
 - 4. Include fuel consumption in gallons per hour at 0.8 power factor at 0.5, 0.75, and 1.0 times generator capacity.
 - 5. Include generator efficiency at 0.8 power factor at 0.5, 0.75, and 1.0 times generator capacity.

6. Include airflow requirements for cooling and combustion air in cubic feet per minute at 0.8 power factor, with air-supply temperature of 95, 80, 70, and 50 deg F. Provide drawings indicating requirements and limitations for location of air intake and exhausts.
7. Include generator characteristics, including, but not limited to, kilowatt rating, efficiency, reactances, and short-circuit current capability.

B. Shop Drawings:

1. Include plans and elevations for engine generator and other components specified. Indicate access requirements affected by height of subbase fuel tank.
2. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Identify fluid drain ports and clearance requirements for proper fluid drain.
4. Design calculations for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
5. Vibration Isolation Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment. Include base weights.
6. Include diagrams for power, signal, and control wiring. Complete schematic, wiring, and interconnection diagrams showing terminal markings for engine generators and functional relationship between all electrical components.

1.4 INFORMATIONAL SUBMITTALS

- A. Seismic Qualification Data: Certificates, for engine generator, 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: With engine and generator mounted on rails, identify center of gravity and total weight, including full fuel tank, supplied enclosure, external silencer, subbase-mounted fuel tank, and each piece of equipment not integral to the engine generator, 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.
- B. Source Quality-Control Reports: Including, but not limited to, the following:
1. Report of factory test on units to be shipped for this Project, showing evidence of compliance with specified requirements.
 2. Report of sound generation.
 3. Report of exhaust emissions showing compliance with applicable regulations.
- C. Field quality-control reports.
- D. Warranty: For special warranty.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For packaged engine generators to include in emergency, operation, and maintenance manuals.
 - 1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
 - a. List of tools and replacement items recommended to be stored at Project for ready access. Include part and drawing numbers, current unit prices, and source of supply.
 - b. Operating instructions laminated and mounted adjacent to generator location.
 - c. Training plan.

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. Fuses: One for every 10 of each type and rating, but no fewer than one of each.
 - 2. Indicator Lamps: Two for every six of each type used, but no fewer than two of each.
 - 3. Filters: One set each of lubricating oil, fuel, and combustion-air filters.
 - 4. Tools: Each tool listed by part number in operations and maintenance manual.

1.7 QUALITY ASSURANCE

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

1.8 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of packaged engine generators and associated auxiliary components that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: Three years from date of Substantial Completion.
 - a. No deductibles or registration fees shall be allowed.
 - b. All costs to provide and install a temporary generator set shall be included should a warranty repair take longer than 48 hours.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 - 1. Kohler Power Systems.

2. Caterpillar; Engine Div.
3. Onan/Cummins Power Generation; Industrial Business Group.

2.2 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Engine generator housing, fuel tank, engine generator, batteries, battery racks, silencers, sound attenuating equipment, accessories, and components shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
 1. The term "withstand" means "the unit will remain in place without separation of any parts when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
 2. Shake-table testing shall comply with ICC-ES AC156. Testing shall be performed with all fluids at worst-case normal levels.
 3. Component Importance Factor: 1.0.
- B. B11 Compliance: Comply with B11.19.
- C. NFPA Compliance:
 1. Comply with NFPA 37.
 2. Comply with NFPA 70.
- D. UL Compliance: Comply with UL 2200.
- E. Engine Exhaust Emissions: Comply with EPA Tier 4 requirements and applicable state and local government requirements.
- F. Noise Emission: The generator enclosure shall be sound attenuated Level II.
- G. Environmental Conditions: Engine generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:
 1. Ambient Temperature: 5 to 104 deg F.
 2. Relative Humidity: Zero to 95 percent.
 3. Altitude: Sea level to 500 feet (150 m).

2.3 ENGINE GENERATOR ASSEMBLY DESCRIPTION

- A. Factory-assembled and -tested, water-cooled engine, with brushless generator and accessories.
- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and use.
- C. Power Rating: Industrial.
- D. Overload Capacity: 110 percent of service load for 1 hour in 12 consecutive hours.
- E. Service Load: 124kW/155kVA (minimum).

- F. Power Factor: 0.8, lagging.
- G. Frequency: 60 Hz.
- H. Voltage: 208 V ac.
- I. Phase: Three-phase, four wire, wye.
- J. Induction Method: Naturally aspirated.
- K. Governor: Adjustable isochronous, with speed sensing.
- L. Mounting Frame: Structural steel framework to maintain alignment of mounted components without depending on concrete foundation. Provide lifting attachments sized and spaced to prevent deflection of base during lifting and moving.
 - 1. Rigging Diagram: Inscribed on metal plate permanently attached to mounting frame to indicate location and lifting capacity of each lifting attachment and engine generator center of gravity.
- M. Capacities and Characteristics:
 - 1. Power Output Ratings: Nominal ratings as indicated excluding power required for the continued and repeated operation of the unit and auxiliaries, **with capacity as required to operate as a unit as evidenced by records of prototype testing.**
 - 2. Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of component.
- N. Engine Generator Performance:
 - 1. Steady-State Voltage Operational Bandwidth: 3 percent of rated output voltage from no load to full load.
 - 2. Transient Voltage Performance: Not more than 20 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within three seconds.
 - 3. Steady-State Frequency Operational Bandwidth: 0.5 percent of rated frequency from no load to full load.
 - 4. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.
 - 5. Transient Frequency Performance: Less than 5 percent variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within five seconds.
 - 6. Output Waveform: At no load, harmonic content measured line to line or line to neutral shall not exceed 5 percent total and 3 percent for single harmonics. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.
 - 7. Sustained Short-Circuit Current: For a three-phase, bolted short circuit at system output terminals, system shall supply a minimum of 250 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to generator system components.
 - 8. Start Time: Comply with NFPA 110, Type 60, system requirements.

2.4 DIESEL ENGINE

- A. Fuel: ASTM D975, diesel fuel oil, Grade 2-D S15.
- B. Rated Engine Speed: 1800 rpm.
- C. Lubrication System: Engine or skid-mounted.
 - 1. Filter and Strainer: Rated to remove 90 percent of particles 5 micrometers and smaller while passing full flow.
 - 2. Thermostatic Control Valve: Control flow in system to maintain optimum oil temperature. Unit shall be capable of full flow and is designed to be fail-safe.
 - 3. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.
- D. Jacket Coolant Heater: Electric-immersion type, factory installed in coolant jacket system. Comply with UL 499.
- E. Cooling System: Closed loop, liquid cooled, with radiator factory mounted on engine generator set mounting frame and integral engine-driven coolant pump.
 - 1. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.
 - 2. Size of Radiator: Adequate to contain expansion of total system coolant from cold start to 110 percent load condition.
 - 3. Expansion Tank: Constructed of welded steel plate and rated to withstand maximum closed-loop coolant system pressure for engine used. Equip with gage glass and petcock.
 - 4. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.
 - 5. Coolant Hose: Flexible assembly with inside surface of nonporous rubber and outer covering of aging-, UV-, and abrasion-resistant fabric.
 - a. Rating: 50-psig maximum working pressure with coolant at 180 deg F, and noncollapsible under vacuum.
 - b. End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.
- F. Muffler/Silencer: Critical type, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.
 - 1. Minimum sound attenuation of 25 dB at 500 Hz.
 - 2. Sound level measured at a distance of 25 feet from exhaust discharge after installation is complete shall be 78 dBA or less.
- G. Air-Intake Filter: Heavy-duty, engine-mounted air cleaner with replaceable dry-filter element and "blocked filter" indicator.
- H. Starting System: 12V electric, with negative ground.

1. Components: Sized so they are not damaged during a full engine-cranking cycle with ambient temperature at maximum specified in "Performance Requirements" Article.
2. Cranking Motor: Heavy-duty unit that automatically engages and releases from engine flywheel without binding.
3. Cranking Cycle: 60 seconds.
4. Battery: Lead acid, with capacity within ambient temperature range specified in "Performance Requirements" Article to provide specified cranking cycle at least three times without recharging.
5. Battery Cable: Size as recommended by engine manufacturer for cable length indicated. Include required interconnecting conductors and connection accessories.
6. Battery Compartment: Factory fabricated of metal with acid-resistant finish and thermal insulation. Thermostatically controlled heater shall be arranged to maintain battery above 50 deg F regardless of external ambient temperature within range specified in "Performance Requirements" Article. Include accessories required to support and fasten batteries in place. Provide ventilation to exhaust battery gases.
7. Battery Stand: Factory-fabricated, two-tier metal with acid-resistant finish designed to hold the quantity of battery cells required and to maintain the arrangement to minimize lengths of battery interconnections.
8. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation and 35-A minimum continuous rating.
9. Battery Charger: Current-limiting, automatic-equalizing, and float-charging type designed for lead-acid batteries. Unit shall comply with UL 1236 and include the following features:
 - a. Operation: Equalizing-charging rate of 10 A shall be initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit shall then be automatically switched to a lower float-charging mode and shall continue to operate in that mode until battery is discharged again.
 - b. Automatic Temperature Compensation: Adjust float and equalize voltages for variations in ambient temperature from minus 40 to 140 deg F to prevent overcharging at high temperatures and undercharging at low temperatures.
 - c. Automatic Voltage Regulation: Maintain constant output voltage regardless of input voltage variations up to plus or minus 10 percent.
 - d. Ammeter and Voltmeter: Flush mounted in door. Meters shall indicate charging rates.
 - e. Safety Functions: Sense abnormally low battery voltage and close contacts providing low battery voltage indication on control and monitoring panel. Sense high battery voltage and loss of ac input or dc output of battery charger. Either condition shall close contacts that provide a battery-charger malfunction indication at system control and monitoring panel.
 - f. Enclosure and Mounting: NEMA 250, Type 1, wall-mounted cabinet.

2.5 DIESEL FUEL-OIL SYSTEM

- A. Comply with NFPA 30.
- B. Piping: Fuel-oil piping shall be Schedule 40 black steel, complying with requirements in Section 231113 "Facility Fuel-Oil Piping." Cast iron, aluminum, copper, and galvanized steel shall not be used in the fuel-oil system.

- C. Main Fuel Pump: Mounted on engine to provide primary fuel flow under starting and load conditions.
- D. Fuel Filtering: Remove water and contaminants larger than 1 micron.
- E. Relief-Bypass Valve: Automatically regulates pressure in fuel line and returns excess fuel to source.
- F. Subbase-Mounted, Double-Wall, Fuel-Oil Tank: Factory installed and piped, complying with UL 142 fuel-oil tank. Features include the following:
 - 1. Tank level indicator.
 - 2. Fuel-Tank Capacity: Minimum 133 percent of total fuel required for planned operation plus fuel for periodic maintenance operations between fuel refills.
 - 3. Leak detection in interstitial space.
 - 4. Vandal-resistant fill cap.
 - 5. Containment Provisions: Comply with requirements of authorities having jurisdiction.

2.6 CONTROL AND MONITORING

- A. Automatic Starting System Sequence of Operation: When mode-selector switch on the control and monitoring panel is in the automatic position, remote-control contacts in one or more separate automatic transfer switches initiate starting and stopping of engine generator. When mode-selector switch is switched to the on position, engine generator starts. The off position of same switch initiates engine generator shutdown. When engine generator is running, specified system or equipment failures or derangements automatically shut down engine generator and initiate alarms.
- B. Manual Starting System Sequence of Operation: Switching on-off switch on the generator control panel to the on position starts engine generator. The off position of same switch initiates engine generator shutdown. When engine generator is running, specified system or equipment failures or derangements automatically shut down engine generator and initiate alarms.
- C. Provide minimum run time control set for 30 minutes with override only by operation of a remote emergency-stop switch.
- D. Comply with UL 508A.
- E. Configuration: Operating and safety indications, protective devices, basic system controls, and engine gages shall be grouped in a common control and monitoring panel mounted on the engine generator. Mounting method shall isolate the control panel from engine generator vibration. Panel shall be powered from the engine generator battery.
- F. Control and Monitoring Panel:
 - 1. Digital controller with integrated LCD, controls, and microprocessor, capable of local and remote control, monitoring, and programming, with battery backup.
 - 2. Instruments: Located on the control and monitoring panel and viewable during operation.
 - a. Engine lubricating-oil pressure gage.

- b. Engine-coolant temperature gage.
 - c. DC voltmeter (alternator battery charging).
 - d. Running-time meter.
 - e. AC voltmeter, connected to a phase selector switch.
 - f. AC ammeter, connected to a phase selector switch.
 - g. AC frequency meter.
 - h. Generator-voltage adjusting rheostat.
3. Controls and Protective Devices: Controls, shutdown devices, and common alarm indication, including the following:
- a. Cranking control equipment.
 - b. Run-Off-Auto switch.
 - c. Control switch not in automatic position alarm.
 - d. Overcrank alarm.
 - e. Overcrank shutdown device.
 - f. Low water temperature alarm.
 - g. High engine temperature prealarm.
 - h. High engine temperature.
 - i. High engine temperature shutdown device.
 - j. Overspeed alarm.
 - k. Overspeed shutdown device.
 - l. Low fuel main tank.
 - m. Coolant low-level alarm.
 - n. Coolant low-level shutdown device.
 - o. Coolant high-temperature prealarm.
 - p. Coolant high-temperature alarm.
 - q. Coolant low-temperature alarm.
 - r. Coolant high-temperature shutdown device.
 - s. EPS supplying load indicator.
 - t. Battery high-voltage alarm.
 - u. Low cranking voltage alarm.
 - v. Battery-charger malfunction alarm.
 - w. Battery low-voltage alarm.
 - x. Lamp test.
 - y. Contacts for local and remote common alarm.
 - z. Low-starting air pressure alarm.
 - aa. Low-starting hydraulic pressure alarm.
 - bb. Remote manual stop shutdown device.
 - cc. Air shutdown damper alarm when used.
 - dd. Air shutdown damper shutdown device when used.
 - ee. Hours of operation.
 - ff. Engine generator metering, including voltage, current, Hz, kW, kVA, and power factor.
 - gg. Generator overcurrent protective device not closed alarm.

G. Connection to Datalink:

- 1. A separate terminal block, factory wired to Form C dry contacts, for each alarm and status indication.

- H. Provide remote annunciator panel and connections for datalink transmission of indications via ModBus and Ethernet. Remote Alarm Annunciator: An LED indicator light labeled with proper alarm conditions shall identify each alarm event, and a common audible signal shall sound for each alarm condition. Silencing switch in face of panel shall silence signal without altering visual indication. Connect so that after an alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset. Cabinet and faceplate are surface- or flush-mounting type to suit mounting conditions indicated.
1. Overcrank alarm.
 2. Coolant low-temperature alarm.
 3. High engine temperature prealarm.
 4. High engine temperature alarm.
 5. Low lube oil pressure alarm.
 6. Overspeed alarm.
 7. Low fuel main tank alarm.
 8. Low coolant level alarm.
 9. Low cranking voltage alarm.
 10. Contacts for local and remote common alarm.
 11. Audible-alarm silencing switch.
 12. Air shutdown damper when used.
 13. Run-Off-Auto switch.
 14. Control switch not in automatic position alarm.
 15. Fuel tank derangement alarm.
 16. Fuel tank high-level shutdown of fuel supply alarm.
 17. Lamp test.
 18. Low cranking voltage alarm.
 19. Generator overcurrent protective device not closed.
- I. Supporting Items: Include sensors, transducers, terminals, relays, and other devices and include wiring required to support specified items. Locate sensors and other supporting items on engine or generator unless otherwise indicated.
- J. Remote Emergency-Stop Switch: wall mounted, NEMA 4 enclosure, unless otherwise indicated; and labeled. Push button shall be protected from accidental operation.
- K. Provide a 120V weatherproof NEMA 4X red LED non-flashing beacon light and install next to the administration building entrance door which will energize when the generator is running. Provide a heavy duty control relay with at least two normally open and two normally closed field convertible contacts rated for a minimum of 10amps AC and 120V, 60Hz coil in NEMA 1 enclosure and connect to the generator control panel generator running auxiliary contact. Connect the 120V non-flashing beacon light and control relay to the generator enclosure 120V power source used for the generator battery charger or other 120V source serving the generator. Provide all required power/control wiring and conduit.
- L. Provide a relay contact in the generator control panel which will output a signal capable of energizing the coil of a relay when the generator is running so that a beacon light will be activated whenever the generator is running.

2.7 GENERATOR OVERCURRENT AND FAULT PROTECTION

- A. Overcurrent protective devices shall be coordinated to optimize selective tripping when a short circuit occurs.
- B. Generator Circuit Breaker: Molded-case, electronic-trip type; 100 percent rated; complying with UL 489.
 - 1. Tripping Characteristics: Adjustable long-time and short-time delay and instantaneous.
 - 2. Trip Settings: Selected to coordinate with generator thermal damage curve.
 - 3. Shunt Trip: Connected to trip breaker when engine generator is shut down by other protective devices.
 - 4. Mounting: Adjacent to, or integrated with, control and monitoring panel.

2.8 GENERATOR, EXCITER, AND VOLTAGE REGULATOR

- A. Comply with NEMA MG 1.
- B. Drive: Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.
- C. Electrical Insulation: Class H.
- D. Stator-Winding Leads: Brought out to terminal box to permit future reconnection for other voltages if required. Provide 12-lead alternator.
- E. Range: Provide broad range of output voltage by adjusting the excitation level.
- F. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, overspeed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.
- G. Enclosure: Drip-proof.
- H. Instrument Transformers: Mounted within generator enclosure.
- I. Voltage Regulator: Solid-state type, separate from exciter, providing performance as specified.
 - 1. Adjusting Rheostat on Control and Monitoring Panel: Provide plus or minus 5 percent adjustment of output-voltage operating band.
 - 2. Maintain voltage within 30percent on one step, full load.
 - 3. Provide anti-hunt provision to stabilize voltage.
 - 4. Maintain frequency within 10 percent and stabilize at rated frequency within 2 seconds.
- J. Strip Heater: Thermostatically controlled unit arranged to maintain stator windings above dew point.
- K. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.
- L. Subtransient Reactance: 12 percent, maximum.

2.9 OUTDOOR ENGINE GENERATOR ENCLOSURE

- A. Description: Vandal-resistant, sound-attenuating, weatherproof steel housing; wind resistant up to 100 mph. Multiple panels shall be lockable and provide adequate access to components requiring maintenance. Panels shall be removable by one person without tools. Instruments and control shall be mounted within enclosure.
 - 1. Sound Attenuation Level: 2.
- B. Structural Design and Anchorage: Comply with ASCE/SEI 7 for wind loads up to 100 mph.
- C. Hinged Doors: With padlocking provisions.
- D. Thermal Insulation: Manufacturer's standard materials and thickness selected in coordination with space heater to maintain winter interior temperature within operating limits required by engine generator components.
- E. Muffler Location: Within enclosure.
- F. Exhaust stack: Provide an exhaust stack above the enclosure roof. Stack size and height shall be determined by the generator supplier and shall meet local and state codes but shall be 3 feet minimum. All required supports, guy wires, and accessories to connect the exhaust stack to the muffler and support from the enclosure shall be provided by the generator supplier for a complete operational exhaust system.
- G. Engine-Cooling Airflow through Enclosure: Maintain temperature rise of system components within required limits when unit operates at 110 percent of rated load for two hours with ambient temperature at top of range specified in system service conditions.
 - 1. Louvers: Fixed-engine, cooling-air inlet and discharge. Stormproof and drainable louvers prevent entry of rain and snow.
 - 2. Automatic Dampers: At engine cooling-air inlet and discharge. Dampers shall be closed to reduce enclosure heat loss in cold weather when unit is not operating.

2.10 VIBRATION ISOLATION DEVICES

- A. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic restraint.
 - 1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to wind loads or if weight is removed; factory-drilled baseplate bonded to 1/4-inch-thick, elastomeric isolator pad attached to baseplate underside; and adjustable equipment-mounting and -leveling bolt that acts as blocking during installation.
 - 2. Outside Spring Diameter: Not less than 80 percent of compressed height of the spring at rated load.
 - 3. Minimum Additional Travel: 50 percent of required deflection at rated load.
 - 4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
 - 5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
 - 6. Minimum Deflection: 1 inch.

- B. Comply with requirements in Section 232116 "Hydronic Piping Specialties" for vibration isolation and flexible connector materials for steel piping.
- C. Comply with requirements in Section 233113 "Metal Ducts" for vibration isolation and flexible connector materials for exhaust shroud and ductwork.
- D. Vibration isolation devices shall not be used to accommodate misalignments or to make bends.

2.11 FINISHES

- A. Indoor and Outdoor Enclosures and Components: Manufacturer's standard finish over corrosion-resistant pretreatment and compatible primer.

2.12 SOURCE QUALITY CONTROL

- A. Prototype Testing: Factory test engine generator using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.
 - 1. Tests: Comply with IEEE 115.
- B. Project-Specific Equipment Tests: Before shipment, factory test engine generator and other system components and accessories manufactured specifically for this Project. Perform tests at rated load and power factor. Include the following tests:
 - 1. Test components and accessories furnished with installed unit that are not identical to those on tested prototype to demonstrate compatibility and reliability.
 - 2. Test generator, exciter, and voltage regulator as a unit.
 - 3. Full load run.
 - 4. Maximum power.
 - 5. Voltage regulation.
 - 6. Transient and steady-state governing.
 - 7. Single-step load pickup.
 - 8. Safety shutdown.
 - 9. Provide 14 days' advance notice of tests and opportunity for observation of tests by Owner's representative.
 - 10. Report factory test results within 10 days of completion of test.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas, equipment bases, and conditions, with Installer present, for compliance with requirements for installation and other conditions affecting packaged engine generator performance.
- B. Examine roughing-in for piping systems and electrical connections. Verify actual locations of connections before packaged engine generator installation.

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

3.2 PREPARATION

- A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:
 - 1. Notify Owner no fewer than two working days in advance of proposed interruption of electrical service.
 - 2. Do not proceed with interruption of electrical service without Owner's written permission.

3.3 INSTALLATION

- A. Comply with NECA 1 and NECA 404.
- B. Comply with packaged engine generator manufacturers' written installation.
- C. Equipment Mounting:
 - 1. Install packaged engine generators on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."
 - 2. Coordinate size and location of concrete bases for packaged engine generators. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified with concrete.
 - 3. Install packaged engine generator with restrained spring isolators specified above on a concrete base. Secure engine generator with anchor bolts installed in concrete bases.
- D. Install packaged engine generator to provide access, without removing connections or accessories, for periodic maintenance.
- E. Drain Piping: Install condensate drain piping to muffler drain outlet full size of drain connection with a shutoff valve, stainless-steel flexible connector, and Schedule 40 black steel pipe with welded joints.
 - 1. Piping materials and installation requirements are specified in Section 232113 "Hydronic Piping."
 - 2. Drain piping valves, connectors, and installation requirements are specified in Section 232116 "Hydronic Piping Specialties."
- F. Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.

3.4 CONNECTIONS

- A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping and specialties.

- B. Connect fuel, cooling-system, and exhaust-system piping adjacent to packaged engine generator to allow space for service and maintenance.
- C. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- D. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables." Provide a minimum of one 90-degree bend in flexible conduit routed to the engine generator from a stationary element.
- E. Balance single-phase loads to obtain a maximum of 10 percent unbalance between any two phases.

3.5 IDENTIFICATION

- A. Identify system components according to Section 230553 "Identification for HVAC Piping and Equipment" and Section 260553 "Identification for Electrical Systems."

3.6 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- B. Tests and Inspections:
 - 1. Perform tests recommended by manufacturer and each visual and mechanical inspection and electrical and mechanical test listed in first two subparagraphs below, as specified in NETA ATS. Certify compliance with test parameters.
 - a. Visual and Mechanical Inspection:
 - 1) Compare equipment nameplate data with Drawings and the Specifications.
 - 2) Inspect physical and mechanical condition.
 - 3) Inspect anchorage, alignment, and grounding.
 - 4) Verify that the unit is clean.
 - b. Electrical and Mechanical Tests:
 - 1) Perform insulation-resistance tests according to IEEE 43.
 - a) Machines Larger Than 200 hp Test duration shall be 10 minutes. Calculate polarization index.
 - b) Machines 200 hp or Less: Test duration shall be one minute. Calculate the dielectric-absorption ratio.
 - 2) Test protective relay devices.
 - 3) Verify phase rotation, phasing, and synchronized operation as required by the application.
 - 4) Functionally test engine shutdown for low oil pressure, overtemperature, overspeed, and other protection features as applicable.

- 5) Verify correct functioning of the governor and regulator.
2. Battery Tests: Equalize charging of battery cells according to manufacturer's written instructions. Record individual cell voltages.
 - a. Measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions.
 - b. Test for contact integrity of all connectors. Perform an integrity load test and a capacity load test for the battery.
 - c. Verify acceptance of charge for each element of the battery after discharge.
 - d. Verify that measurements are within manufacturer's specifications.
 3. Battery-Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.
 4. System Integrity Tests: Methodically verify proper installation, connection, and integrity of each element of engine generator system before and during system operation. Check for air, exhaust, and fluid leaks.
 5. Exhaust-System Back-Pressure Test: Use a manometer with a scale exceeding 40-inch wg. Connect to exhaust line close to engine exhaust manifold. Verify that back pressure at full-rated load is within manufacturer's written allowable limits for the engine.
 6. Exhaust Emissions Test: Comply with applicable government test criteria.
 7. Voltage and Frequency Transient Stability Tests: Use recording oscilloscope to measure voltage and frequency transients for 50 and 100 percent step-load increases and decreases, and verify that performance is as specified.
 8. Harmonic-Content Tests: Measure harmonic content of output voltage at 25 and 100 percent of rated linear load. Verify that harmonic content is within specified limits.
 9. Noise Level Tests: Measure A-weighted level of noise emanating from engine generator installation, including engine exhaust and cooling-air intake and discharge, at four locations 25 feet from edge of the generator enclosure, and compare measured levels with required values.
- C. Coordinate tests with tests for transfer switches and run them concurrently.
 - D. Test instruments shall have been calibrated within the past 12 months, traceable to NIST Calibration Services, and adequate for making positive observation of test results. Make calibration records available for examination on request.
 - E. Leak Test: After installation, charge exhaust, coolant, and fuel systems and test for leaks. Repair leaks and retest until no leaks exist.
 - F. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation for generator and associated equipment.
 - G. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - H. Remove and replace malfunctioning units and retest as specified above.
 - I. Retest: Correct deficiencies identified by tests and observations, and retest until specified requirements are met.

- J. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations. Attach a label or tag to each tested component indicating satisfactory completion of tests.

3.7 MAINTENANCE SERVICE

- A. Initial Maintenance Service: Beginning at Substantial Completion, provide 12 months' full maintenance by skilled employees of manufacturer's designated service organization. Include quarterly exercising to check for proper starting, load transfer, and running under load. Include routine preventive maintenance as recommended by manufacturer and adjusting as required for proper operation. Provide parts and supplies same as those used in the manufacture and installation of original equipment.

3.8 DEMONSTRATION

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

END OF SECTION 263213

SECTION 263600
TRANSFER SWITCHES

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes automatic transfer switches rated 600 V and less.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for transfer switches.
 - 2. Include rated capacities, operating characteristics, electrical characteristics, and accessories.
- B. Shop Drawings:
 - 1. Include plans, elevations, sections, details showing minimum clearances, conductor entry provisions, gutter space, and installed features and devices.
 - 2. Include material lists for each switch specified.

1.3 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: Furnish 3 copies of an Operations and Maintenance Manual including product submittal information, equipment identification with serial numbers of each component, wiring diagrams, control diagrams, startup and operating procedures and instructions, emergency manuals, emergency procedures and instructions, inspection procedures, maintenance schedule, maintenance procedures and documentation, shutdown instructions, license requirements including inspection and renewal dates, performance curves, engineering data and tests, list of tools and replacement items recommended to be stored at Project for ready access, training plan, maintenance service contracts, and warranties and bonds. Also include the following:
 - a. Features and operating sequences, both automatic and manual.
 - b. List of all factory settings of relays; provide relay-setting and calibration instructions, including software, where applicable.

1.5 WARRANTY

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of transfer switch or transfer switch components that fail in materials or workmanship within specified warranty period.
 - 1. Warranty Period: One year from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. Comply with NEMA ICS 1.
- C. Comply with NFPA 110.
- D. Comply with UL 1008 unless requirements of these Specifications are stricter.
- E. Indicated Current Ratings: Apply as defined in UL 1008 for continuous loading and total system transfer, including tungsten filament lamp loads not exceeding 30 percent of switch ampere rating, unless otherwise indicated.
- F. Tested Fault-Current Closing and Short-Circuit Ratings: Adequate for duty imposed by protective devices at installation locations in Project under the fault conditions indicated, based on testing according to UL 1008.
- G. Repetitive Accuracy of Solid-State Controls: All settings shall be plus or minus 2 percent or better over an operating temperature range of minus 20 to plus 70 deg C.
- H. Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.62. Components shall meet or exceed voltage-impulse withstand test of NEMA ICS 1.
- I. Electrical Operation: Accomplish by a nonfused, momentarily energized solenoid or electric-motor-operated mechanism. Switches for emergency or standby purposes shall be mechanically and electrically interlocked in both directions to prevent simultaneous connection to both power sources unless closed transition.
- J. Neutral Terminal: Solid and fully rated unless otherwise indicated.
- K. Factory Wiring: Train and bundle factory wiring and label, consistent with Shop Drawings, by color-code or by numbered or lettered wire and cable tape markers at terminations. Color-coding and wire and cable markers are specified in Section 260553 "Identification for Electrical Systems."
 - 1. Designated Terminals: Pressure type, suitable for types and sizes of field wiring indicated.

2. Power-Terminal Arrangement and Field-Wiring Space: Suitable for top, side, or bottom entrance of feeder conductors as indicated.
 3. Control Wiring: Equipped with lugs suitable for connection to terminal strips.
 4. Accessible via front access.
- L. Enclosures: General-purpose NEMA 250, Type 1 or Type 12, complying with NEMA ICS 6 and UL 508, unless otherwise indicated.

2.2 CONTACTOR-TYPE AUTOMATIC TRANSFER SWITCHES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
1. Eaton.
 2. Emerson.
 3. Kohler Power Systems.
 4. Onan/Cummins Power Generation.
 5. Russelectric, Inc.
- B. Comply with Level 1 equipment according to NFPA 110.
- C. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.
1. Limitation: Switches using molded-case switches or circuit breakers or insulated-case circuit-breaker components are unacceptable.
 2. Switch Action: Double throw; mechanically held in both directions.
 3. Contacts: Silver composition or silver alloy for load-current switching. Contactor-style automatic transfer-switch units, rated 600 A and higher, shall have separate arcing contacts.
 4. Conductor Connectors: Suitable for use with conductor material and sizes.
 5. Material: Hard-drawn copper, 98 percent conductivity.
 6. Main and Neutral Lugs: Compression type.
 7. Ground Lugs and Bus-Configured Terminators: Compression type.
 8. Ground bar.
 9. Connectors shall be marked for conductor size and type according to UL 1008.
- D. Automatic Open-Transition Transfer Switches: Interlocked to prevent the load from being closed on both sources at the same time.
1. Sources shall be mechanically and electrically interlocked to prevent closing both sources on the load at the same time.
- E. Signal-Before-Transfer Contacts: A set of normally open/normally closed dry contacts operates in advance of retransfer to normal source. Interval shall be adjustable from 1 to 30 seconds.
- F. Digital Communication Interface: Matched to capability of remote annunciator or annunciator and control panel.
- G. Automatic Transfer-Switch Controller Features:
1. Controller operates through a period of loss of control power.

2. Undervoltage Sensing for Each Phase of Normal Source: Sense low phase-to-ground voltage on each phase. Pickup voltage shall be adjustable from 85 to 100 percent of nominal, and dropout voltage shall be adjustable from 75 to 98 percent of pickup value. Factory set for pickup at 90 percent and dropout at 85 percent.
3. Voltage/Frequency Lockout Relay: Prevent premature transfer to generator. Pickup voltage shall be adjustable from 85 to 100 percent of nominal. Factory set for pickup at 90 percent. Pickup frequency shall be adjustable from 90 to 100 percent of nominal. Factory set for pickup at 95 percent.
4. Time Delay for Retransfer to Normal Source: Adjustable from zero to 30 minutes, and factory set for 10 minutes. Override shall automatically defeat delay on loss of voltage or sustained undervoltage of emergency source, provided normal supply has been restored.
5. Test Switch: Simulate normal-source failure.
6. Switch-Position Pilot Lights: Indicate source to which load is connected.
7. Source-Available Indicating Lights: Supervise sources via transfer-switch normal- and emergency-source sensing circuits.
 - a. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."
 - b. Emergency Power Supervision: Red light with nameplate engraved "Emergency Source Available."
8. Unassigned Auxiliary Contacts: Two normally open, single-pole, double-throw contacts for each switch position, rated 10 A at 240-V ac.
9. Transfer Override Switch: Overrides automatic retransfer control so transfer switch will remain connected to emergency power source regardless of condition of normal source. Pilot light indicates override status.
10. Engine Starting Contacts: One isolated and normally closed, and one isolated and normally open; rated 10 A at 32-V dc minimum.
11. Engine Shutdown Contacts: Time delay adjustable from zero to five minutes, and factory set for five minutes. Contacts shall initiate shutdown at remote engine-generator controls after retransfer of load to normal source.
12. Engine-Generator Exerciser: Solid-state, programmable-time switch starts engine generator and transfers load to it from normal source for a preset time, then retransfers and shuts down engine after a preset cool-down period. Initiates exercise cycle at preset intervals adjustable from 7 to 30 days. Running periods shall be adjustable from 10 to 30 minutes. Factory settings shall be for 7-day exercise cycle, 20-minute running period, and 5-minute cool-down period. Exerciser features include the following:
 - a. Exerciser Transfer Selector Switch: Permits selection of exercise with and without load transfer.
 - b. Push-button programming control with digital display of settings.
 - c. Integral battery operation of time switch when normal control power is unavailable.

2.3 SOURCE QUALITY CONTROL

- A. Factory Tests: Test and inspect components, assembled switches, and associated equipment according to UL 1008. Ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements. Perform dielectric strength test complying with NEMA ICS 1.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Provide workspace and clearances required by NFPA 70.
- B. Identify components according to Section 260553 "Identification for Electrical Systems."
- C. Set field-adjustable intervals and delays, relays, and engine exerciser clock.
- D. Comply with NECA 1.

3.2 CONNECTIONS

- A. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.
- B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- C. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- D. Route and brace conductors according to manufacturer's written instructions and Section 260529 "Hangers and Supports for Electrical Systems." Do not obscure manufacturer's markings and labels.
- E. Final connections to equipment shall be made with liquidtight, flexible metallic conduit no more than 12 in length.

3.3 FIELD QUALITY CONTROL

- A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 - 1. After installing equipment, test for compliance with requirements according to NETA ATS.
 - 2. Visual and Mechanical Inspection:
 - a. Compare equipment nameplate data with Drawings and Specifications.
 - b. Inspect physical and mechanical condition.
 - c. Inspect anchorage, alignment, grounding, and required clearances.
 - d. Verify that the unit is clean.
 - e. Verify appropriate lubrication on moving current-carrying parts and on moving and sliding surfaces.
 - f. Verify that manual transfer warnings are attached and visible.
 - g. Verify tightness of all control connections.

- h. Inspect bolted electrical connections for high resistance using one of the following methods, or both:
 - 1) Use of low-resistance ohmmeter.
 - 2) Verify tightness of accessible bolted electrical connections by calibrated torque-wrench method according to manufacturer's published data.
 - i. Perform manual transfer operation.
 - j. Verify positive mechanical interlocking between normal and alternate sources.
 - k. Perform visual and mechanical inspection of surge arresters.
 - l. Inspect control power transformers.
 - 1) Inspect for physical damage, cracked insulation, broken leads, tightness of connections, defective wiring, and overall general condition.
 - 2) Verify that primary and secondary fuse or circuit-breaker ratings match Drawings.
 - 3) Verify correct functioning of drawout disconnecting contacts, grounding contacts, and interlocks.
3. Electrical Tests:
- a. Perform insulation-resistance tests on all control wiring with respect to ground.
 - b. Perform a contact/pole-resistance test. Compare measured values with manufacturer's acceptable values.
 - c. Verify settings and operation of control devices.
 - d. Calibrate and set all relays and timers.
 - e. Verify phase rotation, phasing, and synchronized operation.
 - f. Perform automatic transfer tests.
 - g. Verify correct operation and timing of the following functions:
 - 1) Normal source voltage-sensing and frequency-sensing relays.
 - 2) Engine start sequence.
 - 3) Time delay on transfer.
 - 4) Alternative source voltage-sensing and frequency-sensing relays.
 - 5) Automatic transfer operation.
 - 6) Interlocks and limit switch function.
 - 7) Time delay and retransfer on normal power restoration.
 - 8) Engine cool-down and shutdown feature.
4. Measure insulation resistance phase-to-phase and phase-to-ground with insulation-resistance tester. Include external annunciation and control circuits. Use test voltages and procedure recommended by manufacturer. Comply with manufacturer's specified minimum resistance.
- a. Check for electrical continuity of circuits and for short circuits.
 - b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
 - c. Verify that manual transfer warnings are properly placed.
 - d. Perform manual transfer operation.
5. After energizing circuits, perform each electrical test for transfer switches stated in NETA ATS and demonstrate interlocking sequence and operational function for each switch at least three times.
- a. Simulate power failures of normal source to automatic transfer switches and retransfer from emergency source with normal source available.
 - b. Simulate loss of phase-to-ground voltage for each phase of normal source.

- c. Verify time-delay settings.
 - d. Verify pickup and dropout voltages by data readout or inspection of control settings.
- C. Coordinate tests with tests of generator and run them concurrently.
- D. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays.
- E. Transfer switches will be considered defective if they do not pass tests and inspections.
- F. Remove and replace malfunctioning units and retest as specified above.
- G. Prepare test and inspection reports.
- H. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switch. Remove all access panels so joints and connections are accessible to portable scanner.
 - 1. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
 - 2. Record of Infrared Scanning: Prepare a certified report that identifies switches checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.4 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain transfer switches and related equipment.
- B. Coordinate this training with that for generator equipment.

END OF SECTION 263600

SECTION 264113
LIGHTNING PROTECTION FOR STRUCTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

- A. Section includes lightning protection for structures.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.
- B. Shop Drawings: For air terminals and mounting accessories.
 - 1. Layout of the lightning protection system, along with details of the components to be used in the installation.
 - 2. Include indications for use of raceway, data on how concealment requirements will be met, and calculations required by NFPA 780 for bonding of grounded and isolated metal bodies.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For qualified Installer and manufacturer. Include data on listing or certification by UL.
- B. Certification, signed by Contractor, that roof adhesive is approved by manufacturer of roofing material.
- C. Field quality-control reports.
- D. Comply with recommendations in NFPA 780, Annex D, "Inspection and Maintenance of Lightning Protection Systems," for maintenance of the lightning protection system.
- E. Other Informational Submittals: Plans showing dimensioned as-built locations of grounding features, including the following:
 - 1. Ground rods.
 - 2. Ground loop conductor.

1.5 QUALITY ASSURANCE

- A. Installer Qualifications: Certified by UL or LPI as a Master Installer/Designer, trained and approved for installation of units required for this Project.
- B. System Certificate:
 - 1. UL Master Label or LPI System Certificate.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 780, "Definitions" Article.

1.6 COORDINATION

- A. Coordinate installation of lightning protection with installation of other building systems and components, including electrical wiring, supporting structures and building materials, metal bodies requiring bonding to lightning protection components, and building finishes.
- B. Coordinate installation of air terminals attached to roof systems with roofing manufacturer and Installer.
- C. Flashings of through-roof assemblies shall comply with roofing manufacturers' specifications.

PART 2 - PRODUCTS

2.1 LIGHTNING PROTECTION SYSTEM COMPONENTS

- A. Comply with UL 96 and NFPA 780.
- B. Roof-Mounted Air Terminals: NFPA 780,, copper unless otherwise indicated.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 - a. Advanced Lightning Technology, Ltd.
 - b. East Coast Lightning Equipment Inc.
 - c. ERICO International Corporation.
 - d. Harger Lightning & Grounding.
 - e. Heary Bros. Lightning Protection Co. Inc.
 - f. Independent Protection Co.
 - g. National Lightning Protection.
 - h. Preferred Lightning Protection.
 - i. Robbins Lightning, Inc.
 - j. Thompson Lightning Protection, Inc.
 - 2. Air Terminals More than 24 Inches Long: With brace attached to the terminal at not less than half the height of the terminal.
 - 3. Single-Membrane, Roof-Mounted Air Terminals: Designed specifically for single-membrane roof system materials. Comply with requirements in roofing Sections.

- C. Main and Bonding Conductors: Copper.
- D. Ground Loop Conductor: As indicated on plans.
- E. Ground Rods: Copper-clad steel; 3/4 inch in diameter by 10 feet long.
- F. Heavy-Duty, Stack-Mounted, Lightning Protection Components: Solid copper.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install lightning protection components and systems according to UL 96A and NFPA 780.
- B. Install conductors with direct paths from air terminals to ground connections. Avoid sharp bends.
- C. Conceal the following conductors:
 - 1. System conductors.
 - 2. Down conductors.
 - 3. Interior conductors.
 - 4. Conductors within normal view of exterior locations at grade within 200 feet of building.
- D. Cable Connections: Use crimped or bolted connections for all conductor splices and connections between conductors and other components. Use exothermic-welded connections in underground portions of the system.
- E. Cable Connections: Use exothermic-welded connections for all conductor splices and connections between conductors and other components.
 - 1. Exception: In single-ply membrane roofing, exothermic-welded connections may be used only below the roof level.
- F. Air Terminals on Single-Ply Membrane Roofing: Comply with roofing membrane and adhesive manufacturer's written instructions.
- G. Bond extremities of vertical metal bodies exceeding 60 feet in length to lightning protection components.
- H. Ground Loop: Install ground-level, potential equalization conductor and extend around the perimeter of area or item indicated.
 - 1. Bury ground ring not less than 24 inches from building foundation.
 - 2. Bond ground terminals to the ground loop.
 - 3. Bond grounded building systems to the ground loop conductor within 12 feet of grade level.
- I. Bond lightning protection components with intermediate-level interconnection loop conductors to grounded metal bodies of building at 60-foot intervals.

3.2 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

- A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies.

3.3 CORROSION PROTECTION

- A. Do not combine materials that can form an electrolytic couple that will accelerate corrosion in the presence of moisture unless moisture is permanently excluded from junction of such materials.
- B. Use conductors with protective coatings where conditions cause deterioration or corrosion of conductors.

3.4 FIELD QUALITY CONTROL

- A. Notify Architect at least 48 hours in advance of inspection before concealing lightning protection components.
- B. UL Inspection: Meet requirements to obtain a UL Master Label for system.
- C. LPI System Inspection: Meet requirements to obtain an LPI System Certificate.

END OF SECTION 264113

SECTION 265100
INTERIOR LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Interior lighting fixtures, lamps, and ballasts.
 - 2. Emergency lighting units.
 - 3. Exit signs.
 - 4. Lighting fixture supports.

- B. Related Sections:
 - 1. Section 260923 "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.

1.2 DEFINITIONS

- A. BF: Ballast factor.
- B. CCT: Correlated color temperature.
- C. CRI: Color-rendering index.
- D. HID: High-intensity discharge.
- E. LED: Light emitting diode.
- F. LER: Luminaire efficacy rating.
- G. Lumen: Measured output of lamp and luminaire, or both.
- H. Luminaire: Complete lighting fixture, including ballast housing if provided.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:
 - 1. Physical description of lighting fixture including dimensions.
 - 2. Emergency lighting units including battery and charger.
 - 3. Ballast, including BF.
 - 4. Energy-efficiency data.
 - 5. Life, output (lumens, CCT, and CRI), and energy-efficiency data for lamps.
 - 6. Photometric data and adjustment factors based on laboratory tests, complying with IESNA Lighting Measurements Testing & Calculation Guides, of each lighting

fixture type. The adjustment factors shall be for lamps, ballasts, and accessories identical to those indicated for the lighting fixture as applied in this Project.

- a. Testing Agency Certified Data: For indicated fixtures, photometric data shall be certified by a qualified independent testing agency. Photometric data for remaining fixtures shall be certified by manufacturer.
 - b. Manufacturer Certified Data: Photometric data shall be certified by a manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
- B. Shop Drawings: For nonstandard or custom lighting fixtures. Include plans, elevations, sections, details, and attachments to other work.
1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 2. Wiring Diagrams: For power, signal, and control wiring.
- C. Installation instructions.

1.4 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of ballast for bi-level and dimmer-controlled fixtures, from manufacturer.
- B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For lighting equipment and fixtures to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.
- B. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910, complying with the IESNA Lighting Measurements Testing & Calculation Guides.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. Comply with NFPA 70.

- E. FM Global Compliance: Lighting fixtures for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.

1.7 COORDINATION

- A. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including lighting controls, fire alarm, HVAC equipment, fire alarm system, and partition assemblies.

1.8 WARRANTY

- A. Special Warranty for Emergency Lighting Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.
 1. Warranty Period for Emergency Lighting Unit Batteries: 5 years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining four years.
 2. Warranty Period for Self-Powered Exit Sign Batteries: 5 years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining four years.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, product(s) indicated on Drawings.

2.2 GENERAL REQUIREMENTS FOR LIGHTING FIXTURES AND COMPONENTS

- A. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.
- B. Metal Parts: Free of burrs and sharp corners and edges.
- C. Sheet Metal Components: Steel unless otherwise indicated. Form and support to prevent warping and sagging.
- D. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.
- E. Diffusers and Globes:

1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
 - a. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.
 - b. UV stabilized.
 2. Glass: Annealed crystal glass unless otherwise indicated.
- F. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps and ballasts. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
1. Label shall include the following lamp and ballast characteristics:
 - a. "USE ONLY" and include specific lamp type.
 - b. Lamp diameter code (T-4, T-5, T-8, T-12, etc.), tube configuration (twin, quad, triple, etc.), base type, and nominal wattage for fluorescent and compact fluorescent luminaires.
 - c. Start type (preheat, rapid start, instant start, etc.) for fluorescent and compact fluorescent luminaires.
 - d. CCT and CRI for all luminaires.
- G. Electromagnetic-Interference Filters: Factory installed to suppress conducted electromagnetic interference as required by MIL-STD-461E. Fabricate lighting fixtures with one filter on each ballast indicated to require a filter.

2.3 LED LUMINAIRES

- A. Electrical
1. Operating voltage: 24 Vdc, 120 Vac at 60 Hz, 277 Vac at 60Hz, or universal voltage (120, 220/240, 277 Vac at 50/60 Hz)
 2. Power factor: ≥ 0.90 (at full luminaire output and across specified voltage range)
 3. Total harmonic distortion: $\leq 20\%$ (at full luminaire output and across specified voltage range)
 4. Surge protection:
 - a. Interior Luminaires: ANSI C62.41-2002 Category A surge protection standards up to and including 2.5 kV.
 - b. Exterior Luminaires: 10kV surge suppression protection tested in accordance with IEEE/ANSI C62.41.2.
 5. Sound: Class A not to exceed a measured value of 24dB
 6. Maximum standby power: 1W
- B. Warranty: 5 years on equipment
- C. Power Supply/Driver:
1. Driver efficiency (at full load):
 - a. $\geq 85\%$ for drivers capable of ≥ 50 watts
 - b. $\geq 80\%$ for drivers capable of < 50 watts
 2. Federal Communications Commission (FCC) compliance: FCC Part 15 Class A (Commercial) requirements for EMI/RFI emissions
- D. Accessibility for Maintenance

1. Power supplies/drivers/ballasts, LED arrays, boards or light engines shall be easily field replaceable using common hand tools (e.g. screwdrivers, pliers, etc.) and without uninstalling the luminaire
- E. Compliance Requirements
1. Luminaire shall be UL listed, or ETL listed to UL specifications.
- F. Chromaticity
1. Correlated Color Temperature (CCT): Provide as indicated on luminaire schedule.
 2. Acceptable tolerances as provided in ANSI C78.377-2011.
 3. Color rendering index (CRI): \geq Provide as indicated on luminaire schedule.
 4. Tested per LM-79-2008
- G. Lumen maintenance/Rated lamp life
1. $\geq 77.4\%$ of initial lumens @ 36,000 hours (this equates to a $\geq 70\%$ of initial lumens @ 50,000 hour target.)
 2. Determined by IES LM-80 data [parameters (drive current and steady-state temperature)]
- H. Optional Provisions
1. Emergency lighting
 2. Emergency battery pack available factory or field installed
- I. Dimming
1. Manufacturers shall provide listing of compatible dimmers that have been tested and approved for use with their products
 2. Dimming protocol
 - a. Analog 0-10v dimming
 - b. Continuous, flicker-free dimming from 100% to 10%

2.4 EXIT SIGNS

- A. General Requirements for Exit Signs: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.
- B. Internally Lighted Signs:
1. Lamps for AC Operation: LEDs, 50,000 hours minimum rated lamp life.
 2. Self-Powered Exit Signs (Battery Type): Integral automatic charger in a self-contained power pack.
 - a. Battery: Sealed, maintenance-free, nickel-cadmium type.
 - b. Charger: Fully automatic, solid-state type with sealed transfer relay.
 - c. Operation: Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.
 - d. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.
 - e. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.

- f. Remote Test: Switch in hand-held remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.
- g. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.
- 3. Master Sign/Remote Emergency Lighting Configurations:
 - a. Master Unit: Comply with requirements above for self-powered exit signs, and provide additional capacity in battery for power connection to remote unit.
 - b. Remote Unit: Comply with requirements above for self-powered exit signs, except omit power supply, battery, and test features. Arrange to receive full power requirements from master unit. Connect for testing concurrently with master unit as a unified system.

2.5 LIGHTING FIXTURE SUPPORT COMPONENTS

- A. Comply with Section 260529 "Hangers and Supports for Electrical Systems" for channel- and angle-iron supports and nonmetallic channel and angle supports.
- B. Single-Stem Hangers: 1/2-inch steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.
- C. Twin-Stem Hangers: Two, 1/2-inch steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.
- D. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage.
- E. Wires for Humid Spaces: ASTM A 580/A 580M, Composition 302 or 304, annealed stainless steel, 12 gage.
- F. Rod Hangers: 3/16-inch minimum diameter, cadmium-plated, threaded steel rod.
- G. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Lighting fixtures:
 - 1. Set level, plumb, and square with ceilings and walls unless otherwise indicated.
 - 2. Install lamps in each luminaire.
- B. Temporary Lighting: If it is necessary, and approved by Architect, to use permanent luminaires for temporary lighting, install and energize the minimum number of

luminaires necessary. When construction is sufficiently complete, remove the temporary luminaires, disassemble, clean thoroughly, install new lamps, and reinstall.

- C. Remote Mounting of Ballasts: Distance between the ballast and fixture shall not exceed that recommended by ballast manufacturer. Verify, with ballast manufacturers, maximum distance between ballast and luminaire.
- D. Lay-in Ceiling Lighting Fixtures Supports: Use grid as a support element.
 - 1. Install ceiling support system rods or wires, independent of the ceiling suspension devices, for each fixture. Locate not more than 6 inches from lighting fixture corners.
 - 2. Support Clips: Fasten to lighting fixtures and to ceiling grid members at or near each fixture corner with clips that are UL listed for the application.
 - 3. Fixtures of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two 3/4-inch metal channels spanning and secured to ceiling tees.
 - 4. Install at least one independent support rod or wire from structure to a tab on lighting fixture. Wire or rod shall have breaking strength of the weight of fixture at a safety factor of 3.
- E. Suspended Lighting Fixture Support:
 - 1. Pendants and Rods: Where longer than 48", brace to limit swinging.
 - 2. Stem-Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers.
 - 3. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end.
 - 4. Do not use grid as support for pendant luminaires. Connect support wires or rods to building structure.
- F. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.2 IDENTIFICATION

- A. Install labels with panel and circuit numbers on concealed junction and outlet boxes. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.3 FIELD QUALITY CONTROL

- A. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.
- B. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

END OF SECTION 265100

SECTION 265600
EXTERIOR LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Exterior luminaires with lamps and ballasts.
 - 2. Accessories.

- B. Related Sections:
 - 1. Section 265100 "Interior Lighting".

1.2 DEFINITIONS

- A. CCT: Correlated color temperature.
- B. CRI: Color-rendering index.
- C. LED: Light emitting diode.
- D. LER: Luminaire efficacy rating.
- E. Luminaire: Complete lighting fixture, including ballast housing if provided.

1.3 ACTION SUBMITTALS

- A. Product Data: For each luminaire and support component, arranged in order of lighting unit designation. Include data on features, accessories, finishes, and the following:
 - 1. Physical description of luminaire, including materials, dimensions, effective projected area, and verification of indicated parameters.
 - 2. Details of attaching luminaires and accessories.
 - 3. Details of installation and construction.
 - 4. Luminaire materials.
 - 5. Photometric data based on laboratory tests of each luminaire type, complete with indicated lamps, ballasts, and accessories.
 - a. Testing Agency Certified Data: For indicated luminaires, photometric data shall be certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.
 - b. Manufacturer Certified Data: Photometric data shall be certified by manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.
 - 6. Ballasts, including energy-efficiency data.
 - 7. Lamps, including life, output, CCT, CRI, lumens, and energy-efficiency data.
 - 8. Materials, dimensions, and finishes of poles.
 - 9. Means of attaching luminaires to supports, and indication that attachment is suitable for components involved.

- B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.
 - 1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
 - 2. Wiring Diagrams: For power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For luminaires to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

- A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.
- B. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by an independent agency, with the experience and capability to conduct the testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. Comply with IEEE C2, "National Electrical Safety Code."
- E. Comply with NFPA 70.

1.7 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace products that fail in materials or workmanship; that corrode; or that fade, stain, perforate, erode, or chalk due to effects of weather or solar radiation within specified warranty period. Manufacturer may exclude lightning damage, hail damage, vandalism, abuse, or unauthorized repairs or alterations from special warranty coverage.
 - 1. Warranty Period for Luminaires: Five years from date of Substantial Completion unless otherwise noted in the Luminaire Schedule.
 - 2. Warranty Period for Metal Corrosion: Five years from date of Substantial Completion unless otherwise noted in the Luminaire Schedule.
 - 3. Warranty Period for Color Retention: Five years from date of Substantial Completion unless otherwise noted in the Luminaire Schedule.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, products indicated on Drawings.

2.2 GENERAL REQUIREMENTS FOR LUMINAIRES

- A. Luminaires shall comply with UL 1598 and be listed and labeled for installation in wet locations by an NRTL acceptable to authorities having jurisdiction.
 - 1. LER Tests Incandescent Fixtures: Where LER is specified, test according to NEMA LE 5A.
 - 2. LER Tests Fluorescent Fixtures: Where LER is specified, test according to NEMA LE 5 and NEMA LE 5A as applicable.
- B. Lateral Light Distribution Patterns: Comply with IESNA RP-8 for parameters of lateral light distribution patterns indicated for luminaires.
- C. Metal Parts: Free of burrs and sharp corners and edges.
- D. Sheet Metal Components: Corrosion-resistant aluminum unless otherwise indicated. Form and support to prevent warping and sagging.
- E. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed luminaires.
- F. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses. Designed to disconnect ballast when door opens.
- G. Exposed Hardware Material: Stainless steel.
- H. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.
- I. Reflecting surfaces shall have minimum reflectance as follows unless otherwise indicated:
 - 1. White Surfaces: 85 percent.
 - 2. Specular Surfaces: 83 percent.
 - 3. Diffusing Specular Surfaces: 75 percent.
- J. Lenses and Refractors Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.
- K. Luminaire Finish: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping.

- L. Factory-Applied Finish for Steel Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or SSPC-SP 8, "Pickling."
 2. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.
 - a. Color: White.
- M. Factory-Applied Finish for Aluminum Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
 2. Natural Satin Finish: Provide fine, directional, medium satin polish (AA-M32); buff complying with AA-M20; and seal aluminum surfaces with clear, hard-coat wax.
 3. Class I, Clear Anodic Finish: AA-M32C22A41 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 611.
 4. Class I, Color Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker) complying with AAMA 611.
 - a. Color: White.
- N. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps and ballasts. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.
1. Label shall include the following lamp and ballast characteristics:
 - a. "USES ONLY" and include specific lamp type.
 - b. Lamp diameter code (T-4, T-5, T-8, T-12), tube configuration (twin, quad, triple), base type, and nominal wattage for fluorescent and compact fluorescent luminaires.
 - c. Lamp type, wattage, bulb type (ED17, BD56, etc.) and coating (clear or coated) for HID luminaires.
 - d. Start type (preheat, rapid start, instant start) for fluorescent and compact fluorescent luminaires.
 - e. ANSI ballast type (M98, M57, etc.) for HID luminaires.
 - f. CCT and CRI for all luminaires.

2.3 GENERAL REQUIREMENTS FOR POLES AND SUPPORT COMPONENTS

- A. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts unless otherwise indicated.
- B. Mountings, Fasteners, and Appurtenances: Corrosion-resistant items compatible with support components.

1. Materials: Shall not cause galvanic action at contact points.
2. Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication unless otherwise indicated.
3. Anchor-Bolt Template: Plywood or steel.

PART 3 - EXECUTION

3.1 LUMINAIRE INSTALLATION

- A. Fasten luminaire to indicated structural supports.
 1. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.
- B. Adjust luminaires that require field adjustment or aiming.

3.2 CORROSION PREVENTION

- A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.
- B. Steel Conduits: Comply with Section 260533 "Raceways and Boxes for Electrical Systems." In concrete foundations, wrap conduit with 10 mil. thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

3.3 GROUNDING

- A. Ground metal poles and support structures according to Section 260526 "Grounding and Bonding for Electrical Systems."
 1. Install grounding electrode for each pole unless otherwise indicated.
 2. Install grounding conductor pigtail in the base for connecting luminaire to grounding system.
- B. Ground nonmetallic poles and support structures according to Section 260526 "Grounding and Bonding for Electrical Systems."
 1. Install grounding electrode for each pole.
 2. Install grounding conductor and conductor protector.
 3. Ground metallic components of pole accessories and foundations.

3.4 FIELD QUALITY CONTROL

- A. Inspect each installed fixture for damage. Replace damaged fixtures and components.
- B. Illumination Observations: Verify normal operation of lighting units after installing luminaires and energizing circuits with normal power source.
 1. Verify operation of photoelectric controls.
- C. Illumination Tests:

1. Measure light intensities at night. Use photometers with calibration referenced to NIST standards. Comply with the following IESNA testing guide(s):
 - a. IESNA LM-5, "Photometric Measurements of Area and Sports Lighting Installations."
 - b. IESNA LM-50, "Photometric Measurements of Roadway Lighting Installations."
 - c. IESNA LM-52, "Photometric Measurements of Roadway Sign Installations."
 - d. IESNA LM-64, "Photometric Measurements of Parking Areas."
 - e. IESNA LM-72, "Directional Positioning of Photometric Data."

- D. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

END OF SECTION 265600

SECTION 271500
COMMUNICATIONS HORIZONTAL CABLING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. UTP cabling.
 - 2. 62.5/125-micrometer, optical fiber cabling.
 - 3. Coaxial cable.
 - 4. Cable connecting hardware, patch panels, and cross-connects.
 - 5. Telecommunications outlet/connectors.
 - 6. Cabling system identification products.
 - 7. Cable management system.

1.2 DEFINITIONS

- A. BICSI: Building Industry Consulting Service International.
- B. Consolidation Point: A location for interconnection between horizontal cables extending from building pathways and horizontal cables extending into furniture pathways.
- C. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.
- D. EMI: Electromagnetic interference.
- E. IDC: Insulation displacement connector.
- F. LAN: Local area network.
- G. MUTOA: Multiuser telecommunications outlet assembly, a grouping in one location of several telecommunications outlet/connectors.
- H. Outlet/Connectors: A connecting device in the work area on which horizontal cable or outlet cable terminates.
- I. RCDD: Registered Communications Distribution Designer.
- J. UTP: Unshielded twisted pair.

1.3 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate layout and installation of telecommunications cabling with Owner's telecommunications and LAN equipment and service suppliers.

- B. Coordinate telecommunications outlet/connector locations with location of power receptacles at each work area.

1.4 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings:
 - 1. Cabling administration drawings and printouts.
 - 2. Wiring diagrams to show typical wiring schematics, including the following:
 - a. Cross-connects.
 - b. Patch panels.
 - c. Patch cords.
 - 3. Cross-connects and patch panels. Detail mounting assemblies, and show elevations and physical relationship between the installed components.

1.5 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Test cables upon receipt at Project site.
 - 1. Test optical fiber cables to determine the continuity of the strand end to end. Use optical fiber flashlight.
 - 2. Test optical fiber cables while on reels. Use an optical time domain reflectometer to verify the cable length and locate cable defects, splices, and connector; including the loss value of each. Retain test data and include the record in maintenance data.
 - 3. Test each pair of UTP cable for open and short circuits.

PART 2 - PRODUCTS

2.1 HORIZONTAL CABLING DESCRIPTION

- A. Horizontal cable and its connecting hardware provide the means of transporting signals between the telecommunications outlet/connector and the horizontal cross-connect located in the communications equipment room. This cabling and its connecting hardware are called a "permanent link," a term that is used in the testing protocols.
 - 1. TIA/EIA-568-B.1 requires that a minimum of two telecommunications outlet/connectors be installed for each work area.

2. Horizontal cabling shall contain no more than one transition point or consolidation point between the horizontal cross-connect and the telecommunications outlet/connector.
 3. Bridged taps and splices shall not be installed in the horizontal cabling.
 4. Splitters shall not be installed as part of the optical fiber cabling.
- B. A work area is approximately 100 sq. ft., and includes the components that extend from the telecommunications outlet/connectors to the station equipment.
- C. The maximum allowable horizontal cable length is 295 feet. This maximum allowable length does not include an allowance for the length of 16 feet to the workstation equipment or in the horizontal cross-connect.

2.2 PERFORMANCE REQUIREMENTS

- A. General Performance: Horizontal cabling system shall comply with transmission standards in TIA/EIA-568-B.1 when tested according to test procedures of this standard.
- B. Surface-Burning Characteristics: Comply with ASTM E 84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.
1. Flame-Spread Index: 25 or less.
 2. Smoke-Developed Index: 50 or less.
- C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- D. Grounding: Comply with J-STD-607-A.

2.3 UTP CABLE

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
1. 3M.
 2. Belden CDT Networking Division/NORDX.
 3. CommScope, Inc.
 4. General Cable; General Cable Corporation.
 5. Optical Cable Corporation.
 6. Superior Essex Inc.
- B. Description: 100-ohm, four-pair UTP, formed into 25-pair, binder groups covered with a blue thermoplastic jacket.
1. Comply with ICEA S-90-661 for mechanical properties.
 2. Comply with TIA/EIA-568-B.1 for performance specifications.
 3. Comply with TIA/EIA-568-B.2, Category 6.

4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:
 - a. Communications, General Purpose: Type CM or CMG.
 - b. Communications, Plenum Rated: Type CMP, complying with NFPA 262.
 - c. Communications, Riser Rated: Type CMR, complying with UL 1666.
 - d. Communications, Limited Purpose: Type CMX.
 - e. Multipurpose: Type MP or MPG.
 - f. Multipurpose, Plenum Rated: Type MPP, complying with NFPA 262.
 - g. Multipurpose, Riser Rated: Type MPR, complying with UL 1666.

2.4 UTP CABLE HARDWARE

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 1. American Technology Systems Industries, Inc.
 2. Belden CDT Networking Division/NORDX.
 3. Hubbell Premise Wiring.
 4. Leviton Manufacturing Co., Inc.
 5. Optical Cable Corporation.
 6. Panduit Corp.
- B. General Requirements for Cable Connecting Hardware: Comply with TIA/EIA-568-B.2, IDC type, with modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of same category or higher.
- C. Connecting Blocks: 110-style IDC for Category 6. Provide blocks for the number of cables terminated on the block, plus 10 percent spare. Integral with connector bodies, including plugs and jacks where indicated.
- D. Jacks and Jack Assemblies: Modular, color-coded, eight-position modular receptacle units with integral IDC-type terminals.
- E. Patch Cords: Factory-made, four-pair cables in 36-inch lengths; terminated with eight-position modular plug at each end.
 1. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure Category 6 performance. Patch cords shall have latch guards to protect against snagging.

2.5 COAXIAL CABLE

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
 1. Alpha Wire.

2. Belden CDT Networking Division/NORDX.
 3. CommScope, Inc.
- B. Cable Characteristics: Broadband type, recommended by cable manufacturer specifically for broadband data transmission applications. Coaxial cable and accessories shall have 75-ohm nominal impedance with a return loss of 20 dB maximum from 7 to 806 MHz.
- C. RG-6/U: NFPA 70, Type CATV or CM.
1. No. 16 AWG, solid, copper-covered steel conductor; gas-injected, foam-PE insulation.
 2. Double shielded with 100 percent aluminum-foil shield and 60 percent aluminum braid.
 3. Jacketed with black PVC or PE.
 4. Suitable for indoor installations.
- D. RG59/U (Plenum Rated): NFPA 70, Type CMP.
1. No. 20 AWG, solid, copper-covered steel conductor; foam fluorinated ethylene propylene insulation.
 2. Double shielded with 100 percent aluminum-foil shield and 65 percent aluminum braid.
 3. Copolymer jacket.
- E. NFPA and UL compliance, listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 1655 and with NFPA 70 "Radio and Television Equipment" and "Community Antenna Television and Radio Distribution" Articles. Types are as follows:
1. CATV Cable: Type CATV.
 2. CATV Plenum Rated: Type CATVP, complying with NFPA 262.
 3. CATV Riser Rated: Type CATVR, complying with UL 1666.
 4. CATV Limited Rating: Type CATVX.

2.6 COAXIAL CABLE HARDWARE

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
1. Emerson Network Power Connectivity Solutions.
 2. Leviton Manufacturing Co., Inc.
 3. Siemon Co. (The).
- B. Coaxial-Cable Connectors: Type BNC, 75 ohms.

2.7 TELECOMMUNICATIONS OUTLET/CONNECTORS

- A. Jacks: 100-ohm, balanced, twisted-pair connector; four-pair, eight-position modular. Comply with TIA/EIA-568-B.1.

- B. Workstation Outlets: Two-port-connector assemblies mounted in single faceplate.
 - 1. Plastic Faceplate: High-impact plastic. Coordinate color with Section 262726 "Wiring Devices."
 - 2. For use with snap-in jacks accommodating any combination of UTP, optical fiber, and coaxial work area cords.
 - a. Flush mounting jacks, positioning the cord at a 45-degree angle.
 - 3. Legend: Machine printed, in the field, using adhesive-tape label.

2.8 GROUNDING

- A. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems" for grounding conductors and connectors.
- B. Comply with J-STD-607-A.

2.9 IDENTIFICATION PRODUCTS

- A. Comply with TIA/EIA-606-A and UL 969 for labeling materials, including label stocks, laminating adhesives, and inks used by label printers.
- B. Comply with requirements in Section 260553 "Identification for Electrical Systems."

2.10 SOURCE QUALITY CONTROL

- A. Factory test UTP and optical fiber cables on reels according to TIA/EIA-568-B.1.
- B. Factory test UTP cables according to TIA/EIA-568-B.2.
- C. Factory-sweep test coaxial cables at frequencies from 5 MHz to 1 GHz. Sweep test shall test the frequency response, or attenuation over frequency, of a cable by generating a voltage whose frequency is varied through the specified frequency range and graphing the results.
- D. Cable will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 ENTRANCE FACILITIES

- A. Coordinate backbone cabling with the protectors and demarcation point provided by communications service provider.

3.2 WIRING METHODS

- A. Install cables in pathways and cable trays except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces and in gypsum board partitions where unenclosed wiring method may be used. Conceal pathways and cables except in unfinished spaces.
 - 1. Install plenum cable in environmental air spaces, including plenum ceilings.
- B. Conceal conductors and cables in accessible ceilings, walls, and floors where possible.
- C. Wiring within Enclosures:
 - 1. Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii.
 - 2. Install lacing bars and distribution spools.
 - 3. Install conductors parallel with or at right angles to sides and back of enclosure.

3.3 INSTALLATION OF CABLES

- A. Comply with NECA 1.
- B. General Requirements for Cabling:
 - 1. Comply with TIA/EIA-568-B.1.
 - 2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
 - 3. Install 110-style IDC termination hardware unless otherwise indicated.
 - 4. Consolidation points may be used only for making a direct connection to telecommunications outlet/connectors:
 - a. Do not use consolidation point as a cross-connect point, as a patch connection, or for direct connection to workstation equipment.
 - b. Locate consolidation points for UTP at least 49 feet from communications equipment room.
 - 5. Terminate conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
 - 6. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
 - 7. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
 - 8. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Install lacing bars and distribution spools.
 - 9. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.

10. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
11. In the communications equipment room, install a 10-foot-long service loop on each end of cable.
12. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.

C. UTP Cable Installation:

1. Comply with TIA/EIA-568-B.2.
2. Do not untwist UTP cables more than 1/2 inch from the point of termination to maintain cable geometry.

D. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend UTP cable not in a wireway or pathway a minimum of 8 inches above ceilings by cable supports not more than 60 inches apart.
3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

E. Separation from EMI Sources:

1. Comply with BICSI TDMM and TIA-569-B for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:
 - a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.
 - b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
 - c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.
3. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.

3.4 FIRESTOPPING

- A. Comply with requirements in Section 078413 "Penetration Firestopping."
- B. Comply with TIA-569-B, Annex A, "Firestopping."
- C. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.5 GROUNDING

- A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

- B. Comply with J-STD-607-A.
- C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.
- D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

3.6 IDENTIFICATION

- A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- B. Cable Schedule: Post in prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.
- C. Cable and Wire Identification:
 - 1. Label each cable within 4 inches of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
 - 2. Each wire connected to building-mounted devices is not required to be numbered at device if color of wire is consistent with associated wire connected and numbered within panel or cabinet.
 - 3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding.
 - 4. Label each terminal strip and screw terminal in each cabinet, rack, or panel.
 - a. Individually number wiring conductors connected to terminal strips, and identify each cable or wiring group being extended from a panel or cabinet to a building-mounted device shall be identified with name and number of particular device as shown.
 - b. Label each unit and field within distribution racks and frames.
 - 5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.
 - 6. Uniquely identify and label work area cables extending from the MUTOA to the work area. These cables may not exceed the length stated on the MUTOA label.
- D. Labels shall be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA/EIA-606-A.
 - 1. Cables use flexible vinyl or polyester that flex as cables are bent.

3.7 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections:
1. Visually inspect UTP and optical fiber cable jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA/EIA-568-B.1.
 2. Visually confirm Category 6, marking of outlets, cover plates, outlet/connectors, and patch panels.
 3. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
 4. UTP Performance Tests:
 - a. Test for each outlet and MUTOA. Perform the following tests according to TIA/EIA-568-B.1 and TIA/EIA-568-B.2:
 - 1) Wire map.
 - 2) Length (physical vs. electrical, and length requirements).
 - 3) Insertion loss.
 - 4) Near-end crosstalk (NEXT) loss.
 - 5) Power sum near-end crosstalk (PSNEXT) loss.
 - 6) Equal-level far-end crosstalk (ELFEXT).
 - 7) Power sum equal-level far-end crosstalk (PSELFEXT).
 - 8) Return loss.
 - 9) Propagation delay.
 - 10) Delay skew.
 5. Final Verification Tests: Perform verification tests for UTP systems after the complete communications cabling and workstation outlet/connectors are installed.
 - a. Voice Tests: These tests assume that dial tone service has been installed. Connect to the network interface device at the demarcation point. Go off-hook and listen and receive a dial tone. If a test number is available, make and receive a local, long distance, and digital subscription line telephone call.
 - b. Data Tests: These tests assume the Information Technology Staff has a network installed and is available to assist with testing. Connect to the network interface device at the demarcation point. Log onto the network to ensure proper connection to the network.
- B. Document data for each measurement. Data for submittals shall be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.
- C. End-to-end cabling will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.

END OF SECTION 271500

SECTION 283111
DIGITAL, ADDRESSABLE FIRE-ALARM SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fire-alarm control unit.
2. Manual fire-alarm boxes.
3. System smoke detectors.
4. Heat detectors.
5. Notification appliances.
6. Remote annunciator.
7. Addressable interface device.
8. Digital alarm communicator transmitter.
9. Radio alarm transmitter.

B. Related Requirements:

1. Section 260533 "Raceways and Boxes for Electrical Systems".

1.2 DEFINITIONS

A. EMT: Electrical Metallic Tubing.

B. FACP: Fire Alarm Control Panel.

C. HLI: High Level Interface.

D. NICET: National Institute for Certification in Engineering Technologies.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product, including furnished options and accessories.

1. Include construction details, material descriptions, dimensions, profiles, and finishes.
2. Include rated capacities, operating characteristics, and electrical characteristics.

B. Shop Drawings: For fire-alarm system.

1. Comply with recommendations and requirements in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
2. Include plans, elevations, sections, details, and attachments to other work.
3. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and locations. Indicate

conductor sizes, indicate termination locations and requirements, and distinguish between factory and field wiring.

4. Detail assembly and support requirements.
5. Include voltage drop calculations for notification-appliance circuits.
6. Include battery-size calculations.
7. Include input/output matrix.
8. Include statement from manufacturer that all equipment and components have been tested as a system and meet all requirements in this Specification and in NFPA 72.
9. Include performance parameters and installation details for each detector.
10. Include voice/alarm signaling-service equipment rack or console layout, grounding schematic, amplifier power calculation, and single-line connection diagram.
11. Include floor plans to indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits and point-to-point wiring diagrams.

C. General Submittal Requirements:

1. Submittals shall be approved by authorities having jurisdiction prior to submitting them to Engineer.
2. Shop Drawings shall be prepared by persons with the following qualifications:
 - a. Trained and certified by manufacturer in fire-alarm system design.
 - b. NICET-certified, fire-alarm technician; Level IV minimum.
 - c. Licensed or certified by authorities having jurisdiction.

D. Delegated-Design Submittal: For notification appliances and smoke and heat detectors, in addition to submittals listed above, indicate compliance with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Drawings showing the location of each notification appliance and smoke and heat detector, ratings of each, and installation details as needed to comply with listing conditions of the device.
2. Design Calculations: Calculate requirements for selecting the spacing and sensitivity of detection, complying with NFPA 72. Calculate spacing and intensities for strobe signals and sound-pressure levels for audible appliances.
3. Indicate audible appliances required to produce square wave signal per NFPA 72.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer.
- B. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: Furnish 3 copies of an Operations and Maintenance Manual including product submittal information, equipment identification with serial numbers of each component, wiring diagrams, control diagrams, startup and operating procedures and instructions, emergency manuals, emergency procedures and instructions,

inspection procedures, maintenance schedule, maintenance procedures and documentation, shutdown instructions, license requirements including inspection and renewal dates, performance curves, engineering data and tests, list of tools and replacement items recommended to be stored at Project for ready access, training plan, maintenance service contracts, and warranties and bonds.

1. Include the following and deliver copies to authorities having jurisdiction:
 - a. Comply with the "Records" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
 - b. Provide "Fire Alarm and Emergency Communications System Record of Completion Documents" according to the "Completion Documents" Article in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
 - c. Complete wiring diagrams showing connections between all devices and equipment. Each conductor shall be numbered at every junction point with indication of origination and termination points.
 - d. Riser diagram.
 - e. Device addresses.
 - f. Record copy of site-specific software.
 - g. Provide "Inspection and Testing Form" according to the "Inspection, Testing and Maintenance" chapter in NFPA 72, and include the following:
 - 1) Equipment tested.
 - 2) Frequency of testing of installed components.
 - 3) Frequency of inspection of installed components.
 - 4) Requirements and recommendations related to results of maintenance.
 - 5) Manufacturer's user training manuals.
 - h. Manufacturer's required maintenance related to system warranty requirements.
 - i. Abbreviated operating instructions for mounting at fire-alarm control unit and each annunciator unit.

B. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.
2. Program Software Backup: On magnetic media or compact disk, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.

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. Lamps for Remote Indicating Lamp Units: Quantity equal to 10 percent of amount installed, but no fewer than one unit.
2. Lamps for Strobe Units: Quantity equal to 10 percent of amount installed, but no fewer than one unit.
3. Smoke Detectors, Fire Detectors: Quantity equal to 10 percent of amount of each type installed, but no fewer than one unit of each type.

4. Detector Bases: Quantity equal to two percent of amount of each type installed, but no fewer than one unit of each type.
5. Keys and Tools: One extra set for access to locked or tamperproofed components.
6. Audible and Visual Notification Appliances: One of each type installed.
7. Fuses: Two of each type installed in the system. Provide in a box or cabinet with compartments marked with fuse types and sizes.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project.
- B. Installer Qualifications: Installation shall be by personnel certified by NICET as fire-alarm Level III technician.
- C. NFPA Certification: Obtain certification according to NFPA 72 by an NRTL (nationally recognized testing laboratory).

1.8 PROJECT CONDITIONS

- A. Perform a full test of the existing system prior to starting work. Document any equipment or components not functioning as designed.
- B. Use of Devices during Construction: Protect devices during construction unless devices are placed in service to protect the facility during construction.

1.9 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace fire-alarm system equipment and components that fail in materials or workmanship within specified warranty period.
 1. Warranty Extent: All equipment and components not covered in the Maintenance Service Agreement.
 2. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

- A. Source Limitations for Fire-Alarm System and Components: Components shall be compatible with, and operate as an extension of, existing system. Provide system manufacturer's certification that all components provided have been tested as, and will operate as, a system.
- B. Noncoded, UL-certified FM Global-placarded addressable system, with multiplexed signal transmission and horn/strobe evacuation.

- C. Automatic sensitivity control of certain smoke detectors.
- D. All components provided shall be listed for use with the selected system.
- E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2.2 SYSTEMS OPERATIONAL DESCRIPTION

- A. Fire-alarm signal initiation shall be by one or more of the following devices:
 - 1. Manual stations.
 - 2. Heat detectors.
 - 3. Smoke detectors.
- B. Fire-alarm signal shall initiate the following actions:
 - 1. Continuously operate alarm notification appliances.
 - 2. Identify alarm and specific initiating device at fire-alarm control unit and remote annunciators.
 - 3. Transmit an alarm signal to the remote alarm receiving station.
 - 4. Record events in the system memory.
- C. Supervisory signal initiation shall be by one or more of the following devices and actions:
 - 1. User disabling of zones or individual devices.
- D. System trouble signal initiation shall be by one or more of the following devices and actions:
 - 1. Open circuits, shorts, and grounds in designated circuits.
 - 2. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
 - 3. Loss of communication with any addressable sensor, input module, relay, control module, remote annunciator, printer interface, or Ethernet module.
 - 4. Loss of primary power at fire-alarm control unit.
 - 5. Ground or a single break in internal circuits of fire-alarm control unit.
 - 6. Abnormal ac voltage at fire-alarm control unit.
 - 7. Break in standby battery circuitry.
 - 8. Failure of battery charging.
 - 9. Abnormal position of any switch at fire-alarm control unit or annunciator.
- E. System Supervisory Signal Actions:
 - 1. Initiate notification appliances.
 - 2. Identify specific device initiating the event at fire-alarm control unit and remote annunciators.

3. After a time delay of 200 seconds, transmit a trouble or supervisory signal to the remote alarm receiving station.
4. Transmit system status to building management system.

2.3 PERFORMANCE REQUIREMENTS

- A. Seismic Performance: Fire-alarm control unit and raceways shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.
1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

2.4 FIRE-ALARM CONTROL UNIT

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
1. GE UTC Fire & Security; A United Technologies Company.
 2. Notifier.
 3. Siemens Industry, Inc.; Fire Safety Division.
 4. SimplexGrinnell LP.
- B. General Requirements for Fire-Alarm Control Unit:
1. Field-programmable, microprocessor-based, modular, power-limited design with electronic modules, complying with UL 864.
 - a. System software and programs shall be held in nonvolatile flash, electrically erasable, programmable, read-only memory, retaining the information through failure of primary and secondary power supplies.
 - b. Include a real-time clock for time annotation of events on the event recorder and printer.
 - c. Provide communication between the FACP and remote circuit interface panels, annunciators, and displays.
 - d. The FACP shall be listed for connection to a central-station signaling system service.
 - e. Provide nonvolatile memory for system database, logic, and operating system and event history. The system shall require no manual input to initialize in the event of a complete power down condition. The FACP shall provide a minimum 500-event history log.
 2. Addressable Initiation Device Circuits: The FACP shall indicate which communication zones have been silenced and shall provide selective silencing of alarm notification appliance by building communication zone.
 3. Addressable Control Circuits for Operation of Notification Appliances and Mechanical Equipment: The FACP shall be listed for releasing service.

- C. Alphanumeric Display and System Controls: Arranged for interface between human operator at fire-alarm control unit and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.
 - 1. Annunciator and Display: Liquid-crystal type, 80 characters, minimum.
 - 2. Keypad: Arranged to permit entry and execution of programming, display, and control commands.

- D. Initiating-Device, Notification-Appliance, and Signaling-Line Circuits:
 - 1. Pathway Class Designations: NFPA 72, Class A.
 - 2. Pathway Survivability: Level 0.
 - 3. Install no more than 100 addressable devices on each signaling-line circuit.
 - 4. Serial Interfaces:
 - a. One dedicated RS 485 port for central-station operation using point ID DACT.
 - b. One RS 485 port for remote annunciators, Ethernet module, or multi-interface module (printer port).
 - c. One RS 232 port for PC configuration.

- E. Smoke-Alarm Verification:
 - 1. Initiate audible and visible indication of an "alarm-verification" signal at fire-alarm control unit.
 - 2. Activate an approved "alarm-verification" sequence at fire-alarm control unit and detector.
 - 3. Sound general alarm if the alarm is verified.
 - 4. Cancel fire-alarm control unit indication and system reset if the alarm is not verified.

- F. Notification-Appliance Circuit:
 - 1. Audible appliances shall sound in a three-pulse temporal pattern, as defined in NFPA 72.
 - 2. Visual alarm appliances shall flash in synchronization where multiple appliances are in the same field of view, as defined in NFPA 72.

- G. Remote Smoke-Detector Sensitivity Adjustment: Controls shall select specific addressable smoke detectors for adjustment, display their current status and sensitivity settings, and change those settings. Allow controls to be used to program repetitive, time-scheduled, and automated changes in sensitivity of specific detector groups. Record sensitivity adjustments and sensitivity-adjustment schedule changes in system memory, and print out the final adjusted values on system printer.

- H. Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, supervisory, and trouble signals to a remote alarm station.

- I. Primary Power: 24-V dc obtained from 120-V ac service and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble signals, supervisory

and digital alarm communicator transmitters and digital alarm radio transmitters shall be powered by 24-V dc source.

1. Alarm current draw of entire fire-alarm system shall not exceed 80 percent of the power-supply module rating.
- J. Secondary Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch.
1. Batteries: Sealed, valve-regulated, recombinant lead acid.
- K. Instructions: Computer printout or typewritten instruction card mounted behind a plastic or glass cover in a stainless-steel or aluminum frame. Include interpretation and describe appropriate response for displays and signals. Briefly describe the functional operation of the system under normal, alarm, and trouble conditions.

2.5 MANUAL FIRE-ALARM BOXES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
1. GE UTC Fire & Security; A United Technologies Company.
 2. Notifier.
 3. Siemens Industry, Inc.; Fire Safety Division.
 4. SimplexGrinnell LP.
- B. General Requirements for Manual Fire-Alarm Boxes: Comply with UL 38. Boxes shall be finished in red with molded, raised-letter operating instructions in contrasting color; shall show visible indication of operation; and shall be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer's surface back box.
1. Single-action mechanism, pull-lever type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control unit.
 2. Double-action mechanism requiring two actions to initiate an alarm, pull-lever type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control unit.
 3. Station Reset: Key- or wrench-operated switch.

2.6 SYSTEM SMOKE DETECTORS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
1. GE UTC Fire & Security; A United Technologies Company.
 2. Notifier.
 3. Siemens Industry, Inc.; Fire Safety Division.

4. SimplexGrinnell LP.

B. General Requirements for System Smoke Detectors:

1. Comply with UL 268; operating at 24-V dc, nominal.
2. Detectors shall be two-wire type.
3. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.
4. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
5. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
6. Integral Visual-Indicating Light: LED type, indicating detector has operated and power-on status.
7. Remote Control: Unless otherwise indicated, detectors shall be digital-addressable type, individually monitored at fire-alarm control unit for calibration, sensitivity, and alarm condition and individually adjustable for sensitivity by fire-alarm control unit.

C. Photoelectric Smoke Detectors:

1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:
 - a. Primary status.
 - b. Device type.
 - c. Present average value.
 - d. Present sensitivity selected.
 - e. Sensor range (normal, dirty, etc.).

2.7 HEAT DETECTORS

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

1. GE UTC Fire & Security; A United Technologies Company.
2. Notifier.
3. Siemens Industry, Inc.; Fire Safety Division.
4. SimplexGrinnell LP.

B. General Requirements for Heat Detectors: Comply with UL 521.

1. Temperature sensors shall test for and communicate the sensitivity range of the device.

C. Heat Detector, Combination Type: Actuated by either a fixed temperature of 135 deg For a rate of rise that exceeds 15 deg Fper minute unless otherwise indicated.

1. Mounting: Twist-lock base interchangeable with smoke-detector bases.
 2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.
- D. Heat Detector, Fixed-Temperature Type: Actuated by temperature that exceeds a fixed temperature of 190 deg F.
1. Mounting: Twist-lock base interchangeable with smoke-detector bases.
 2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.

2.8 NOTIFICATION APPLIANCES

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
1. GE UTC Fire & Security; A United Technologies Company.
 2. Siemens Industry, Inc.; Fire Safety Division.
 3. SimplexGrinnell LP.
 4. System Sensor.
 5. Wheelock; a brand of Eaton.
- B. General Requirements for Notification Appliances: Connected to notification-appliance signal circuits, zoned as indicated, equipped for mounting as indicated, and with screw terminals for system connections.
1. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly, equipped for mounting as indicated, and with screw terminals for system connections.
- C. Horns: Electric-vibrating-polarized type, 24-V dc; with provision for housing the operating mechanism behind a grille. Comply with UL 464. Horns shall produce a sound-pressure level of 90 dBA, measured 10 feet from the horn, using the coded signal prescribed in UL 464 test protocol.
- D. Visible Notification Appliances: Xenon strobe lights complying with UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch- high letters on the lens.
1. Rated Light Output:
 - a. 15, 30, 75, 110 cd as required and determined by approved fire alarm manufacturer.
 - b. 15/30/75/110 cd, selectable in the field.
 2. Mounting: Wall mounted unless otherwise indicated.
 3. Flashing shall be in a temporal pattern, synchronized with other units.
 4. Strobe Leads: Factory connected to screw terminals.
 5. Mounting Faceplate: Factory finished, red.

2.9 REMOTE ANNUNCIATOR

- A. Description: Annunciator functions shall match those of fire-alarm control unit for alarm, supervisory, and trouble indications. Manual switching functions shall match those of fire-alarm control unit, including acknowledging, silencing, resetting, and testing.
 - 1. Mounting: Flush or Surface cabinet, NEMA 250, Type 1.
- B. Display Type and Functional Performance: Alphanumeric display and LED indicating lights shall match those of fire-alarm control unit. Provide controls to acknowledge, silence, reset, and test functions for alarm, supervisory, and trouble signals.

2.10 ADDRESSABLE INTERFACE DEVICE

- A. General:
 - 1. Include address-setting means on the module.
 - 2. Store an internal identifying code for control panel use to identify the module type.
 - 3. Listed for controlling HVAC fan motor controllers.
- B. Monitor Module: Microelectronic module providing a system address for alarm-initiating devices for wired applications with normally open contacts.
- C. Integral Relay: Capable of providing a direct signal to elevator controller to initiate elevator recall.
 - 1. Allow the control panel to switch the relay contacts on command.
 - 2. Have a minimum of two normally open and two normally closed contacts available for field wiring.
- D. Control Module:
 - 1. Operate notification devices.
 - 2. Operate solenoids for use in sprinkler service.

2.11 DIGITAL ALARM COMMUNICATOR TRANSMITTER

- A. Digital alarm communicator transmitter shall be acceptable to the remote central station and shall comply with UL 632.
- B. Functional Performance: Unit shall receive an alarm, supervisory, or trouble signal from fire-alarm control unit and automatically capture one telephone line and dial a preset number for a remote central station. When contact is made with central station(s), signals shall be transmitted. If service on either line is interrupted for longer than 45 seconds, transmitter shall initiate a local trouble signal and transmit the signal indicating loss of telephone line to the remote alarm receiving station over the remaining line. Transmitter shall automatically report telephone service restoration to the central station. If service is lost on both telephone lines, transmitter shall initiate the local trouble signal.

- C. Local functions and display at the digital alarm communicator transmitter shall include the following:
 - 1. Verification that both telephone lines are available.
 - 2. Programming device.
 - 3. LED display.
 - 4. Manual test report function and manual transmission clear indication.
 - 5. Communications failure with the central station or fire-alarm control unit.

- D. Digital data transmission shall include the following:
 - 1. Address of the alarm-initiating device.
 - 2. Address of the supervisory signal.
 - 3. Address of the trouble-initiating device.
 - 4. Loss of ac supply.
 - 5. Loss of power.
 - 6. Low battery.
 - 7. Abnormal test signal.
 - 8. Communication bus failure.

- E. Secondary Power: Integral rechargeable battery and automatic charger.

- F. Self-Test: Conducted automatically every 24 hours with report transmitted to central station.

2.12 RADIO ALARM TRANSMITTER

- A. Transmitter shall comply with NFPA 1221 and 47 CFR 90. Coordinate exact requirements with the Fire Department.

- B. Description: Manufacturer's standard commercial product; factory assembled, wired, and tested; ready for installation and operation.
 - 1. Packaging: A single, modular, NEMA 250, Type 1 metal enclosure with a tamper-resistant flush tumbler lock.
 - 2. Signal Transmission Mode and Frequency: VHF or UHF 2-W power output, coordinated with operating characteristics of the established remote alarm receiving station designated by Owner.
 - 3. Normal Power Input: 120-V ac.
 - 4. Secondary Power: Integral-sealed, rechargeable, 12-V battery and charger. Comply with NFPA 72 requirements for battery capacity; submit calculations.
 - 5. Antenna: Omnidirectional, coaxial half-wave, dipole type with driving point impedance matched to transmitter and antenna cable output impedance. Wind-load strength of antenna and mounting hardware and supports shall withstand 100 mph with a gust factor of 1.3 without failure.
 - 6. Antenna Cable: Coaxial cable with impedance matched to the transmitter output impedance.
 - 7. Antenna-Cable Connectors: Weatherproof.
 - 8. Alarm Interface Devices: Circuit boards, modules, and other auxiliary devices, integral to the transmitter, matching fire-alarm and other system outputs to

message-generating inputs of the transmitter that produce required message transmissions.

- C. Functional Performance: Unit shall receive alarm, supervisory, or trouble signal from fire-alarm control unit or from its own internal sensors or controls and shall automatically transmit signal along with a unique code that identifies the transmitting station to the remote alarm receiving station. Transmitted messages shall correspond to standard designations for fire-reporting system to which the signal is being transmitted and shall include separately designated messages in response to the following events or conditions:
 - 1. Transmitter Low-Battery Condition: Sent when battery voltage is below 85 percent of rated value.
 - 2. System Test Message: Initiated manually by a test switch within the transmitter cabinet, or automatically at an optionally preselected time, once every 24 hours, with transmission time controlled by a programmed timing device integral to transmitter controls.
 - 3. Transmitter Trouble Message: Actuated by failure, in excess of one-minute duration, of the transmitter normal power source, derangement of the wiring of the transmitter, or any alarm input interface circuit or device connected to it.
 - 4. Local Fire-Alarm-System Trouble Message: Initiated by events or conditions that cause a trouble signal to be indicated on the building system.
 - 5. Local Fire-Alarm-System Alarm Message: Actuated when the building system goes into an alarm state. Identifies device that initiated the alarm.
 - 6. Local Fire-Alarm-System, Supervisory-Alarm Message: Actuated when the building alarm system indicates a supervisory alarm.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions for compliance with requirements for ventilation, temperature, humidity, and other conditions affecting performance of the Work.
 - 1. Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment and wiring are installed, before installation begins.
- B. Examine roughing-in for electrical connections to verify actual locations of connections before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 EQUIPMENT INSTALLATION

- A. Comply with NFPA 72, NFPA 101, and requirements of authorities having jurisdiction for installation and testing of fire-alarm equipment. Install all electrical wiring to comply with requirements in NFPA 70 including, but not limited to, Article 760, "Fire Alarm Systems."

1. Devices placed in service before all other trades have completed cleanup shall be replaced.
 2. Devices installed but not yet placed in service shall be protected from construction dust, debris, dirt, moisture, and damage according to manufacturer's written storage instructions.
- B. Install wall-mounted equipment, with tops of cabinets not more than 78 inches above the finished floor.
- C. Manual Fire-Alarm Boxes:
1. Install manual fire-alarm box in the normal path of egress within 60 inches of the exit doorway.
 2. Mount manual fire-alarm box on a background of a contrasting color.
 3. The operable part of manual fire-alarm box shall be between 42 inches and 48 inches above floor level. All devices shall be mounted at the same height unless otherwise indicated.
- D. Smoke- or Heat-Detector Spacing:
1. Comply with the "Smoke-Sensing Fire Detectors" section in the "Initiating Devices" chapter in NFPA 72, for smoke-detector spacing.
 2. Comply with the "Heat-Sensing Fire Detectors" section in the "Initiating Devices" chapter in NFPA 72, for heat-detector spacing.
 3. Smooth ceiling spacing shall not exceed 30 feet.
 4. Spacing of detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas shall be determined according to Annex A in NFPA 72.
 5. HVAC: Locate detectors not closer than 36 inches from air-supply diffuser or return-air opening.
 6. Lighting Fixtures: Locate detectors not closer than 12 inches from any part of a lighting fixture and not directly above pendant mounted or indirect lighting.
- E. Install a cover on each smoke detector that is not placed in service during construction. Cover shall remain in place except during system testing. Remove cover prior to system turnover.
- F. Remote Status and Alarm Indicators: Install in a visible location near each smoke detector, sprinkler water-flow switch, and valve-tamper switch that is not readily visible from normal viewing position.
- G. Audible Alarm-Indicating Devices: Install not less than 6 inches below the ceiling. Install bells and horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille. Install all devices at the same height unless otherwise indicated.
- H. Visible Alarm-Indicating Devices: Install adjacent to each alarm bell or alarm horn and at least 6 inches below the ceiling. Install all devices at the same height unless otherwise indicated.
- I. Device Location-Indicating Lights: Locate in public space near the device they monitor.

- J. Antenna for Radio Alarm Transmitter: Mount to building structure where indicated. Use mounting arrangement and substrate connection that resists 100-mph wind load with a gust factor of 1.3 without damage.

3.3 PATHWAYS

- A. Pathways above recessed ceilings and in nonaccessible locations may be routed exposed.
- B. Pathways shall be installed in EMT.
- C. All fire alarm junction box covers to be red.

3.4 CONNECTIONS

- A. For fire-protection systems related to doors in fire-rated walls and partitions and to doors in smoke partitions, comply with requirements in Section 087100 "Door Hardware." Connect hardware and devices to fire-alarm system.
 - 1. Verify that hardware and devices are listed for use with installed fire-alarm system before making connections.
- B. Make addressable connections with a supervised interface device to the following devices and systems. Install the interface device less than 10 feet from the device controlled. Make an addressable confirmation connection when such feedback is available at the device or system being controlled.
 - 1. Alarm-initiating connection to elevator-shaft smoke/heat dampers.
 - 2. Alarm-initiating connection to elevator recall system and components.
 - 3. Supervisory connections at valve supervisory switches.

3.5 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."
- B. Install framed instructions in a location visible from fire-alarm control unit.

3.6 GROUNDING

- A. Ground fire-alarm control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to fire-alarm control unit.
- B. Ground shielded cables at the control panel location only. Insulate shield at device location.

3.7 FIELD QUALITY CONTROL

- A. Field tests shall be witnessed by authorities having jurisdiction and the Engineer.
- B. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.
- C. Perform tests and inspections.
- D. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 - 1. Visual Inspection: Conduct visual inspection prior to testing.
 - a. Inspection shall be based on completed record Drawings and system documentation that is required by the "Completion Documents, Preparation" table in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
 - b. Comply with the "Visual Inspection Frequencies" table in the "Inspection" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72; retain the "Initial/Reacceptance" column and list only the installed components.
 - 2. System Testing: Comply with the "Test Methods" table in the "Testing" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
 - 3. Test audible appliances for the public operating mode according to manufacturer's written instructions. Perform the test using a portable sound-level meter complying with Type 2 requirements in ANSI S1.4.
 - 4. Test audible appliances for the private operating mode according to manufacturer's written instructions.
 - 5. Test visible appliances for the public operating mode according to manufacturer's written instructions.
 - 6. Factory-authorized service representative shall prepare the "Fire Alarm System Record of Completion" in the "Documentation" section of the "Fundamentals" chapter in NFPA 72 and the "Inspection and Testing Form" in the "Records" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
- E. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.
- F. Fire-alarm system will be considered defective if it does not pass tests and inspections.
- G. Prepare test and inspection reports.
- H. Maintenance Test and Inspection: Perform tests and inspections listed for weekly, monthly, quarterly, and semiannual periods. Use forms developed for initial tests and inspections.
- I. Annual Test and Inspection: One year after date of Substantial Completion, test fire-alarm system complying with visual and testing inspection requirements in NFPA 72. Use forms developed for initial tests and inspections.

3.8 MAINTENANCE SERVICE

- A. Initial Maintenance Service: Beginning at Substantial Completion, maintenance service shall include 12 months' full maintenance by skilled employees of manufacturer's designated service organization. Include preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper operation. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
 - 1. Include visual inspections according to the "Visual Inspection Frequencies" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
 - 2. Perform tests in the "Test Methods" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
 - 3. Perform tests per the "Testing Frequencies" table in the "Testing" paragraph of the "Inspection, Testing and Maintenance" chapter in NFPA 72.

3.9 SOFTWARE SERVICE AGREEMENT

- A. Comply with UL 864.
- B. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two years.
- C. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.
 - 1. Upgrade Notice: At least 30 days to allow Owner to schedule access to system and to upgrade computer equipment if necessary.

3.10 DEMONSTRATION

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

END OF SECTION 283111

MAINE TURNPIKE AUTHORITY

SPECIFICATIONS

PART IV – APPENDICES

CONTRACT 2019.04

INTERCHANGE 103 BARRIER TOLL PLAZA
OPEN ROAD TOLLING CONVERSION
MILE 103.0

APPENDIX A

ASBESTOS DEMOLITION IMPACT ASSESSMENT
BY ABATEMENT PROFESSIONALS DATED JUNE 14, 2018

June 14, 2018

Greg Edwards, PE, ENV SP
Senior Principal, Transportation
Stantec
55 Green Mountain Drive South Burlington VT 05403-7824
Ph: (Direct) (802) 497-6398
Email: greg.edwards@stantec.com

Re: Asbestos Demolition Impact Assessment, Maine Turnpike Exit 103, Gardiner, Maine.

Dear Mr. Edwards:

Abatement Professionals Corporation (APC) is providing you with the asbestos bulk testing results for the samples collected at the MTA Exit 103 that will be taken down as part of the reconstruction of this location from readily accessible building materials that may be impacted by demolition/renovations activities.

APC collected Eleven (11) bulk samples of suspect building materials that may be impacted during renovations/demolition activities. There were also two locations that I did not collect samples from that do contain asbestos based on previous testing. One of these areas is the lab tops in the toll booths. To collect a sample, I would have needed to break the tops and I did not want to create a situation of friability. The other material included the hard board panels on the rear of the building. These are transite cement boards and the sampling of the caulking confirms that asbestos is present in the caulking. However, I could also see the grey board behind it and to collect a sample of this material I would have needed to break the panel and would have exposed the building to exterior elements. The building materials collected included multiple types of flooring, ceiling materials, tank coverings materials, and other miscellaneous suspect materials within the boundaries of the complex. The MDEP Chapter 425 and USEPA has minimum sampling requirements for asbestos building material investigations the requirements are as follows:

Surfacing materials: Sprayed or applied by trowel and include fireproofing materials and various plasters. At least three bulk samples of surfacing materials were collected from each homogeneous area that was less than 1,000-square feet. Five bulk samples were collected for areas 1,000 to 5,000-square feet, and seven bulk samples were collected for area greater than 5,000-square feet.

Thermal system insulation: Including boiler cover, pipe cover, and duct insulation were assessed. The materials were either assumed to be asbestos containing or were sampled as follows; At least three bulk samples of thermal system insulation from each homogenous area or at least one bulk sample from each homogeneous patched area if the section is less than six linear or square feet.

Miscellaneous ACM: Includes a variety of ceiling tiles, floor tiles, and gypsum board. Sample quantities for miscellaneous ACM follow the same requirements as for the two previously mentioned ACM types.

The bulk samples were collected with standard sampling protocols, properly packaged, maintained and shipped to Northeast Labs, Westbrook, Maine for analysis by Polarized Light Microscopy (PLM) & (NOB) specific to asbestos content by volume.

The bulk sample analysis indicates that the structure has regulated asbestos containing building materials in the following forms;

Asbestos Materials	Location	% Asbestos	Regulated
Caulking	Around hardboard Panels	1.31% Tremolite	Yes
Transite panels	Rear of building window wall	Assumed	Yes
Lab Tops	Toll Booths	Assumed	Yes

Lead Paints	Location		Regulated
Structural steel around toll booths	Toll booths		Yes
Steel beams of bridge supports	Bridge structure		Yes

Universal Waste	Location		Regulated
Light bulbs	Throughout		Yes
Light Ballasts	Throughout		Yes
Exit Lighting	Throughout		Yes

The attached bulk sample analysis indicates that there are detectable levels of asbestos in a number of the building materials tested and must be removed by a State of Maine certified asbestos abatement contractor. Should any additional suspect building materials be found during any of the demolition/renovation work, the work should immediately stop until additional sampling can be conducted.

Budgetary cost for the removal and disposal of the asbestos and universal waste should be carried at \$14,000.00

We appreciate the opportunity to service your asbestos testing needs, should you require further bulk or air quality sampling please feel free to contact us at any time.

Very truly,



Robert W. Rickett Jr, CIE,CMR
President

Certificate of Analysis

Administrative Offices
Phone: 1-207-873-7711
Fax: 1-207-873-7022

Customer Service
Phone: 207-878-6481
Fax: 207-887-8387

Analysis Report of Bulk Material via
EPA Method 600/R-93/116 Polarized
Light Microscopy

Attention: Robert W Rickett Jr
Abatement Professionals Corp
590 County Rd Suite 2
Westbrook, ME 04092

Project Number: MTA Exit 103
PO Number: 501802862-872
Lab Range: 6/4/2018
Received Date: 6/4/2018
Report Date: 6/6/2018

Non-Asbestos	
Fibrous	Non-Fibrous

Sample ID	Description	Test	Analyzed Date	Analyst	Color	Fibrous	Non-Fibrous	Asbestos
501802862	B1A/Tile	PLM NOB	6/5/2018	ASM	GRAY	--	8%	Not Detected
501802863	B1B/Tile	PLM NOB	6/5/2018	ASM	GRAY	--	7%	Not Detected
501802864	B1C/Tile	PLM NOB	6/5/2018	ASM	GRAY	--	17%	Not Detected
501802865	B2A/Olin Tile	PLM Visual Estimate	6/6/2018	DJP	GRAY	90%	10%	Not Detected
501802866	B2B/Olin Tile	PLM Visual Estimate	6/6/2018	DJP	GRAY	90%	10%	Not Detected
501802867	B2C/Olin Tile	PLM Visual Estimate	6/6/2018	DJP	GRAY	85%	15%	Not Detected
501802868	B3A/Caulk	400 Point Count	6/5/2018	ASM	GRAY	--	73.69%	Tremolite 1.31%
501802869	B3B/Caulk	PLM NOB	6/5/2018	ASM	GRAY	--	--	Positive Stop
501802870	B3C/Caulk	PLM NOB	6/5/2018	ASM	GRAY	--	--	Positive Stop
501802871	B4A/Plaster	PLM Visual Estimate	6/6/2018	DJP	GRAY	--	100%	Not Detected
501802872	B5A/Tank	PLM Visual Estimate	6/6/2018	DJP	TAN	60%	40%	Not Detected

Should you have any questions concerning your asbestos test result(s), please feel free to call us. Thank you for using Northeast Laboratory Services. Contact NEL for your other environmental analytical needs, including water testing for lead and arsenic or indoor air quality.



P.O. BOX 788
Waterville Maine, 04901-0788
120 Main Street
Westbrook, Maine 04092

Certificate of Analysis

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Analysis Report of Bulk Material via
EPA Method 600/R-93/116 Polarized
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Attention: Robert W Rickett Jr
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590 County Rd Suite 2
Westbrook, ME 04092

Project Number: MTA Exit 103
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Authorized By  Andrew McCaw, Laboratory Supervisor
Review Date 6/6/2018

Analytical results and reports are generated by NEL at the request of and for the exclusive use of the person or entity (client) named on this report. Results, reports or copies of same will not be released by NEL to any third party without the prior express written consent from the client named in this report. This report applies only to those samples taken at the time, place and location referenced by the client. This report makes no express or implied warranty or guarantee as to the sampling methodology used by the individual performing the sampling. The client is solely responsible for the use and interpretation of these results and NEL makes no express or implied warranties as to such use or interpretation. NEL is not able to make and does not make a determination as to the environmental soundness, safety or health of a property from only the samples sent to their laboratory for analysis. Unless otherwise specified by the Client, NEL reserves the right to dispose of all samples after the testing of such samples is sufficiently completed or after a thirty-day period, whichever period is greater. NEL liability extends only to the cost of the testing. State of Maine license #LB-0082.



- 872

Chain of Custody Record

Ship Samples To:

Northeast Laboratory Services 999 Forest Avenue Portland, ME 04103	Tel: (207) 878-6481 Toll Free: 1-855-731-9161 Fax: (207) 878-2265	Asbestos Analysis
--	---	-------------------

Company:	Abatement Professionals	Lab Use Only
Address:	590 County Rd	
City, State, Zip:	WESTBROOK, ME 04092	
Client Contact:	Bob Rickett	
Phone:	207 671-4361	
Purchase Order #:		
Email For Reporting:	Bob@AbatementProfessionals.com	
Project Number:	MTA Exit 103	

<p>Analysis: Circle One</p> <p>PLM EPA 600/R-93/116 (<1%)</p> <p>PLM EPA NOB (<1%)</p> <p>POINT COUNT 400 (<0.25%)</p> <p>POINT COUNT 400 W/GRAVIMETRIC (<0.25%)</p> <p>Check For Positive Stop</p>	<p>Turnaround Time: Circle One</p> <p>6 Hour</p> <p>24 Hour</p> <p><u>48 Hour</u></p> <p>72 Hour</p> <p>96 Hour</p> <p>1 Week</p>
---	---

Lab No. (lab use only)	Sample Identification/Product Name	Date and Time Sampled	Sample Matrix	Sample Type	Analysis Requested
862-864	B-1-A - B-1-C	6-1-18	TIC		ACU
865-867	B-2-A - B-2-C	↓	OC/TIC		↓
868-870	B-3-A - B-3-C	↓	CAVIC		↓
871	B-4-A	↓	PLASTER		↓
872	B-5-A	↓	TANK	A04-B	↓

NOB
VEST
NOB
VEST
VEST

Special Sample Information, Testing or Reporting Instructions: 110 TOTAL SAMPLES

Custody Record

Date	Time	Samples Relinquished By	Samples Received By	Comments
6-4-18	12:36	[Signature]	EB	6/4/18 12:36



Picture 1: Structural steel supports tested positive for lead paint



Picture 2: painted cement block at tool booths tested negative for lead paint



Picture 3: toll booth lab tops are assumed to be asbestos based on previous testing of the materials



Picture 4: structural steel supports positive for lead based paints



Picture 5: window caulking that tested positive for asbestos, which is attached to the transter panels



Picture 6: tunnel walkway no asbestos materials found



PAUL R. LEPAGE
GOVERNOR

STATE OF MAINE
DEPARTMENT OF
ENVIRONMENTAL PROTECTION



PAUL MERCER
COMMISSIONER

May 23, 2018

Abatement Professionals Corp.
590 County Road, Suite 2
Westbrook, Maine 04092

Dear Licensee:

Asbestos application(s) for individual certification of the **one** employee(s) listed below have been received and **approved**. Individual certification numbers are listed below and wallet card(s) are enclosed. Card(s) are property of the individual to whom each is issued. Your responsibility as a licensee is to ensure delivery of the cards to persons in your employment. This letter should be retained for your company files as record of certification. **Please attach 1 updated passport size photo with every application.**

Remember, in Maine all **certified employees** working on an asbestos abatement project, whether conducting removal/repair, air monitoring, design, inspection, or analysis functions, **must work for a State of Maine licensed asbestos firm** and carry his/her wallet card(s) on the job site.

As a reminder, prior to renewing your asbestos certification, the State of Maine **requires** an annual refresher course to be taken before submitting a renewal application. A certificate shall expire one year from the last day of the month from the date of issuance, **or on the last day of the month that the training certificate expires**, whichever is sooner.

All our asbestos forms can be found at <http://www.maine.gov/dep/rwm/asbestos/newupdatedformsasb.htm>. Thank you for your cooperation and your completed application(s).

<u>Name</u>	<u>Category</u>	<u>Certification #</u>	<u>Exp. Date</u>
Robert W. Rickett, Jr.	Design Consultant	DC-0027	11/30/2018

Sincerely,

Sandra J. Moody, Environmental Specialist
Division of Remediation
Bureau of Remediation and Waste Management

AUGUSTA
17 STATE HOUSE STATION
AUGUSTA, MAINE 04333-0017
(207) 287-7688 FAX: (207) 287-7826

BANGOR
106 HOGAN ROAD, SUITE 6
BANGOR, MAINE 04401
(207) 941-4570 FAX: (207) 941-4584

PORTLAND
312 CANAL
PORTLAND, MAINE 04101
(207) 825-1100

State of Maine
Asbestos Abatement Program

Robert W. Rickett Jr.

Design Consultant

Cert No. DC-0027
Trn. Exp. Date 11/09/2018

Expiration Date **11/30/2018**

This is not a legal form of official identification






State of Maine
Department of Environmental Protection

LICENSE

Abatement Professionals Corp.

Asbestos Consultant
(Full)

License Number: SF-0028

Expiration Date: 06/30/2019

APPENDIX B

PERMIT BY RULE (PBR) REGULATIONS SECTION 11

Chapter 305: PERMIT BY RULE

1. Introduction. A "permit by rule" or "PBR", when approved by the Department of Environmental Protection (DEP), is an approval for an activity that requires a permit under the Natural Resources Protection Act (NRPA). Only those activities described in this chapter may proceed under the PBR process. A PBR activity will not significantly affect the environment if carried out in accordance with this chapter, and generally has less of an impact on the environment than an activity requiring an individual permit. A PBR satisfies the Natural Resources Protection Act (NRPA) permit requirement and Water Quality Certification requirement.

If a proposed activity is not described in this chapter, or will not be conducted in accordance with the standards of this chapter, the applicant must obtain an individual permit prior to beginning the activity.

A. Location of activity. The location of an activity may affect whether an activity qualifies for PBR, and whether review by the Department of Inland Fisheries and Wildlife is required.

- (1) Type of resource. For some types of activities, the availability of a PBR is affected by the type of natural resource in or adjacent to which the activity is proposed. For example, an applicant proposing an activity consisting of "Movement of rocks or vegetation" may receive a PBR only if the activity will take place in a great pond, river, stream or brook. Limitations concerning the location of activities are addressed in the "Applicability" provision in each section of this chapter.
- (2) Essential habitat. Essential habitats include areas critical to the survival of threatened and endangered species such as the bald eagle, least tern, roseate tern, and piping plover. If the activity is located in essential habitat, such as near an eagle nesting site, a PBR is only available if the applicant obtains written approval from the Department of Inland Fisheries and Wildlife (IF&W). This approval from IF&W must be submitted to the DEP with the PBR notification form, and the applicant must follow any conditions stated in the IF&W approval.

NOTE: Maps showing areas of essential habitat are available from the Department of Inland Fisheries and Wildlife regional headquarters, municipal offices, the Land Use Regulation Commission (for unorganized territories) and DEP regional offices. If the activity is located in essential habitat, IF&W must be contacted to request and obtain a "certification of review and approval".

B. Notification. The applicant must file notice of the activity with the DEP prior to beginning work on the activity. The notification must be on a form provided by the DEP and must include any submissions required in this chapter. The applicant must keep a copy to serve as the permit.

The notification form must be sent to the DEP by certified mail (return receipt requested), or hand delivered to the DEP and date stamped by the department. By signing the notification form, the applicant is representing that the activity will meet the applicability requirements and standards of the rule. In addition, by signing the notification form the applicant represents that the applicant has sufficient title, right, or interest in the property where the proposed activity is to take place.

C. Effective period

- (1) Beginning of period. The PBR becomes effective 14 calendar days after the DEP receives the notification form, unless the DEP approves or denies the PBR prior to that date. If the DEP does not speak with or write to the applicant within this 14 day period regarding the PBR notification, the applicant may proceed to carry out the activity.

There are three exceptions regarding the effective date of an approved PBR:

- (a) Activities listed in Section 10 (Stream crossings) occurring in association with forest management are exempt from the 14 day waiting period.
- (b) Activities listed in Section 10 (Stream crossings) performed or supervised by individuals currently certified in erosion control practices by the DEP are exempt from the 14 day waiting period. To be certified in erosion control practices, an individual must successfully complete all course requirements of the Voluntary Contractor Certification Program administered by the DEP's Nonpoint Source Training and Resource Center.
- (c) Activities that are part of a larger project requiring a permit under the Site Location of Development or the Storm Water Management Acts may not proceed until any required permit under those laws is obtained.

NOTE: Activities that are part of a larger project may require other permits from the DEP also. These other laws may prohibit the start of construction of any part of the project unless a permit under that law is obtained. In these cases, while not a violation of this rule, starting work on a PBR approved activity would be a violation of those other applicable laws.

- (2) End of period. The PBR is generally effective for 2 years from the date of approval, except that a PBR for "Replacement of structures" under Section 4 is effective for 3 years.

NOTE: Activities that qualify under this chapter may need to meet other local, state and federal requirements. Examples -- (1) If an activity extends below the low water line of a lake, coastal wetland or international boundary water, the applicant should contact the Bureau of Parks and Lands (287-3061) concerning possible lease or easement requirements, or (2) If an activity will involve work below the mean high water line in navigable waters of the United States, the applicant should contact the Army Corps of Engineers (623-8367).

D. Discretionary authority. Notwithstanding compliance with the PBR applicability requirements and standards set forth in this chapter, the DEP may require an individual permit application to be filed in any case where credible evidence indicates that the activity:

- (1) May violate the standards of this rule or the NRPA (38 M.R.S.A. Section 480-D);
- (2) Could lead to significant environmental impacts, including cumulative impacts; or
- (3) Could adversely impact a resource of special concern.

If an individual permit is required pursuant to this subsection, the DEP shall notify the applicant in writing within the 14 calendar day waiting period described in sub-section (C) above. When the DEP notifies an applicant that an individual permit is required, no work may be conducted unless and until the individual permit is obtained.

E. Violations. A violation of law occurs when a person, or his or her agent, performs or causes to be performed any activity subject to the NRPA without first obtaining a permit from the DEP, or acts contrary to the provisions of a permit. The person, his or her agent, or both, may be held responsible for the violation. Commonly, the "person" is the landowner, and the "agent" is the contractor carrying out the activity. A violation occurs when:

- (1) An activity occurs that is not allowed under PBR, whether or not a PBR notification form has been filed with and/or approved by the DEP;
- (2) An activity occurs that is allowed under PBR, but a PBR for the activity has not become effective prior to the beginning of the activity; or
- (3) An activity occurs that is allowed under PBR and a PBR for the activity is in effect, but the standards specified in this chapter are not met.

See the "applicability" provision under each activity for rules concerning what activities are allowed under PBR. A PBR is only valid for the person listed on the notification form, or for his or her agent.

Each day that a violation occurs or continues is considered a separate offense. Violations are subject to criminal penalties and civil penalties of not less than \$100 nor more than \$10,000 for each day of that violation (38 M.R.S.A. Section 349).

NOTE: A local Code Enforcement Officer (CEO) may take enforcement action for a violation of the Natural Resources Protection Act if he or she is authorized to represent a municipality in District Court, and he or she has been certified as familiar with court procedures, 30-A M.R.S.A. Section 4452(7).

11. State transportation facilities

A. Applicability

- (1) This section applies to the maintenance, repair, reconstruction, rehabilitation, replacement or minor construction of a State Transportation Facility carried out by, or under the authority of, the Maine Department of Transportation (MaineDOT) or the Maine Turnpike Authority, including any testing or preconstruction engineering, and associated technical support services.
- (2) This section does not apply to an activity within a coastal sand dune system.

NOTE: The construction of a transportation facility other than roads and associated facilities may be subject to the Storm Water Management Law, 38 M.R.S.A. Section 420-D.

B. Standards

- (1) Photographs of the area to be altered by the activity must be taken before work on the site begins. The photographs must be kept on file and be made available at the request of the DEP.
- (2) The activity must be reviewed by the Department of Inland Fisheries and Wildlife and the Department of Marine Resources, as applicable. The applicant must coordinate with the reviewing agencies and incorporate any recommendations from those agencies into the performance of the activity.
- (3) All construction activities undertaken must be detailed in a site-specific Soil Erosion and Water Pollution Control Plan and conducted in accordance with MaineDOT's Best Management Practices for Erosion and Sediment Control, dated January 2000, and Standard Specifications, dated December 2002.
- (4) Alignment changes may not exceed a distance of 200 feet between the old and new center lines in any natural resource.
- (5) The activity may not alter more than 300 feet of shoreline (both shores added together) within a mile stretch of any river, stream or brook, including any bridge width or length of culvert.
- (6) The activity may not alter more than 150 feet of shoreline (both shores added together) within a mile stretch of any outstanding river segment identified in 38 M.R.S.A. 480-P, including any bridge width or length of culvert.
- (7) The activity must minimize wetland intrusion. The activity is exempt from the provisions of Chapter 310, the Wetland and Waterbodies Protection Rules, if the activity alters less than 15,000 square feet of natural resources per mile of roadway (centerline measurement) provided that the following impacts are not exceeded within the 15,000 square foot area:
 - (a) 1,000 square feet of coastal wetland consisting of salt tolerant vegetation or shellfish habitat; or
 - (b) 5,000 square feet of coastal wetland not containing salt tolerant vegetation or shellfish habitat; or
 - (c) 1,000 square feet of a great pond.

All other activities must be performed in compliance with all sections of Chapter 310, the Wetland Protection Rules, except 310.2(C), 5(A), 9(A), 9(B) and 9(C).

- (8) The activity may not permanently block any fish passage in any watercourse containing fish. The applicant must coordinate with the reviewing agencies listed in paragraph 2 above to improve fish passage and incorporate any recommendations from those agencies into the performance of the activity.

NOTE: For guidance on meeting the design objectives for fish passage, including peak flow, maximum velocity, mining depth and gradient, see the MaineDOT Waterbody and Wildlife Crossing Policy and Design Guide (July 2008), developed in conjunction with state and federal resource and regulatory agencies.

- (9) Rocks may not be removed from below the normal high water line of any coastal wetland, freshwater wetland, great pond, river, stream or brook except to the minimum extent necessary for completion of work within the limits of construction.
- (10) If work is performed in a river, stream or brook that is less than three feet deep at the time and location of the activity, the applicant must isolate the work area from the resource and divert stream flows around the work area, maintaining downstream flows while work is in progress.
- (11) Wheeled or tracked equipment may not operate in the water. Equipment operating on the shore may reach into the water with a bucket or similar extension. Equipment may cross streams on rock, gravel or ledge bottom. If avoiding the operation of wheeled or tracked equipment in the water is not possible, the applicant must explain the need to operate in the water. Approval from the DEP to operate in the water must be in writing, and any recommendations from the DEP must be incorporated into the performance of the activity.
- (12) All wheeled or tracked equipment that must travel or work in a vegetated wetland area must travel and work on mats or platforms.
- (13) Any debris or excavated material must be stockpiled either outside the wetland or on mats or platforms. Erosion and sediment control best management practices must be used, where necessary, to prevent sedimentation. Any debris generated during the activity must be prevented from washing downstream and must be removed from the wetland or water body. Disposal of debris must be in conformance with the Maine Hazardous Waste, Septage and Solid Waste Management Act, 38 M.R.S.A. Section 1301 *et seq.*
- (14) Work below the normal high water line of a great pond, river, stream or brook must be done at low water except for emergency work or work agreed to by the resource agencies listed in paragraph 2 above.
- (15) Perimeter controls must be installed before the work starts. Disturbance of natural resources beyond the construction limits shown on the plans is not allowed under this rule.

NOTE: Guidance on the location of construction limits can be obtained from the on site Construction Manager.

- (16) The use of untreated lumber is preferred. Lumber pressure treated with chromated copper arsenate (CCA) may be used only if necessary and only if use is allowed under federal law and not prohibited from sale under 38 M.R.S.A. 1682, and provided it is cured on dry land in a manner that exposes all surfaces to the air for a period of at least 21 days prior to construction. Wood treated with creosote or pentachlorophenol may not be used where it will contact water.

- (17) A temporary road for equipment access must be constructed of crushed stone, blasted ledge, or similar materials that will not cause sedimentation or restrict fish passage. Such roads must be completely removed at the completion of the activity. In addition, any such temporary roads which are in rivers, streams or brooks, must allow for a passage of stormwater flows associated with a 10-year storm.
- (18) Non-native species may not be planted in restored areas.
- (19) Disposal of debris must be in conformance with Maine Hazardous Waste, Septage and Solid Waste Management Act, 38 M.R.S.A. Sections 1301 *et seq.*
- (20) Disturbance of vegetation must be avoided, if possible. Where vegetation is disturbed outside of the area covered by any road or structure construction, it must be reestablished immediately upon completion of the activity and must be maintained.
- (21) A vegetated area at least 25 feet wide must be established and maintained between any new stormwater outfall structure and the high water line of any open water body. A velocity reducing structure must be constructed at the outlet of the stormwater outfall that will create sheet flow of stormwater, and prevent erosion of soil within the vegetated buffer. If the 25 foot vegetated buffer is not practicable, the applicant must explain the reason for a lesser setback in writing. Approval from the DEP must be in writing and any recommendations must be incorporated into the activity.

C. Definitions. The following terms, as used in this chapter, have the following meanings, unless the context indicates otherwise:

- (1) **Diversion.** The rerouting of a river, stream or brook around a construction site and then back to the downstream channel.
- (2) **Fill.** a. (verb) To put into or upon, supply to, or allow to enter a water body or wetland any earth, rock, gravel, sand, silt, clay, peat, or debris; b. (noun) Material, other than structures, placed in or immediately adjacent to a wetland or water body.
- (3) **Floodplain wetlands.** Freshwater wetlands that are inundated with flood water during a 100-year flood event based on flood insurance maps produced by the Federal Emergency Agency or other site specific information.
- (4) **Riprap.** Heavy, irregularly shaped rocks that are fit into place, without mortar, on a slope as defined in the MaineDOT Standard Specifications, dated December 2002.

NOTE: For guidance on erosion and sedimentation controls, consult the Maine Erosion and Sediment Control BMPs, dated March 2003. This handbook and other references are available from the DEP.

APPENDIX C

SUBSURFACE WASTEWATER DISPOSAL SYSTEM APPLICATION

SUBSURFACE WASTEWATER DISPOSAL SYSTEM APPLICATION

PROPERTY LOCATION		>> CAUTION: LPI APPROVAL REQUIRED <<	
City, Town, or Plantation	West Gardiner	Town/City _____	Permit # _____
Street or Road	Exit 103: Interstate 295	Date Permit Issued: ___/___/___	Fee: \$ _____ Double Fee Charged []
Subdivision, Lot #	N/A	L.P.I. # _____	
OWNER/APPLICANT INFORMATION		Local Plumbing Inspector Signature _____	
Name (last, first, MI) Maine Turnpike Authority c/o: Ralph Norwood		Fee: \$ _____ state w/in fee \$ _____ Locally adopted fee _____ Copy: [] Owner [] Town [] State	
Mailing Address of Owner/Applicant	2360 Congress St. Portland, ME 04012	The Subsurface Wastewater Disposal System shall not be installed until a Permit is issued by the Local Plumbing Inspector. The Permit shall authorize the owner or installer to install the disposal system in accordance with this application and the Maine Subsurface Wastewater Disposal Rules.	
Daytime Tel. #	(207) 482-8348		
OWNER OR APPLICANT STATEMENT		CAUTION: INSPECTION REQUIRED	
I state and acknowledge that the information submitted is correct to the best of my knowledge and understand that any falsification is reason for the Department and/or Local Plumbing Inspector to deny a Permit.		I have inspected the installation authorized above and found it to be in compliance with the Subsurface Wastewater Disposal Rules Application.	
Signature of Owner or Applicant _____ Date 2018-07-16		Local Plumbing Inspector Signature _____ (1st) date approved _____ _____ (2nd) date approved _____	

PERMIT INFORMATION		
TYPE OF APPLICATION <input checked="" type="checkbox"/> 1. First Time System <input type="checkbox"/> 2. Replacement System Type replaced: _____ Year installed: _____ <input type="checkbox"/> 3. Expanded System a. <25% Expansion <input type="checkbox"/> b. >25% Expansion <input type="checkbox"/> <input type="checkbox"/> 4. Experimental System <input type="checkbox"/> 5. Seasonal Conversion	THIS APPLICATION REQUIRES <input checked="" type="checkbox"/> 1. No Rule Variance <input type="checkbox"/> 2. First Time System Variance a. Local Plumbing Inspector Approval b. State & Local Plumbing Inspector Approval <input type="checkbox"/> 3. Replacement System Variance a. Local Plumbing Inspector Approval b. State & Local Plumbing Inspector Approval <input type="checkbox"/> 4. Minimum Lot Size Variance <input type="checkbox"/> 5. Seasonal Conversion Permit	DISPOSAL SYSTEM COMPONENTS <input checked="" type="checkbox"/> 1. Complete Non-engineered System <input type="checkbox"/> 2. Primitive System (graywater & alt. toilet) <input type="checkbox"/> 3. Alternative Toilet, specify: _____ <input type="checkbox"/> 4. Non-engineered Treatment Tank (only) <input type="checkbox"/> 5. Holding Tank, _____ gallons <input type="checkbox"/> 6. Non-engineered Disposal Field (only) <input type="checkbox"/> 7. Separated Laundry System <input type="checkbox"/> 8. Complete Engineered System (2000 gpd or more) <input type="checkbox"/> 9. Engineered Treatment Tank (only) <input type="checkbox"/> 10. Engineered Disposal Field (only) <input type="checkbox"/> 11. Pre-treatment, specify: _____ <input type="checkbox"/> 12. Miscellaneous Components
SIZE OF PROPERTY N/A <input type="checkbox"/> SQ. FT. <input type="checkbox"/> ACRES	DISPOSAL SYSTEM TO SERVE <input type="checkbox"/> 1. Single Family Dwelling Unit, No. of Bedrooms: _____ <input type="checkbox"/> 2. Multiple Family Dwelling, No. of Units: _____ <input type="checkbox"/> 3. Other: MTA Tolling Plaza Admin Building (specify) Current Use <input type="checkbox"/> Seasonal <input type="checkbox"/> Year Round <input checked="" type="checkbox"/> Undeveloped	TYPE OF WATER SUPPLY <input checked="" type="checkbox"/> 1. Drilled Well <input type="checkbox"/> 2. Dug Well <input type="checkbox"/> 3. Private <input type="checkbox"/> 4. Public <input type="checkbox"/> 5. Other
SHORELAND ZONING <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No	DESIGN DETAILS (SYSTEM LAYOUT SHOWN ON PAGE 3)	

TREATMENT TANK <input checked="" type="checkbox"/> 1. Concrete a. Regular <input type="checkbox"/> b. Low Profile <input type="checkbox"/> <input type="checkbox"/> 2. Plastic H 20 Load <input type="checkbox"/> 3. Other: _____ CAPACITY: 1000 GAL.	DISPOSAL FIELD TYPE & SIZE <input type="checkbox"/> 1. Stone Bed <input type="checkbox"/> 2. Stone Trench <input checked="" type="checkbox"/> 3. Proprietary Device concrete chamber a. cluster array <input type="checkbox"/> c. Linear b. regular load <input checked="" type="checkbox"/> d. H-20 load <input type="checkbox"/> 4. Other: _____ SIZE: 738 square feet sq. ft. lin. ft.	GARBAGE DISPOSAL UNIT <input checked="" type="checkbox"/> 1. No <input type="checkbox"/> 2. Yes <input type="checkbox"/> 3. Maybe If Yes or Maybe, specify one below: <input type="checkbox"/> a. multi-compartment tank <input type="checkbox"/> b. _____ tanks in series <input type="checkbox"/> c. increase in tank capacity <input type="checkbox"/> d. Filter on Tank Outlet	DESIGN FLOW 180 _____ gallons per day BASED ON: 1. Table 4A (dwelling unit(s)) 2. Table 4C (other facilities) SHOW CALCULATIONS for other facilities 13 employees @ 12 GPD each = 156 GPD. 3. Section 4G (meter readings) ATTACH WATER METER DATA
SOIL DATA & DESIGN CLASS PROFILE CONDITION 8 / AIIID at Observation Hole # 1 Depth 12" of Most Limiting Soil Factor	DISPOSAL FIELD SIZING <input type="checkbox"/> 1. Medium---2.6 sq. ft. / gpd <input type="checkbox"/> 2. Medium---Large 3.3 sq. ft. / gpd <input checked="" type="checkbox"/> 3. Large---4.1 sq. ft. / gpd <input type="checkbox"/> 4. Extra Large---5.0 sq. ft. / gpd	EFFLUENT/EJECTOR PUMP 1. Not Required <input checked="" type="checkbox"/> 2. May Be Required <input type="checkbox"/> 3. Required <input type="checkbox"/> Specify only for engineered systems: DOSE: _____ gallons	LATITUDE AND LONGITUDE at center of disposal area Lat. 44 _____ d 12 _____ m 52.74 _____ S Lon. 80 _____ d 46 _____ m 28.23 _____ S if g.p.s, state margin of error: _____

SITE EVALUATOR STATEMENT			
I certify that on 2018-07-16 (date) I completed a site evaluation on this property and state that the data reported are accurate and that the proposed system is in compliance with the State of Maine Subsurface Wastewater Disposal Rules (10-144 R.C.M.S.).			
_____ Site Evaluator Signature Rodney D. Kelshaw Site Evaluator Name Printed	371 SE # (207) 406-5485 Telephone Number	2018-07-16 Date rodney.kelshaw@stantec.com E-mail Address	STATE OF MAINE DIVISION OF ENVIRONMENTAL HEALTH RODNEY D. KELSHAW No. 371 SITE EVALUATOR

SUBSURFACE WASTEWATER DISPOSAL SYSTEM APPLICATION

Department of Human Services
 Division of Health Engineering
 (207) 287-5672 Fax: (207) 287-3165

Town, City, Plantation
 West Gardiner

Street, Road, Subdivision
 Exit 103: Interstate 295

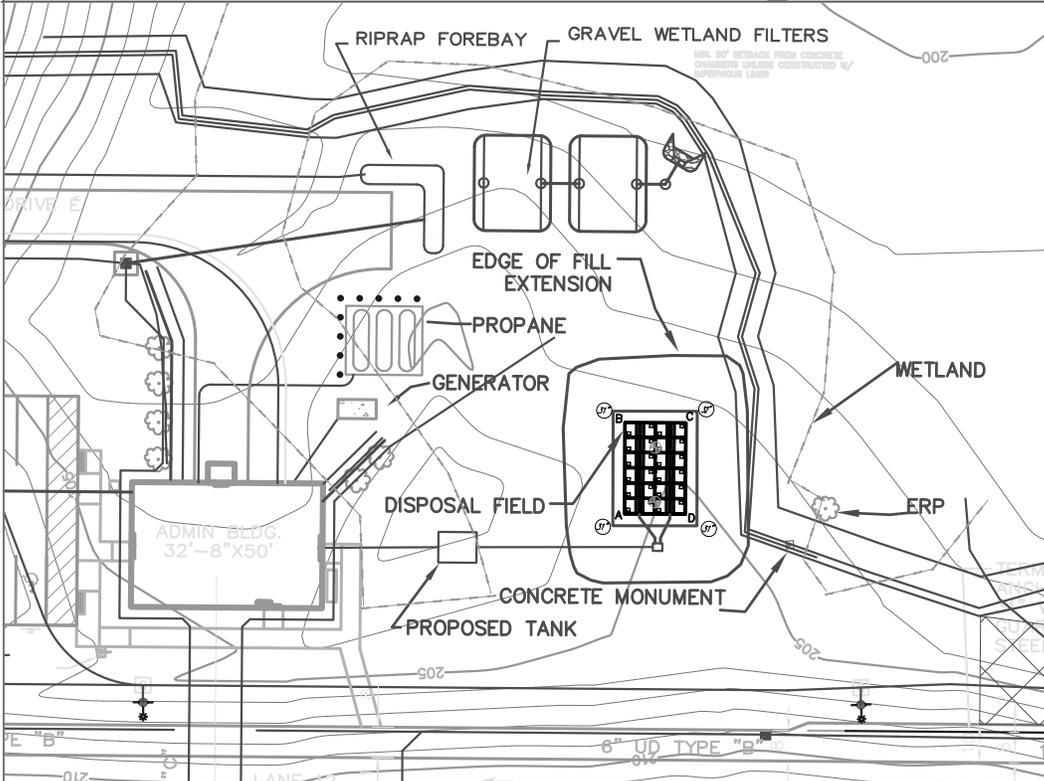
Owner's Name
 Maine Turnpike Authority

SITE PLAN

Scale 1" = 50' ft. or as shown

SITE LOCATION PLAN

SEE SITE LOCATION
 MAP ATTACHED



SITE MEASUREMENTS

- A TO B = 272°
- A TO ERP 53' @ 53°
- B TO ERP 30°
- C TO ERP 43' @ 38°
- D TO ERP 37' @ 1°
- A TO CM 44' @ 14°
- C TO CM 42' @ 52°
- D TO CM 28.5' @ 21°
- ERP TO CM 13' @ 138°

NOTES:
 ERP=ELEVATION REFERENCE POINT
 CM=CONCRETE MONUMENT

SOIL DESCRIPTION AND CLASSIFICATION (Location of Observation Holes Shown Above)

Observation Hole TP 1 Test Pit Boring
3 " Depth of Organic Horizon Above Mineral Soil

Depth Below Mineral Soil Surface (inches)	Texture	Consistency	Color	Mottling
0	sl	VFR	7.5YR6/1 7.5YR3/4	Not Observed
10	fsl	FR	10YR4/6	
20	sil	FI	2.5Y4/3	15% hcr
30	fsl	FR	5Y5/2	
40	lfs	FR		20% hcr
50		L.O.I	36"	

Observation Hole AB 1 Test Pit Boring
3 " Depth of Organic Horizon Above Mineral Soil

Depth Below Mineral Soil Surface (inches)	Texture	Consistency	Color	Mottling
0	sl	VFR	7.5YR6/1 7.5YR3/4	Not Observed
10	fsl	FR	10YR4/6	
20	sil	FI	2.5Y4/3	15% hcr
30	fsl	FR	5Y5/2	
40	lfs	FR		20% hcr
50		L.O.I	36"	

Soil Classification <u>8</u> <u>AIIID</u> Profile Condition	Slope <u>0-3</u> %	Limiting Factor <u>12</u> "	<input type="checkbox"/> Ground Water <input checked="" type="checkbox"/> Restrictive Layer <input type="checkbox"/> Bedrock <input type="checkbox"/> Pit Depth
---	-----------------------	--------------------------------	--

Soil Classification <u>8</u> <u>AIIID</u> Profile Condition	Slope <u>0-3</u> %	Limiting Factor <u>14</u> "	<input type="checkbox"/> Ground Water <input checked="" type="checkbox"/> Restrictive Layer <input type="checkbox"/> Bedrock <input type="checkbox"/> Pit Depth
---	-----------------------	--------------------------------	--

Rodney D. Kelshaw

Site Evaluator Signature

371

SE #

July 16, 2018

Date

HI





American Concrete Industries

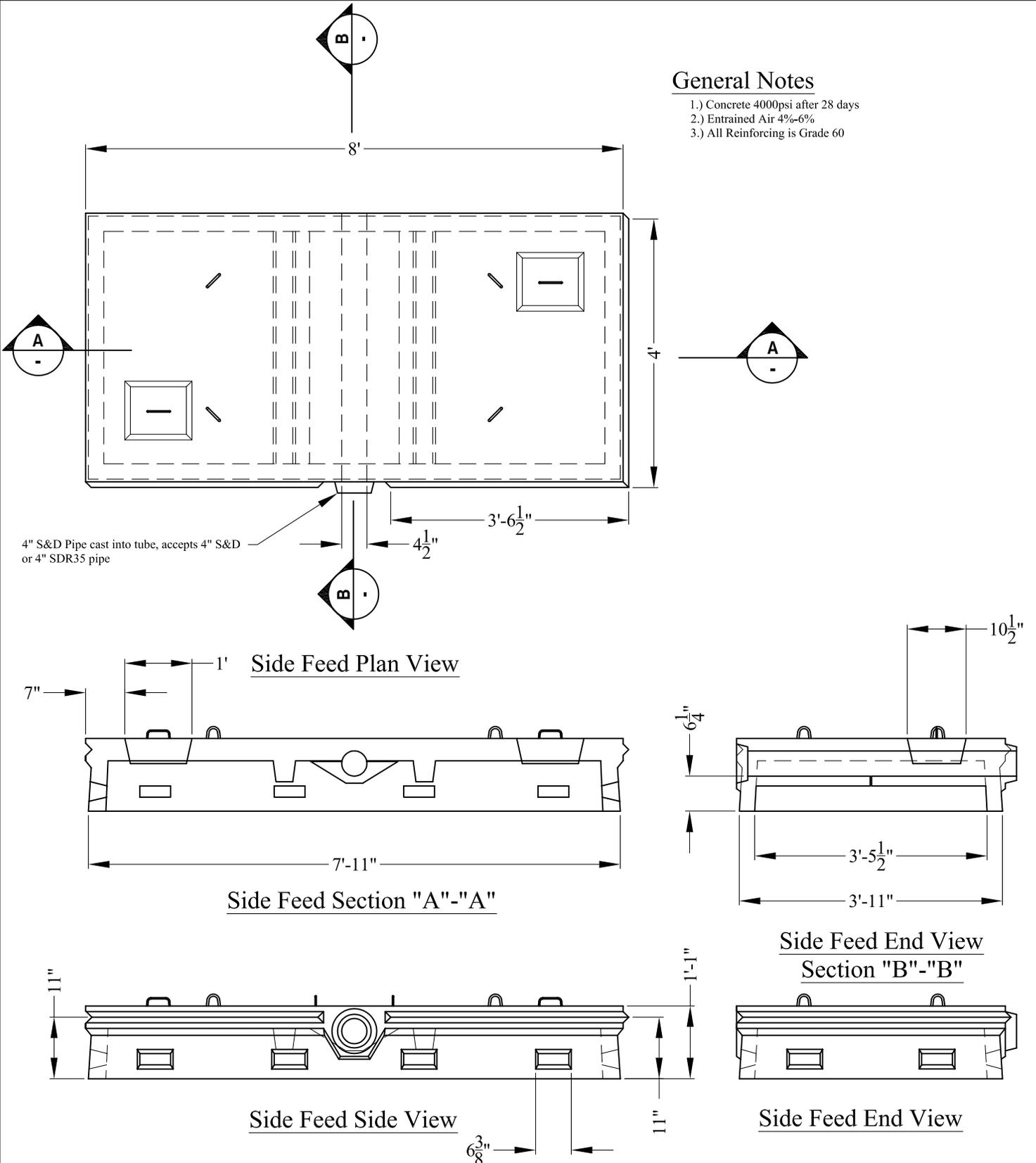
4' X 8' SF Flow Diffuser

Catalog Section: Residential. Leaching Chambers

Layout Name:

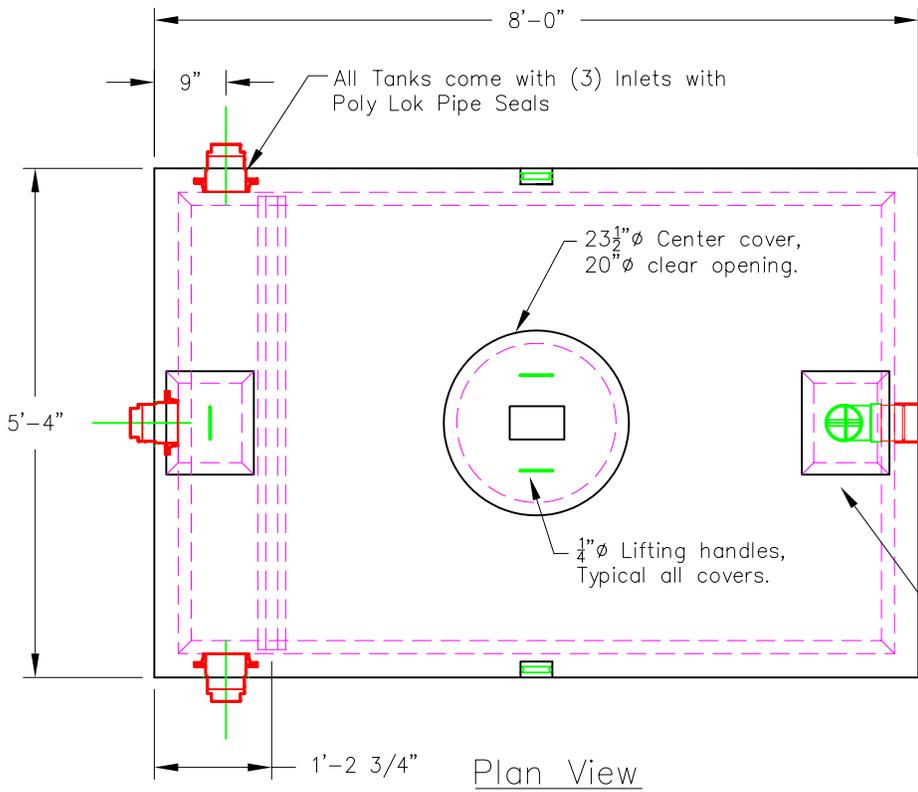
General Notes

- 1.) Concrete 4000psi after 28 days
- 2.) Entrained Air 4%-6%
- 3.) All Reinforcing is Grade 60



1000 Gallon Septic Tank

Weight: 9000 lbs.
 Item # 2039 Standard
 Item # 2133 Heavy Duty



General Notes:

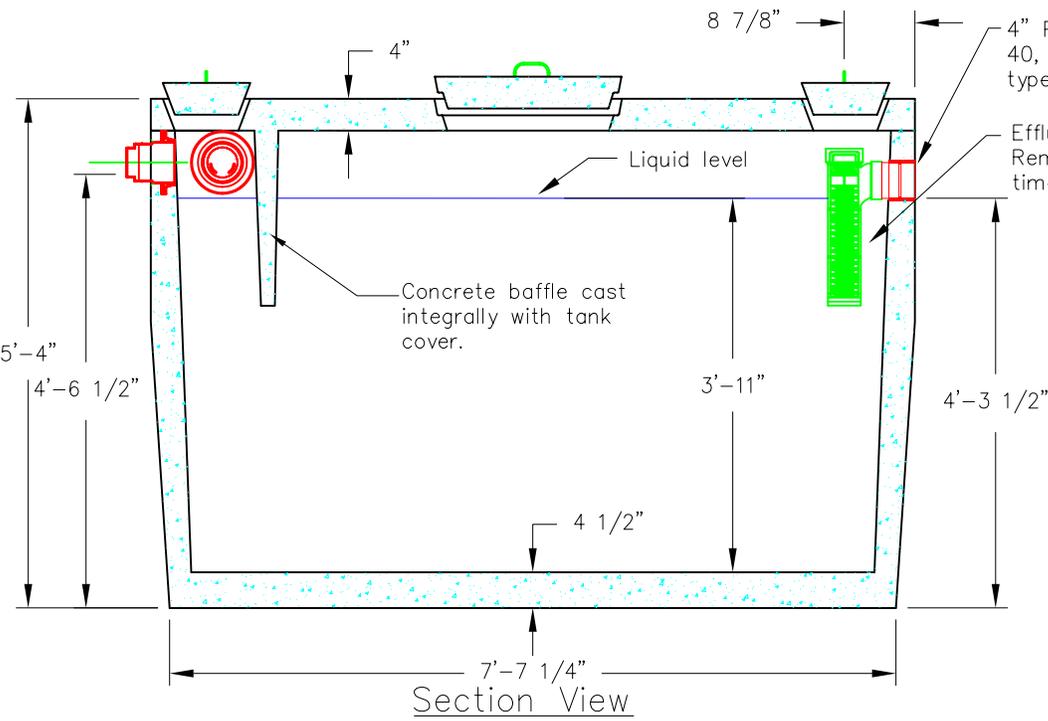
Concrete Specifications:

- 1) 4000 psi @ 28 Days
- 2) 4%-6% Entrained Air
- 3) Tank Penetrations are integrally cast
- 4) All joints sealed with butyl rubber joint sealant

Septic Tank Information:

- 1) Tanks Should be pumped every 3-5 years
- 2) Center access covers should have risers to bring cover access to grade.
- 3) Tanks can be vacuum tested at an additional cost

11" X 13" Cleanout cover
 at each end of tank.
 8" X 10" clear opening.



4" PVC coupling accepts SCH 40, SDR 35 or S&D. All pipe types should be glued.

Effluent filter installed on outlet. Remove, clean and reinstall every time tank is pumped.



American Concrete Industries

2022 Minot Ave. Auburn, ME / 1717 Stillwater Ave. Veazie, ME
 Tel: 207-784-1388 / Tel: 207-947-8334

Last Revised:
 01/06

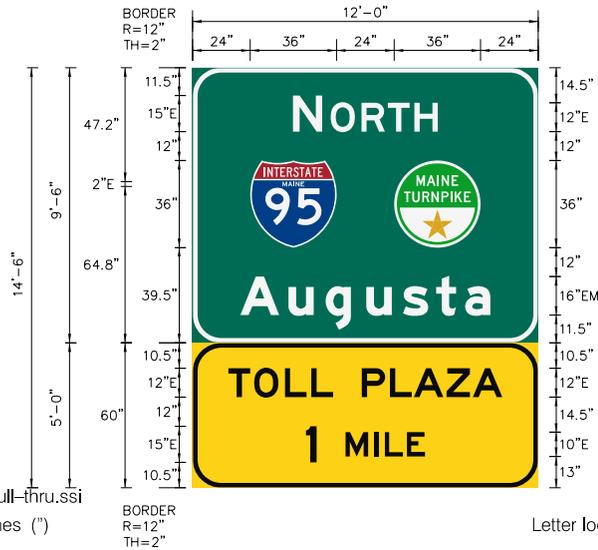
PG. XXX

APPENDIX D

SIGN TEXT LAYOUT SHEETS

SIGN DETAIL

1:75



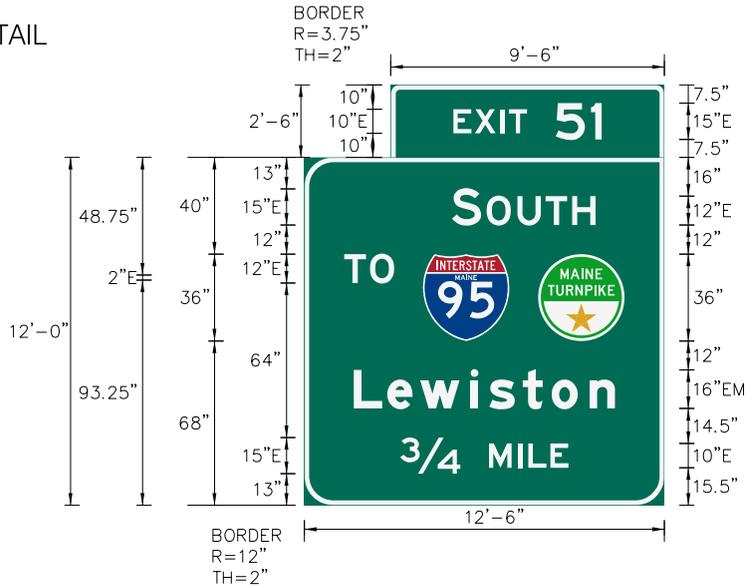
SIGN NUMBER	SP-3
WIDTH x HGHT.	12'-0" x 14'-6"
BORDER WIDTH	2"
CORNER RADIUS	12"
MOUNTING	Overhead
BACKGROUND	TYPE: Reflective
	COLOR: Green/Yellow
LEGEND/BORDER	TYPE: Reflective
	COLOR: White/Black/White

SYMBOL	ROT	X	Y	WID	HT
M1_1(95)	0	24	39.5	36	36
M1_1(MT)	0	84	39.5	36	36

LETTER POSITIONS (X)															LENGTH	SERIES/SIZE
N	O	R	T	H											60.29	E 2000 15,12
41.86	57.51	70.35	81.39	92.43												
M	A	I	N	E											9.12	E 2000 2
37.44	39.66	42.04	42.92	45.06												
A	u	g	u	s	t	a									104.16	EM 2000 16/12
19.92	39.92	55.44	72.4	87.6	101.52	113.52										
T	O	L	L	P	L	A	Z	A							114.12	E 2000 12
14.94	25.62	38.46	49.5	70.5	82.26	92.22	105.78	116.82								
1	M	I	L	E											49.6	E 2000 15,10
47.2	63.7	75.7	80.1	89.3												

SIGN DETAIL

1:75



SIGN NUMBER	SP-4
WIDTH x HGHT.	12'-6" x 12'-0"
BORDER WIDTH	2"
CORNER RADIUS	12"/3.75"
MOUNTING	Overhead
BACKGROUND	TYPE: Reflective
	COLOR: Green
LEGEND/BORDER	TYPE: Reflective
	COLOR: White/White

SYMBOL	ROT	X	Y	WID	HT
M1_1(95)	0	49.38	68	36	36
M1_1(MT)	0	97.38	68	36	36

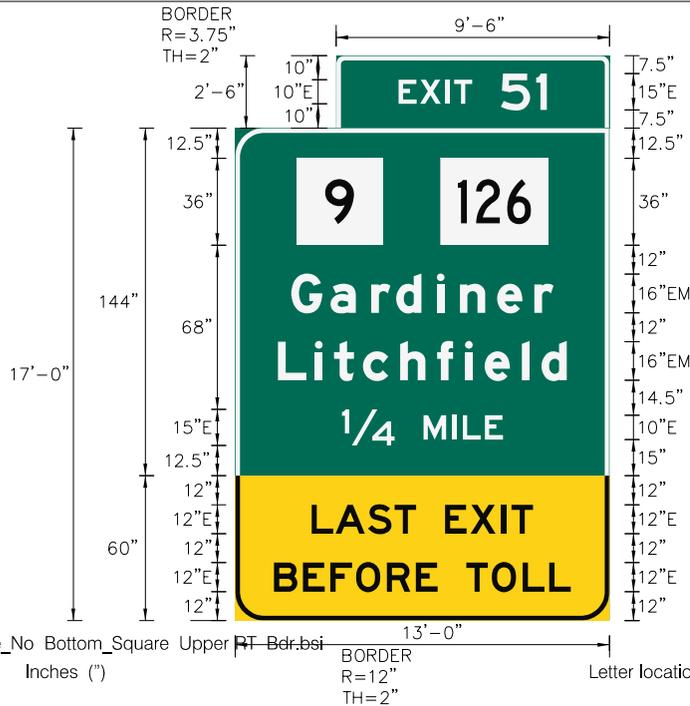
Panel Style: guide_exp_adv_a_Top RT square Bdr.ssi

Dimensions are in Inches (")

Letter locations are panel edge to lower left corner

LETTER POSITIONS (X)																LENGTH	SERIES/SIZE
E	X	I	T	5	1											61.8	E 2000 10,15
26.1	35	45.7	49.2	68.7	83.4												
S	O	U	T	H												59.81	E 2000 15,12
61.47	75.92	88.77	100.53	111.57													
M	A	I	N	E												9.12	E 2000 2
62.82	65.04	67.42	68.3	70.44													
T	O															20.76	E 2000 12
16.62	27.3																
L	e	w	i	s	t	o	n									108.8	EM 2000 16/12
20.6	34.52	48.28	69.24	77.08	91	103	118.84										
3/4	M	I	L	E												70.08	E 2000 15,10
39.96	76.94	88.94	93.34	102.54													

SIGN DETAIL
1:75



SIGN NUMBER	SP-6
WIDTH x HGHT.	13'-0" x 17'-0"
BORDER WIDTH	2"
CORNER RADIUS	12"/3.75"
MOUNTING	Overhead
BACKGROUND	TYPE: Reflective
	COLOR: Green/Yellow
LEGEND/BORDER	TYPE: Reflective
	COLOR: Black/White/White

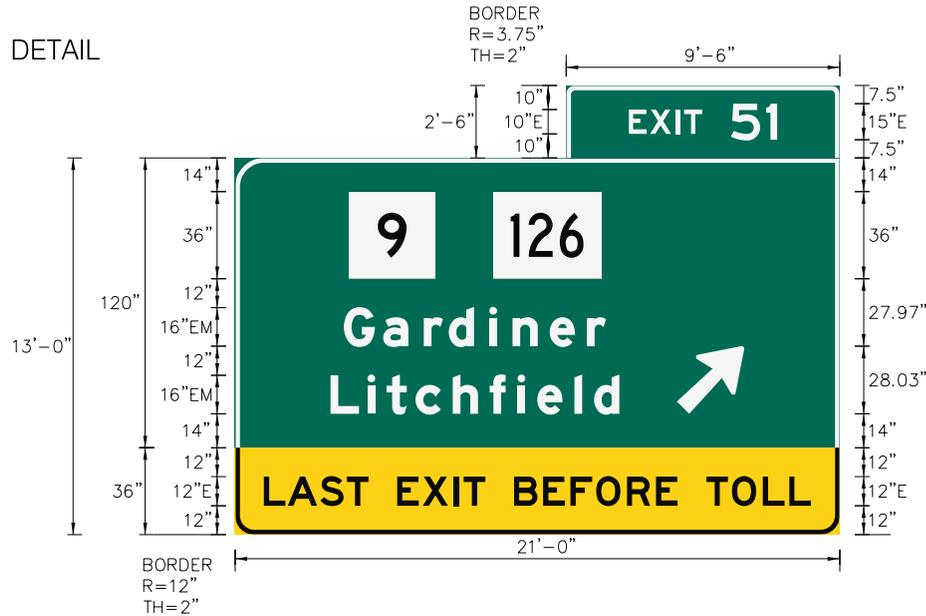
SYMBOL	ROT	X	Y	WID	HT
M1_5(9)	0	25.5	155.5	36	36
M1_5(126)	0	85.5	155.5	45	36

LETTER POSITIONS (X)

LETTER POSITIONS (X)																	LENGTH	SERIES/SIZE
E	X	I	T	5	1												61.8	E 2000
26.1	35	45.7	49.2	68.7	83.4												10,15	
G	a	r	d	i	n	e	r										109.28	EM 2000
23.36	39.68	56.64	67.04	84	93.6	109.12	124.64										16/12	
L	i	t	c	h	f	i	e	l	d								120.32	EM 2000
17.84	33.2	41.2	53.2	68.72	84.08	95.76	103.92	119.44	127.6								16/12	
1/4	M	I	L	E													67.08	E 2000
44.46	78.44	90.44	94.84	104.04													15,10	
L	A	S	T	E	X	I	T										92.28	E 2000
31.86	41.82	55.38	66.42	87.42	98.1	110.94	115.14										12	
B	E	F	O	R	E	T	O	L	L								123.72	E 2000
16.14	28.26	39.66	50.34	63.18	75.3	96.3	106.98	119.82	130.86								12	

SIGN DETAIL

1:75



SIGN NUMBER	SP-8
WIDTH x HGHT.	21'-0" x 13'-0"
BORDER WIDTH	2"
CORNER RADIUS	12"/3.75"
MOUNTING	Overhead
BACKGROUND	TYPE: Reflective
	COLOR: Green/Yellow
LEGEND/BORDER	TYPE: Reflective
	COLOR: White/Black/White

SYMBOL	ROT	X	Y	WID	HT
M1_5(9)	0	47.5	106	36	36
M1_5(126)	0	107.5	106	45	36
AR_Type A	315	184.15	50	22.6	35.6

Panel Style: guide_exp_overhead_no_bottom_square_upper_RT_bdr.ssi

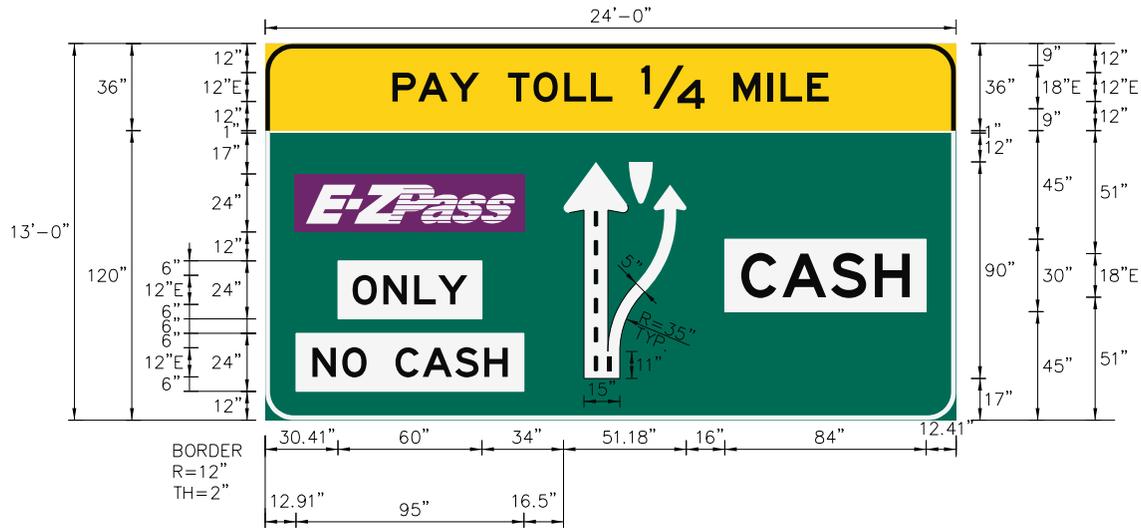
Dimensions are in Inches (")

Letter locations are panel edge to lower left corner

LETTER POSITIONS (X)																	LENGTH	SERIES/SIZE	
E	X	I	T	5	1												61.8	E 2000 10,15	
26.1	35	45.7	49.2	68.7	83.4														
G	a	r	d	i	n	e	r										109.28	EM 2000 16/12	
45.35	61.67	78.63	89.03	105.99	115.59	131.11	146.63												
L	i	t	c	h	f	i	e	l	d								120.32	EM 2000 16/12	
39.83	55.19	63.19	75.19	90.71	106.07	117.75	125.91	141.43	149.59										
L	A	S	T	E	X	I	T	B	E	F	O	R	E	T	O	L	L	228	E 2000 12
12	21.96	35.52	46.56	67.56	78.24	91.08	95.28	116.28	128.4	139.8	150.48	163.32	175.44	196.44	207.12	219.96	231		

SIGN DETAIL

1:75



Panel Style: guide_exp_toll_EZPass_Cash.ssi

Dimensions are in Inches (")

Letter locations are panel edge to lower left corner

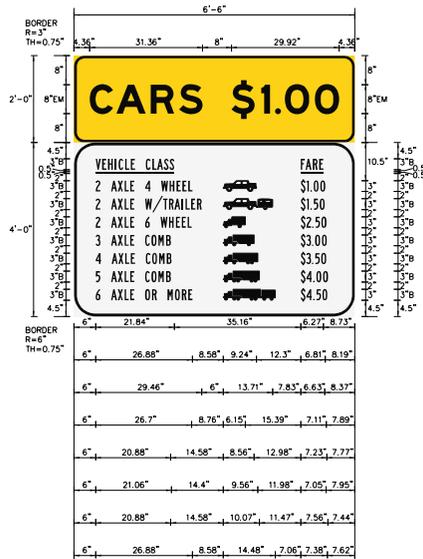
SIGN NUMBER	SP-9
WIDTH x HGHT.	24'-0" x 13'-0"
BORDER WIDTH	2"
CORNER RADIUS	12"
MOUNTING	Overhead
BACKGROUND	TYPE: Reflective
	COLOR: Green/Yellow
LEGEND/BORDER	TYPE: Reflective
	COLOR: Black/White/White

SYMBOL	ROT	X	Y	WID	HT
EZPASS	0	12.41	78	96	24
AR_Type D	0	124.41	85.95	27	21
AR_Type D	0	162.03	86.97	13.6	10.6
MEDIAN_ISL	0	151.58	89.70	10	17.3

LETTER POSITIONS (X)												LENGTH	SERIES/SIZE	
P	A	Y	T	O	L	L	1/4	M	I	L	E			E 2000
53.12	63.8	77	101.24	111.92	124.76	135.8	156.8	195.17	209.57	214.85	225.89	181.77	12,18	
C	A	S	H										E 2000	
198.49	215.59	235.93	254.11									70.2	18	
O	N	L	Y										E 2000	
36.47	49.31	62.15	72.11									47.88	12	
N	O		C	A	S	H							E 2000	
19.73	32.21	42.29	54.29	65.69	79.25	91.37						81.36	12	

SIGN DETAIL

1:50



SIGN NUMBER	SP-18
WIDTH x HGHT.	6'-6" x 4'-0"
BORDER WIDTH	0.75"
CORNER RADIUS	6"Ø
MOUNTING	Ground
BACKGROUND	TYPE: Reflective
	COLOR: Yellow/White
LEGEND/BORDER	TYPE: Reflective
	COLOR: Black/Black

SYMBOL	ROT	X	Y	WID	HT
2 AXLE	0	41.46	34.5	9.24	3
2 AX. W/TRL	0	41.46	29.5	13.71	3
2 AX./6 WH	0	41.46	24.5	6.15	3
3 AXLE	0	41.46	19.5	8.56	3
4 AXLE	0	41.46	14.5	9.56	3
5 AXLE	0	41.46	9.5	10.07	3
6 AXLE	0	41.46	4.5	14.48	3

Panel Style: Toll Fare.ssi

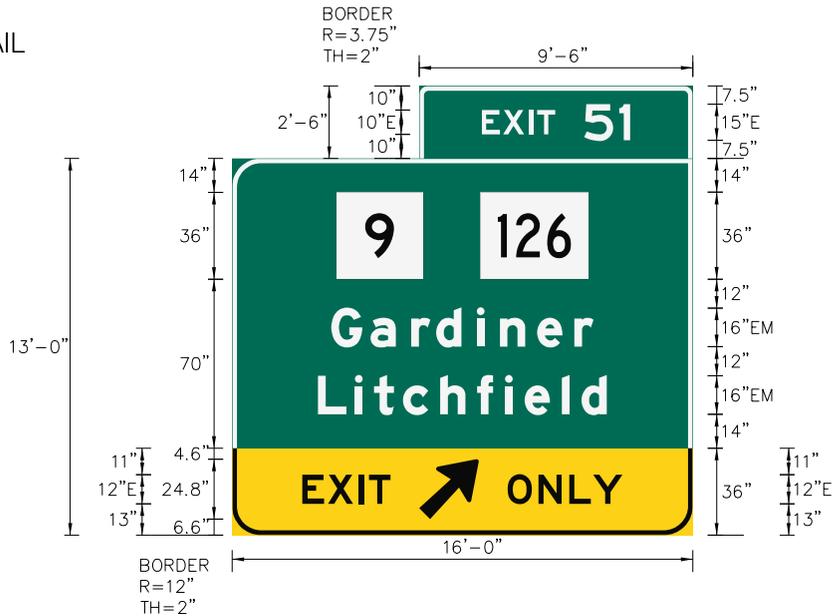
Dimensions are in Inches (")

Letter locations are panel edge to lower left corner

LETTER POSITIONS (X)																		LENGTH	SERIES/SIZE			
C	A	R	S	\$	1	.	0	0											EM 2000			
4.36	11.8	21.32	29.24	43.72	52.04	55.88	58.6	66.92											69.28	8		
V	E	H	I	C	L	E		C	L	A	S	S			F	A	R	E	21.84	B 2000		
6	7.83	9.45	11.4	12.36	14.22	15.78	16.92	19.92	21.78	23.1	24.96	26.55			63	64.32	66.36	68.13	6.27	3		
2		A	X	L	E		4		W	H	E	E	L		\$	1	.	0	0	26.88	B 2000	
6	7.29	10.29	12.15	14.04	15.6	16.74	19.74	21.21	24.21	26.55	28.5	30.12	31.74		63	64.59	65.67	66.57	68.43	6.81	3	
2		A	X	L	E		W	/	T	R	A	I	L	E	R	\$	1	.	5	0	29.46	B 2000
6	7.29	10.29	12.15	14.04	15.6	16.74	19.74	21.75	24.81	26.37	27.9	29.94	30.99	32.55	34.17	63	64.59	65.67	66.57	68.25	6.63	3
2		A	X	L	E		6		W	H	E	E	L		\$	2	.	5	0	26.7	B 2000	
6	7.29	10.29	12.15	14.04	15.6	16.74	19.74	21.03	24.03	26.37	28.32	29.94	31.56		63	64.59	66.15	67.05	68.73	7.11	3	
3		A	X	L	E		C	O	M	B					\$	3	.	0	0	20.88	B 2000	
6	7.29	10.29	12.15	14.04	15.6	16.74	19.74	21.51	23.46	25.59					63	64.53	66.09	66.99	68.85	7.23	3	
4		A	X	L	E		C	O	M	B					\$	3	.	5	0	21.06	B 2000	
6	7.47	10.47	12.33	14.22	15.78	16.92	19.92	21.69	23.64	25.77					63	64.53	66.09	66.99	68.67	7.05	3	

SIGN DETAIL

1:75



Panel Style: Guide_No Bottom_Square Upper RT Bdr.bsi

Dimensions are in Inches (")

Letter locations are panel edge to lower left corner

SIGN NUMBER	SP-25
WIDTH x HGHT.	16'-0" x 13'-0"
BORDER WIDTH	2"
CORNER RADIUS	12"/3.75"
MOUNTING	Overhead
BACKGROUND	TYPE: Reflective
	COLOR: Green/Yellow
LEGEND/BORDER	TYPE: Reflective
	COLOR: White/Black/White

SYMBOL	ROT	X	Y	WID	HT
M1_5(9)	0	43.5	106	36	36
M1_5(126)	0	103.5	106	45	36
AR_Type A	315	78.02	6.6	20	31.5

LETTER POSITIONS (X)																	LENGTH	SERIES/SIZE
E	X	I	T	5	1												61.8	E 2000 10,15
26.1	35	45.7	49.2	68.7	83.4													
G	a	r	d	i	n	e	r										109.28	EM 2000 16/12
41.36	57.68	74.64	85.04	102	111.6	127.12	142.64											
L	i	t	c	h	f	i	e	l	d								120.32	EM 2000 16/12
35.84	51.2	59.2	71.2	86.72	102.08	113.76	121.92	137.44	145.6									
E	X	I	T														36.72	E 2000 12
29.3	39.98	52.82	57.02															
O	N	L	Y														47.88	E 2000 12
114.82	127.66	140.5	150.46															

SIGN DETAIL

1:75



SIGN NUMBER	SP-28
WIDTH x HGHT.	14'-0" x 9'-6"
BORDER WIDTH	2"
CORNER RADIUS	12"
MOUNTING	Overhead
BACKGROUND	TYPE: Reflective
	COLOR: Green
LEGEND/BORDER	TYPE: Reflective
	COLOR: WhiteWhite

SYMBOL	ROT	X	Y	WID	HT
M1_1(295)	0	25.6	67	45	36

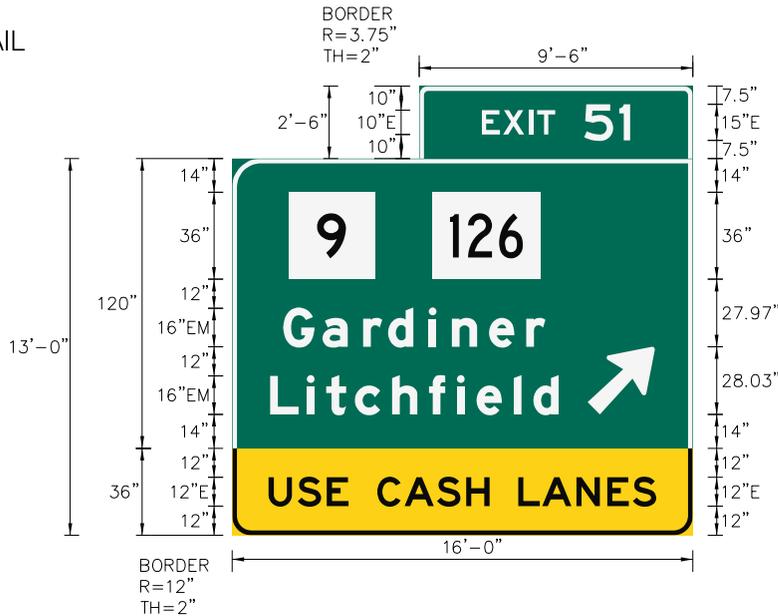
Panel Style: guide_fwy_pull-thru.ssi

Dimensions are in Inches (")

Letter locations are panel edge to lower left corner

LETTER POSITIONS (X)																	LENGTH	SERIES/SIZE
M	A	I	N	E													9.12	E 2000 2
43.87	46.09	48.47	49.35	51.49													59.81	E 2000 15,12
S	O	U	T	H													130.4	EM 2000 16/12
82.6	97.05	109.89	121.65	132.69													104.64	EM 2000 16/12
B	r	u	n	s	w	i	c	k										
18.8	36.24	48.08	65.04	80.24	94	114.96	123.12	138.64										
F	r	e	e	p	o	r	t											
31.68	47.84	58.24	72.32	87.84	101.92	117.76	128											

SIGN DETAIL
1:75



SIGN NUMBER	SP-31
WIDTH x HGHT.	16'-0" x 13'-0"
BORDER WIDTH	2"
CORNER RADIUS	12"/3.75"
MOUNTING	Overhead
BACKGROUND	TYPE: Reflective
	COLOR: Green/Yellow
LEGEND/BORDER	TYPE: Reflective
	COLOR: White/Black/White

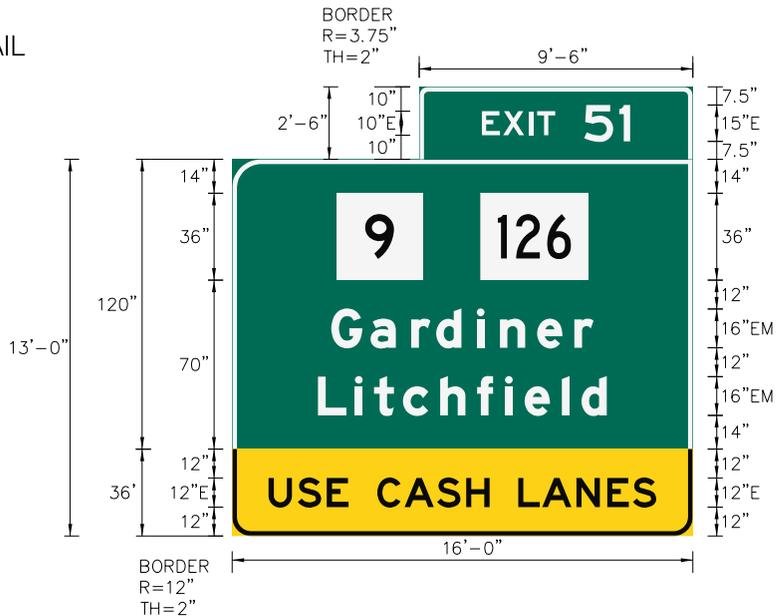
SYMBOL	ROT	X	Y	WID	HT
M1_5(9)	0	23.48	106	36	36
M1_5(126)	0	83.48	106	45	36
AR_Type A	315	148.15	50	22.6	35.6

Panel Style: Guide_No Bottom_Square Upper RT Bdr.bsi
Dimensions are in Inches (")

Letter locations are panel edge to lower left corner

LETTER POSITIONS (X)																LENGTH	SERIES/SIZE
E	X	I	T	5	1											61.8	E 2000 10,15
26.1	35	45.7	49.2	68.7	83.4												
G	a	r	d	i	n	e	r									109.28	EM 2000 16/12
21.35	37.67	54.63	65.03	81.99	91.59	107.11	122.63										
L	i	t	c	h	f	i	e	l	d							120.32	EM 2000 16/12
15.83	31.19	39.19	51.19	66.71	82.07	93.75	101.91	117.43	125.59								
U	S	E	C	A	S	H	L	A	N	E	S					161.52	E 2000 12
15.24	27.36	39.48	60.48	71.88	85.44	97.56	119.28	129.24	143.52	156.36	167.04						

SIGN DETAIL
1:75



SIGN NUMBER	SP-33
WIDTH x HGHT.	16'-0" x 13'-0"
BORDER WIDTH	2"
CORNER RADIUS	12"/3.75"
MOUNTING	Overhead
BACKGROUND	TYPE: Reflective
	COLOR: Green/Yellow
LEGEND/BORDER	TYPE: Reflective
	COLOR: White/Black/White

SYMBOL	ROT	X	Y	WID	HT
M1_5(9)	0	43.5	106	36	36
M1_5(126)	0	103.5	106	45	36

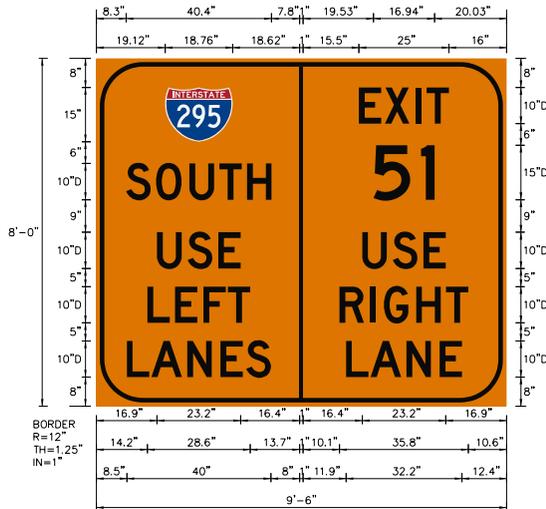
Panel Style: Guide_No Bottom_Square Upper_RT Bdr.bsi
Dimensions are in Inches (")

Letter locations are panel edge to lower left corner

LETTER POSITIONS (X)															LENGTH	SERIES/SIZE
E	X	I	T	5	1										61.8	E 2000 10,15
26.1	35	45.7	49.2	68.7	83.4											
G	a	r	d	i	n	e	r								109.28	EM 2000 16/12
41.36	57.68	74.64	85.04	102	111.6	127.12	142.64									
L	i	t	c	h	f	i	e	l	d						120.32	EM 2000 16/12
35.84	51.2	59.2	71.2	86.72	102.08	113.76	121.92	137.44	145.6							
U	S	E	C	A	S	H	L	A	N	E	S				161.52	E 2000 12
15.24	27.36	39.48	60.48	71.88	85.44	97.56	119.28	129.24	143.52	156.36	167.04					

SIGN DETAIL

1:50



Location(s):
Phase 4 & 5
Approaching New
Active SB Cash
Booths

SIGN NUMBER	CS-1
WIDTH x HGHT.	9'-6" x 8'-0"
BORDER WIDTH	1.25"
CORNER RADIUS	12"
MOUNTING	Ground
BACKGROUND	TYPE: Reflective
	COLOR: Orange
LEGEND/BORDER	TYPE: Reflective
	COLOR: Black/Black

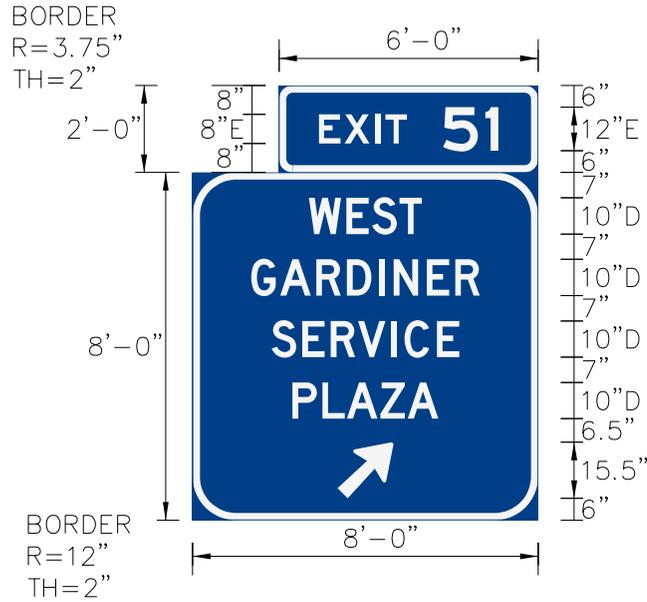
SYMBOL	ROT	X	Y	WID	HT
M1_1(295)	0	19.12	73	18.76	15

Panel Style: Construction Guide.ssi
 Dimensions are in Inches (")

Letter locations are panel edge to lower left corner

LETTER POSITIONS (X)					LENGTH	SERIESIZE	LETTER POSITIONS (X)					LENGTH	SERIESIZE		
S	O	U	T	H			D 2000	E	X	I	T			D 2000	
8.3	16.6	25.9	34.2	41.9	40.4	10	73	80.2	88.7	91.8	25	10			
U	S	E					D 2000	5	1					D 2000	
16.9	25.4	33.9			23.2	10	77.03	90.23			16.94	15			
L	E	F	T				D 2000	U	S	E				D 2000	
14.2	21.9	29.8	36.6			28.6	10	73.9	82.4	90.9			23.2	10	
L	A	N	E	S			D 2000	R	I	G	H	T			D 2000
8.5	15.3	25.3	34.5	41.7	40	10	67.6	76.1	79.9	88.9	97.2	35.8	10		
								L	A	N	E			D 2000	
								69.4	76.2	86.2	95.4	32.2	10		

SIGN DETAIL
1:50



Location(s):
Phase 3
SB Between Existing Plaza & SB Off Ramp (Exit 51)
Phase 4
SB Before Existing Plaza

SIGN NUMBER	CS-4
WIDTH x HGHT.	8'-0" x 8'-0"
BORDER WIDTH	2"
CORNER RADIUS	12"/3.75"
MOUNTING	Ground
BACKGROUND	TYPE: Reflective
	COLOR: Blue
LEGEND/BORDER	TYPE: Reflective
	COLOR: White/White

SYMBOL	ROT	X	Y	WID	HT
AR_Type A	315	40.25	6	12.5	19.69

Panel Style: guide_exp_motor-serv_MOD.ssi
 Dimensions are in Inches (")

Letter locations are panel edge to lower left corner

LETTER POSITIONS (X)																LENGTH	SERIES/SIZE
E	X	I	T	5	1											49.84	E 2000 8,12
11.08	18.2	26.76	29.56	45.56	57.32												
W	E	S	T													31.4	D 2000 10
32.3	42.7	49.9	57.5														
G	A	R	D	I	N	E	R									63.5	D 2000 10
16.25	24.35	34.35	42.85	51.85	55.85	65.05	72.95										
S	E	R	V	I	C	E										52.1	D 2000 10
21.95	30.45	38.35	45.95	55.05	58.85	67.85											
P	L	A	Z	A												40.5	D 2000 10
27.75	36.05	42.85	52.15	59.75													

APPENDIX E

PLAZA SAFETY REQUIREMENTS

PLAZA SAFETY REQUIREMENTS
INTERCHANGE 103 BARRIER TOLL PLAZA
OPEN ROAD TOLLING CONVERSION
(MM 103)

The following are the minimum Plaza Lane closure requirements for completing the work. The limits have been set to protect Turnpike patrons and Toll Attendants from potential harm during the construction. The Contractor shall utilize this information in bidding the work. Drums and construction signs will be paid under their respective pay items. Movement of drums and construction signs will be paid under the Maintenance of Traffic pay item.

The Contractor shall furnish, erect, maintain and relocate twenty 10 inch by 14 inch (minimum dimensions) DANGER – Unauthorized Persons Keep Out, or DANGER – DO NOT ENTER signs, meeting OSHA specifications for size, color and legend, for installation on toll booths or drums, as directed by the Resident. The Contractor shall furnish and install red hazard safety tape between barrels and in cordoned off tunnel and lane areas to identify the hazard areas for Turnpike patrons and Toll Attendants. The purchase, erection, maintenance, and relocation of the hazard signs and hazard safety tape shall be incidental to the mobilization pay item. Providing, maintaining and relocating the specified plywood safety walkways at all locations shall also be incidental to the mobilization pay item.

Unless otherwise specified all labor, materials and equipment required to meet the requirements of Appendix G shall be incidental to the various pay items. Maintenance of Traffic signing shall be in place during plaza work at all times.

APPENDIX F

DEFINED TERMS

DEFINED TERMS

- AVI (Automatic Vehicle Identification): a system consisting of an antenna and reader installed in a toll lane for communication with a transponder located on a vehicle for automatic identification of the transponder as it passes through the lane.
- Canopy Override Switch (COS): shall mean the switch that controls the signal that is located on the canopy on the entry side of each toll lane.
- Sensor Loops: a system for automatic vehicle detection, separation and classification.
- COMM - Communications
- Components: parts that compose a device or piece of equipment.
- DVAS (Digital Video Audit System) – A video camera and image storage system that captures traffic movements in the lane 24 hours a day.
- EMT - Electrical Metallic Tubing
- Gradient Sensor – Part of the Sensor Loop system - a gradient sensor is placed on each side of the Primary sensor.
- Contractor: the Contractor hired by the Authority through a solicitation process to complete the Project.
-
- JB - Junction Box
- Lane Controller (LC): A computer system for each type of toll lane that controls the lane equipment.
- Manual Lane Terminal (or MLT): A device consisting of an array of touch screen buttons and associated electronics for processing toll transactions in the attended tollbooths.
- MTA - Maine Turnpike Authority
- NTS -Not to Scale
- Paypoint Sensor – Part of the Sensor Loop system. Detects when the vehicle has reached the lane paypoint, in this case the tollbooth door centerline.
- Primary Sensor – Part of the Sensor Loop system. Located between two gradient sensors, a 6' x '6 square sensor that participates in vehicle classification.
- Project: shall mean the upgrade of the existing New Gloucester Barrier Toll Lane 8 to the toll collection system described in herein.
- RMC - Rigid Metallic Conduit

- RP (Receipt Printer) – Receipt printer that communicates with the payment system. Located in the booth.
- Specifications: shall mean the Technical Specification and instructions included in this document for the purpose of defining the installation procedures
- SI (Systems Integrator) - The systems integrator/contractor for the MTA toll system.
- SS - Stainless Steel
- TCP (Traffic Control Pedestal): A pedestal to mount a traffic signal and screen with a message to patrons.
- UPS - Uninterrupted Power Supply
- VES (Violation Enforcement System) – Cameras that automatically capture digital photographic images of vehicles and their license plates.

APPENDIX G

PLAZA WORK CHECKLIST

APPENDIX H

PRODUCT DATA SHEETS

Costar CHG3000S Series

Weatherproof Environmental Enclosure



The CHG3000S Series environmental enclosures house 1/3-inch or 1/2-inch format CCD cameras. Side openings allow easy access to the removable camera sled. The weatherproof CHG3000S is designed for indoor and outdoor use and has a body length of 12.5 inches. These housings work with fixed focal length or small zoom lenses. Also available is a 24V heater/blower kit.

Product Features

- For 1/3-inch format CCD cameras
- All aluminum construction
- Side opening for easy access
- Designed for indoor/outdoor applications; for use with fixed mount or pan/tilt
- Dustproof, IP66 weatherproof rated

CHG3000S Series Specifications

Models

CHG3000S	Enclosure, environmental, 12.5-inch (31.75 cm) lower body length
CHG3000SHB	Enclosure, environmental, 12.5-inch (31.75 cm) lower body length. 24V thermostat controlled heater and blower

General

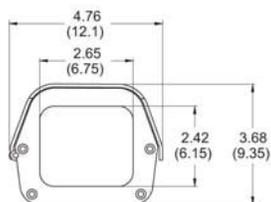
Maximum Camera and Lens Size	Accepts camera and lens combinations (including BNC connector) up to: CHG3000S 11.5" L x 3.5" W x 2.5" H (29.21 cm x 8.89 cm x 6.35 cm) CHG3000SHB 11.5" L x 3.5" W x 2.5" H (29.21 cm x 8.89 cm x 6.35 cm)
Window Size	.11-inch (3.0 mm) thick tempered glass 2.42" H x 2.65" W (6.15 cm x 6.75 cm)
Construction	Die-cast, extruded, and sheet aluminum
Finish	Light-gray polyester power coat
Camera Mounting	Removable camera sled with adjustable height
Housing Mounting	Two (2) 1/4-20 tapped holes
Cable Entry	Two .35-inch (9.0 mm) glands on rear of housing
Rear Locking	Located at rear of housing; available for security lock
Environment	Indoor/outdoor: -10°F to 120°F (-23.33°C to 48.89°C)
Weight	Unit Shipping
CHG3000S	2.70lb (1.23kg) 3.03lb (1.38kg)
CHG3000SHB	3.67lb (1.67kg) 4.18lb (1.90 kg)

Electrical

Input Voltage	24VAC, 50/60Hz lower body length
---------------	----------------------------------

Power Consumption

Heater	Heater activates ON at 42-58°F (6-14°C) and OFF at 72-88°F (22-31°C), 20W, 0.83 Amp
Blower	Blower activates ON at 77-93°F (25-34°C) and OFF at 62-78°F (17-26°C), 2W, 0.08 Amp



Optional Accessories

CHG3000-02	Heater kit, 24V, 20W, 0.83 Amp
CHG3000-03	Blower kit, 24V, 2W, 0.8 Amp

Note: Heater and Blower assemblies require O/I PCB BOARD assembly for connection.

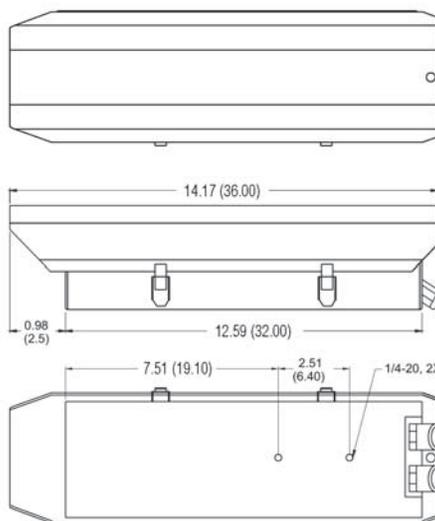
Recommended Mounts

Wall CHG2700	Light duty wall mount. Max. load 20 lb (9.06kg)
Ceiling/Pedestal CHG2720	Medium duty ceiling "J" mount. Max. load 20 lb (9.06kg)

Design and specifications subject to change without notice.

Conversion: 1" = 25.4mm

Measurement conversions are approximate.



Unit: inch(cm)

EM1109/EM2000/EM2200 Mount

PIPE/POLE MOUNT, MEDIUM DUTY, ENCLOSURE

Product Features

- Low Cost
- Manually Adjustable Swivel Head
- Cable Feedthrough Hole
- Supports up to 40 lb (18.14 kg)
- Mounts on Vertical or Horizontal Pipe/Pole; Mounting Straps Included
- Compatible with Most Pelco Enclosures with a 2-Inch (5.08 cm) Mounting Pole Pattern

The **EM1109/EM2000/EM2200** are medium duty enclosure mounts designed for applications where mounting on a pipe or pole is necessary. These mounts can be used with Pelco enclosures having a 2-inch (5.08 cm) mounting hole pattern and are capable of supporting up to 40 lb (18.14 kg). All three mounts feature a manually adjustable swivel head and a cable feedthrough hole to conceal wiring. Multiple mounting holes on the tilt table provide maximum 360-degree horizontal positioning of the enclosure.

The **EM1109** is a pedestal mount for use on a horizontal or vertical pipe or pole. The **EM2000** is a J-type mount for use on a vertical pipe or pole, and the **EM2200** is a "hook" type mount for use on a horizontal pipe or pole. The **EM1109/EM2000/EM2200** must be mounted on pipes or poles having a 3-inch (7.62 cm) to 8-inch (20.32 cm) diameter. Mounts are secured to the pipe or pole with stainless steel mounting straps. Two 1/4-20 mounting bolts required to secure the enclosure to the mount are also supplied.

The **EM1109/EM2000/EM2200** are constructed of aluminum and have a white epoxy powder coat finish.



EM2200



EM2000



EM1109



TECHNICAL SPECIFICATIONS

MODELS

EM1109	Medium duty pedestal mount for horizontal or vertical pipe or pole applications. Manually adjustable swivel head and cable feedthrough hole.
EM2000	Medium duty 90 degree J-mount for vertical pipe or pole applications. Manually adjustable swivel head and cable feedthrough hole.
EM2200	Medium duty "hook" mount for horizontal pipe or pole applications. Manually adjustable swivel head and cable feedthrough hole.

MECHANICAL

Pan Adjustment	Unlimited 360°
Tilt Adjustment	±75°
Locking Method	3/8-16 hex head bolts (on manually adjustable swivel head)

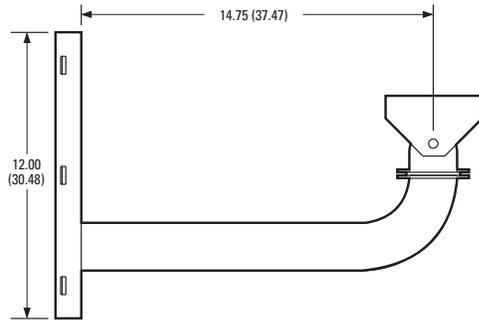
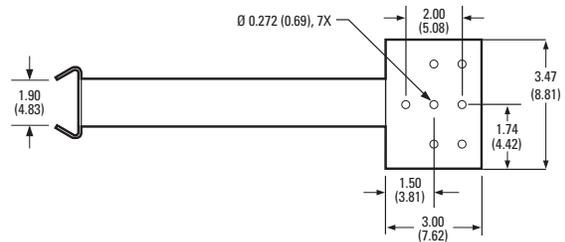
GENERAL

Suggested Mounting Method	Slots provided for mounting straps; 3 stainless steel straps supplied. Straps fit 3-inch (7.62 cm) to 8-inch (20.32 cm) diameter pole.
Enclosure Mounting	2, 1/4-20 mounting bolts (supplied)
Maximum Load	40 lb (18.14 kg)
Construction	Aluminum
Finish	White epoxy polyester powder coat
Environment	Indoor/outdoor
Unit Weight	
EM1109	1.88 lb (0.85 kg)
EM2000	3.05 lb (1.38 kg)
EM2200	3.51 lb (1.59 kg)
Shipping Weight	
EM1109	3 lb (1.36 kg)
EM2000	8 lb (3.60 kg)
EM2200	9 lb (4.10 kg)

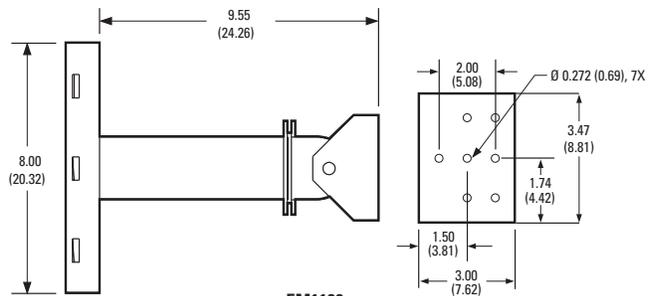
RECOMMENDED ENCLOSURES

Pelco enclosures having a 2-inch (5.08 cm) mounting hole pattern can be used with these mounts. Be sure the enclosure/camera/lens combination you select does not exceed 40 lb (18 kg) and is suitable for the type of mount you have selected. The following list indicates the most applicable enclosures.

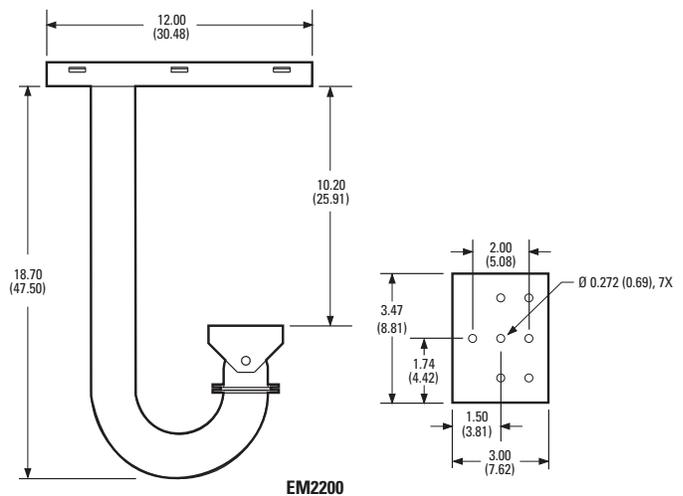
- EH3010/EH3014 Series
- EH4010 EH4014 Series
- EH3508 Series, Environmental
- EH3512/EH3515 Series, Environmental
- EH4700 Series, Environmental
- EH4700DB Series, Environmental
- E700 Series, Dust-Tight
- EHX4E, Explosion-Proof
- EH8100 Series, Pressurized



EM2000



EM1109



EM2200

NOTE: VALUES IN PARENTHESES ARE CENTIMETERS; ALL OTHERS ARE INCHES.



Pelco, Inc. Worldwide Headquarters:
 3500 Pelco Way, Clovis, California 93612-5699 USA
USA & Canada Tel: (800) 289-9100 • FAX: (800) 289-9150
International Tel: +1 (559) 292-1981 • FAX: +1 (559) 348-1120
www.pelco.com

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112 RAILROAD ST., REVERE, MA 02151
(800) 420-0021; (781) 289-1400; (781) 289-1405 (FAX)
www.durantcorp.com

STAT-A-FLEX PRODUCT DATA SHEET

PRODUCT NAME: STAT-A-FLEX TRAFFIC LOOP SEALER
CHEMICAL FAMILY: UNSATURATED POLYESTER RESIN

PHYSICAL PROPERTIES:

BOILING POINT: 293°F (Styrene)
SPECIFIC GRAVITY: 1.25 +/- 0.15
VAPOR PRESSURE: (mm Hg) 5.2 (Styrene)
PERCENT VOLATILE BY WT : 18-22 %
VAPOR DENSITY (AIR=1): 3.6 (Styrene)
EVAPORATION RATE (Bu Ace=1): UK
SOLUBILITY IN WATER: Negligible
WEIGHT PER GALLON: Approx. 10.5 lbs
SHORE D HARDNESS @ 24HRS: 73 +/- 5
VISCOSITY: 104 KU
GEL TIME (@ 77 ° F): 10 – 20 min. [ASTM C881]
TACK FREE (@ 77 ° F): 15-25 min.
CURING TIME (@ 77 ° F): 45-60 min.
ELONGATION: 18 - 20 % [ASTM D638-96]
TENSILE STRENGTH: > 1000 psi [ASTM D638-96]
FLEXURAL STRENGTH: >1200 psi [ASTM D790]
ADHESION
Steel : 800 +/- 100 psi
Portland Cement: 300psi [ASTM D3163-84]
ABSORPTION 24 HOURS
Water: 0.2% [ASTM D570]
No. 3 Oil 0.02% [ASTM D570]
Gasoline 0.04% [ASTM D570]
Jet Fuel (Submersion No Dissolution) 0.06%
3% NaCl 0.2%

STAT-A-FLEX ADVANTAGES:

- Two part, component system, utilizing a liquid methyl ethyl ketone peroxide (MEKP) hardener.
- Bonds to all road surfaces
- Self leveling liquid / Pours fluidly
- Requires no special equipment, just mix and pour
- Cures in less than 20 minutes to produce a tough weather resistant seal
- Adjustable dry times regulated by amount of hardener (MEKP) added
- Totally encapsulates traffic detector loop wire
- Will not react with wire insulation
- Formulated to withstand stresses due to traffic vibrations
- Resistant to cracking caused by expansion and contraction due to temperature changes
- Resistant to most chemicals and solvents including road salts, acids, hydrocarbons, brake fluids, oils, gasoline and jet fuel
- Available in 1 Gal., 3.5 Gal., and 5 Gal. pails

STAT-A-FLEX Application Instructions:

- For best results STAT-A-FLEX should be mixed with a powered mixer
- Mix for one minute, then pour in desired amount of hardener and mix for two minutes
- Pour STAT-A-FLEX into saw cut to be filled (It's that easy!)
- Hardener component amounts may be adjusted according to temperature
- An ACCELERATOR is also available for use in colder climates to further reduce drying time
- NOTE: Improper mixing may cause poor results

STAT-A-FLEX Storage and Shelf Life:

- Best if stored at temperatures under 80 °F
- Shelf life of 12 months (unopened)

Direct-View LED Traffic Controller DOT2424RG-175

PRODUCT NUMBER
5651



CABINET DIMENSIONS
24" H x 24" W x 5" D

ILLUMINATION SOURCE

Super bright, narrow viewing angle LEDs
Available in green, red, blue, amber, and white LEDs
Messages "blankout" when turned off, eliminating confusion
Long life, solid state lighting

ELECTRICAL

Integrated solid state power supply
Photocell for auto photodimming
Standard Voltage: 120 VAC, Optional Voltages: 9-36 V, 240 VAC, 277 VAC
Maximum amps per lighted message (at 120 V) shown in the table below
UL/CUL approved for wet locations

CONSTRUCTION

Faces: Single Faced Sign
Cabinet: (DOT): NEMA 4X Rated, 1/8" wall T5052 aluminum cabinet with continuously welded seams. Optional Visor
Door: Continuous hinge with a 1" x 1/4" silicone gasket and stainless steel tool free door latches
Face Material: impact resistant, 1/4" thick smoke tinted polycarbonate

FINISH

Standard Cabinet Color: Black
Custom colors available upon request

MESSAGE	COLOR	HEIGHT	AMPS
X	30° Red Round	18.0"	0.17
Down Arrow	30° Green Round	18.0"	0.13

Trans-Tech

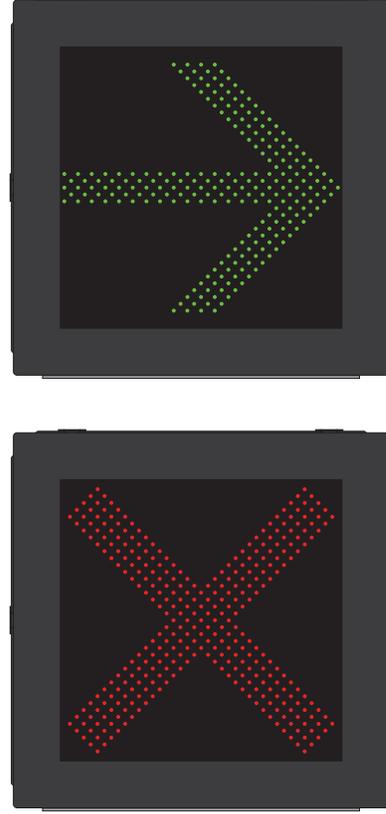
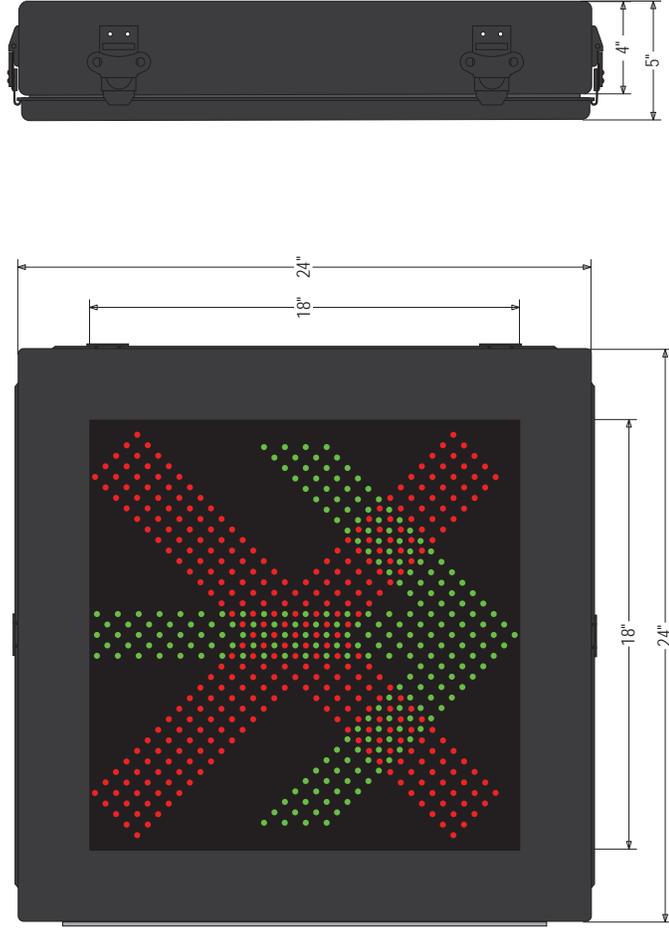
4999 Pittsburgh Ave.
Erie, PA 16509
Phone: (888) 811-7010
Fax: (814) 836-8401
Email: sales@transportation-tech.com
Website: www.transportation-tech.com

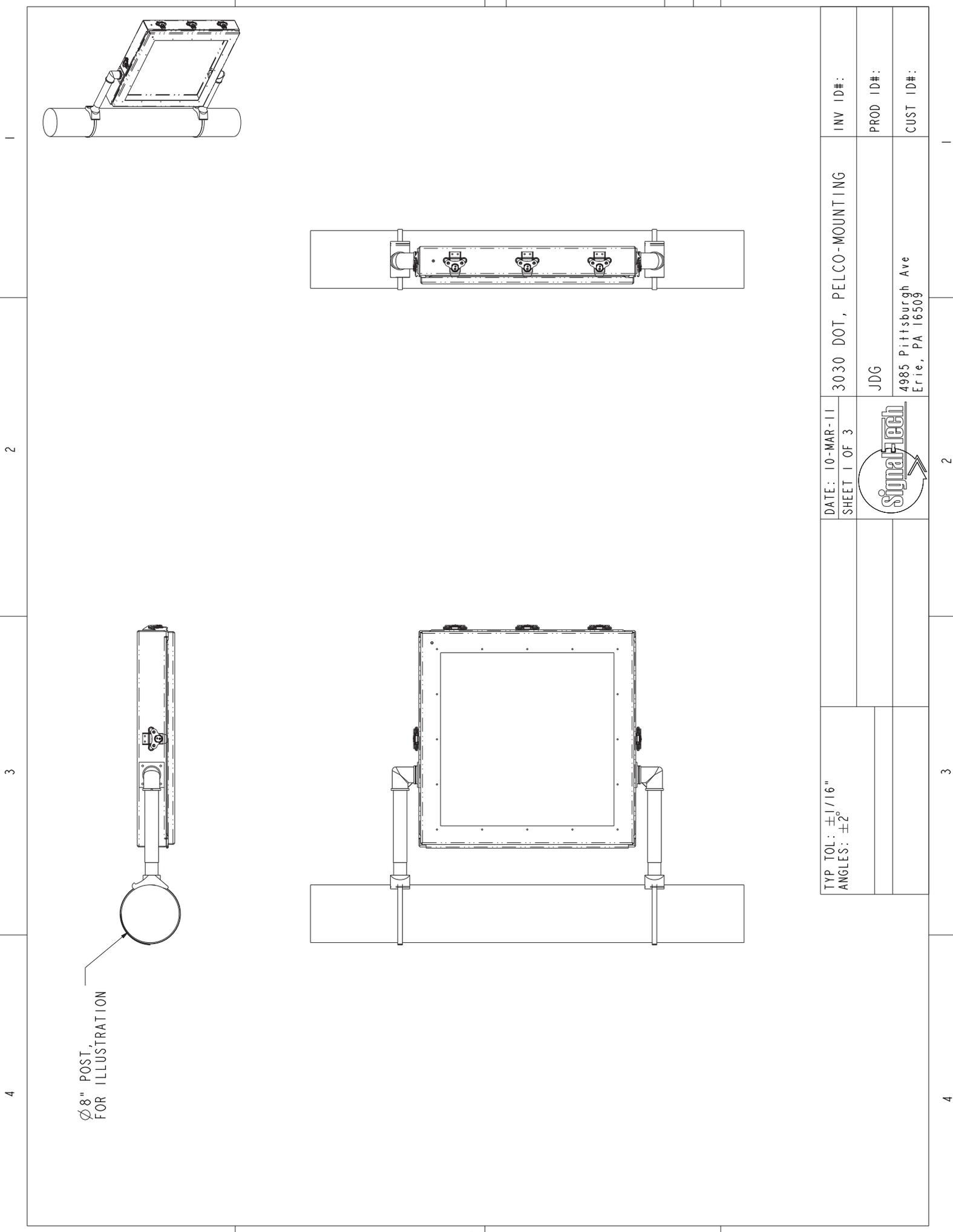


Proudly Made in the USA

Product View

NOTE: Sign image may not exactly represent the finished product. For illustration purposes only.

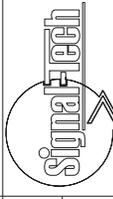




Ø8" POST,
FOR ILLUSTRATION

TYP. TOL: ±.1/16"
ANGLES: ±2°

DATE: 10-MAR-11
SHEET 1 OF 3



3030 DOT, PELCO-MOUNTING

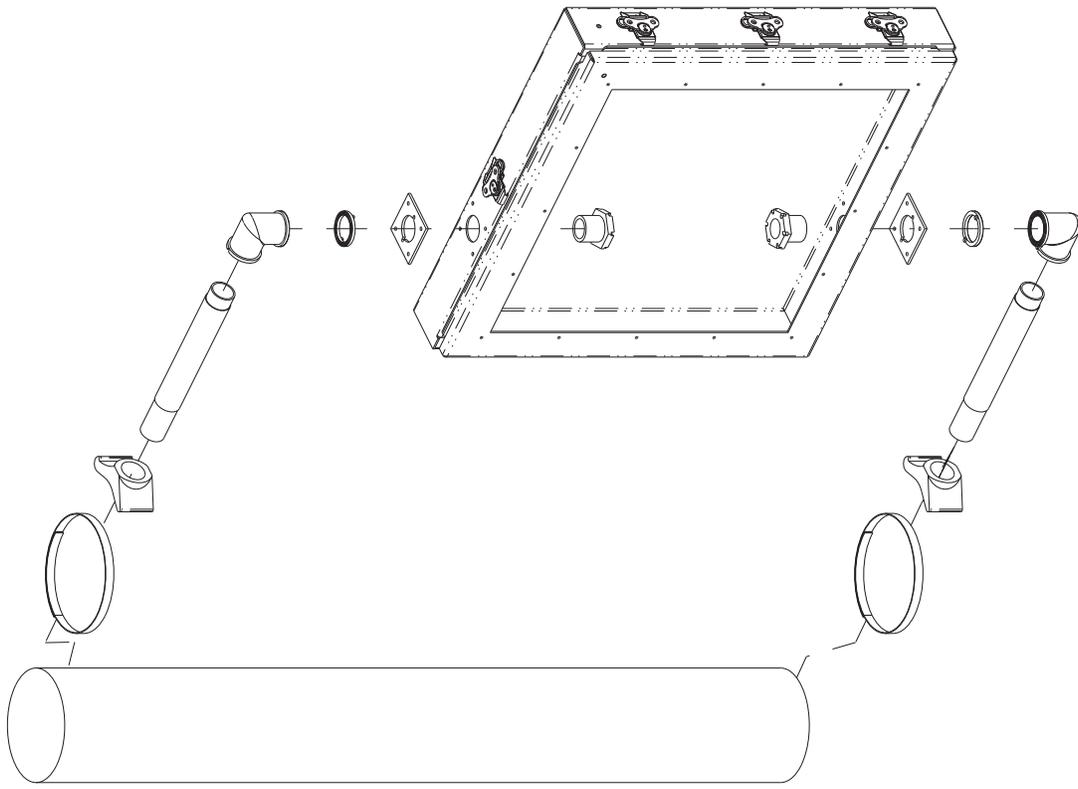
INV ID#:

JDG

PROD ID#:

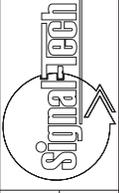
4985 Pittsburgh Ave
Erie, PA 16509

CUST ID#:



TYP TOL: $\pm 1/16"$
 ANGLES: $\pm 2^\circ$

DATE: 10-MAR-11
 SHEET 2 OF 3



3030 DOT, PELCO-MOUNTING

INV ID#:

JDG

4985 Pittsburgh Ave
 Erie, PA 16509

PROD ID#:

CUST ID#:

4	3	2	1
D	C	B	A
AP - 30			

Vanguard® VS-5220 VSLS

Daktronics Vanguard® VS-5220 variable speed limit signs (VSLS) are designed to be an integrated, enforceable, and affordable part of a traffic management system. The signs provide high legibility 18-inch digits that are easily changed as traffic and weather conditions change.

The VS-5220 features an active LED speed limit pixel matrix and surrounding reflective 48-inch wide by 60-inch tall MUTCD-compliant static panel. The high-resolution LED pixel matrix allows clearly formed black digits on a white background that approximate the E-series fonts specified by the MUTCD. In freeway situations, the signs are nearly indistinguishable from static signs. All of this makes them more easily enforced than the amber VSLS seen in the market today.

The signs use a blend of long-life red, green, and blue LEDs to create the white light used for the speed limit background. An integrated light sensor automatically adjusts the LED intensity for all ambient lighting levels. Under full sunlight, the LEDs match the reflectivity of the surrounding speed limit panel. At night, the LEDs dim to a very legible level that will not blind drivers and is not washed out by headlights. Our long-life LED technology is designed for a 100,000 hour life and consumes less than 150 watts at full intensity.

The VS-5220 is designed for the roadside environment and features a number of features typically found only in high-end variable message signs (VMS). A forced-air ventilation system provides filtered air to keep the sign cool. Pixel diagnostics allow remote monitoring of the sign to ensure legibility, and the internal controller and mounting location for communication equipment eliminates the need for costly traffic cabinets.

The VS-5220 features a powerful NTCIP-compliant controller that integrates into nearly any traffic management system. The posted speed limit can be scheduled or controlled manually. The built-in logging function keeps track of all speed limit changes. Daktronics offers Vanguard software, which can control, configure, and monitor the VSLS, as well as any other NTCIP-compliant DMS.

The Vanguard VS-5220 VSLS are the best choice for a speed management solution. The signs offer the features needed, and allow integration into any NTCIP-compatible traffic management system.



Vanguard® VS-5220 VSLS

Key Features

Dynamic Sign Panel

- Programmable matrix capable of two - 18-inch (473 mm) speed digits
- Black digits on white background
- Legible from greater than 1000 ft (305 m)
- High-intensity LED technology
- Wide 30-degree LED viewing angle
- Minimum brightness of 12,400 cd/m²
- Pixel self-diagnostics ensure legibility
- Contrast-enhancing louvers shield pixels from sunlight
- Built-in pixel diagnostics monitor LED operation
- Automatic brightness control using integrated light sensor

Static Sign Panel

- 48-inch by 60-inch aluminum panel
- MUTCD-compliant
- Reflective white 3M sheeting

Cabinet Style

- Lightweight all-aluminum cabinet construction
- Front service access cabinet for easy maintenance
- Forced-air, filtered ventilation system keeps sign cool
- Mounts to existing poles (hardware not included)

Control System & Diagnostics

- Internal NTCIP-compliant controller
- Automatic speed change logging
- Manual or scheduled speed control
- Available Vanguard control software

Specifications

Dynamic Sign Panel Specifications

- Pixel Matrix: 16 rows by 24 columns
- Pixel Pitch: 1.33 in (34 mm)
- Default Font Size: 14 rows by 10 columns
- Active Area: 1'9" H x 2'8" W (544 mm x 816 mm)

Static Sign Panel Specifications

- MUTCD-compliant speed limit panel
- 60" H x 48" W (1.52 m x 1.22 m) panel
- Reflective white 3M sheeting with black E-series lettering

Physical Specifications

- Speed Limit Panel Size: 60" H x 48" W (1.52 m x 1.22 m)
- Sign Cabinet Size: 27" H x 35" W x 6" D (686 mm x 889 mm x 152 mm)
- Sign Weight: 100 lbs (45.4 kg)
- Operating Temperature Range: -40° F to +140° F (-40° C to +60° C)
- Humidity Range: 0 to 99%, non-condensing
- 120 VAC single-phase power (2 wires plus ground)
- Max Power: 197 watts
- Typical Power: 145 watts

Controller Specifications

- NTCIP-compatible controller
- Compatible with dial-up, cellular, fiber, Ethernet, radio, RS-232, RS-422, and other communication devices
- Controller mounted within cabinet
- Internal mounting shelf for communication equipment

Design and Manufacturing Standards

- NTCIP-compliant control system
- Designed to AASHTO wind-load requirements
- Welders certified to AWS D1.2
- NEMA 3R cabinet rating

NTCIP Communication Standards

- NTCIP 1203 – DMS Objects
- NTCIP 1201 – Global Objects
- NTCIP 1101 – STMF
- NTCIP 2101 – PMPP/RS-232
- NTCIP 2103 – PPP/RS-232
- NTCIP 2104 – Ethernet
- NTCIP 2202 – TCP/IP
- NTCIP 2301 – STMF

Daktronics VSLs versus Static Sign



Vanguard® VS-5220 VSLs



Static Speed Limit Sign



VANGUARD® VL-35X0 DISPLAY

LOUVERED FACE, FRONT ACCESS DMS

The Daktronics Vanguard® VL-35X0 dynamic message sign (DMS) is an NTCIP-compliant solution for applications requiring a light-weight package with an extended viewing angle. The VL-35X0 DMS combines Daktronics quality with fundamental functionality to inform travelers in many ITS applications.

Featuring an innovative high-contrast full-matrix design, the VL-35X0 provides legibility ideal for locations such as arterial roads and toll booths. The sign's modular design allows it to be built in many sizes. A 70-degree viewing cone and a 6-inch minimum character height add versatility to the VL-35X0. Available in amber or full color, the display's full-matrix configuration creates larger characters and graphics.

FEATURES AND BENEFITS

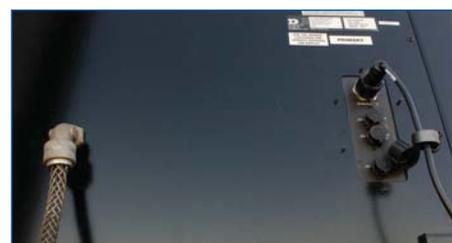
- Lightweight, quick-detach modules for easy front-side access to components
- Durable louvers enhance contrast, optimize brightness, eliminate glare and allow a wide viewing angle
- Continually-cooling, forced-air ventilation for increased DMS longevity
- Available in amber and full color models
- Internal NTCIP-compliant controller built for reliability
- Integrates with Ethernet (wire or fiber) and RS422 serial



Front-access, louvered-face design

TECHNICAL SPECIFICATIONS

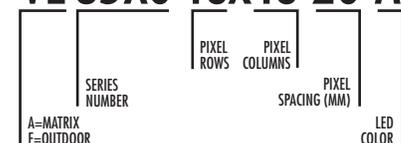
Pixel pitch	20mm center-to-center
Character height	6-inch standard character height
Color capability	Monochrome (amber) or full color
Full Color Brightness	9,500 cd/m ² maximum
Amber Brightness	5,500 cd/m ² maximum
Estimated LED lifetime	100,000+ hours
Viewing cone	70°
Service access	Front access
Control software	Vanguard v4 control software
Power	120 or 240 VAC single phase
Operating temperature	-40° F to +120° F (-40° C to +50° C)
Humidity range	0 to 95%, non-condensing
Display dimming	Automatic dimming 0-100%
Communication options	Cellular, Ethernet (wire or fiber)
Compliance information	NTCIP v2, UL, FCC and NEC



Power and Signal

MODEL NUMBER GUIDE

VL-35X0-16x48-20-A



VANGUARD® VL-35X0 MODEL SPECIFICATIONS

MODEL NUMBER	APPROX. CABINET DIMENSIONS		LINES/ CHAR. WIDE	WEIGHT		MAX. POWER	
	FEET AND INCHES (HxWxD)	METERS		LBS.	K	AMBER	RGB
VL-35X0-16x48-20-A or RGB	1'9" x 3'8" x 8"	.52 x 1.11 x .21	2/9	60	28	220 W	260 W
VL-35X0-16x64-20-A or RGB	1'9" x 4'9" x 8"	.52 x 1.43 x .21	2/12	70	32	250 W	300 W
VL-35X0-16x80-20-A or RGB	1'9" x 5'9" x 8"	.52 x 1.74 x .21	2/16	80	37	310 W	380 W
VL-35X0-16x96-20-A or RGB	1'9" x 6'9" x 8"	.52 x 2.06 x .21	2/19	100	46	340 W	420 W
VL-35X0-16x112-20-A or RGB	1'9" x 7'10" x 8"	.52 x 2.38 x .21	2/22	110	50	360 W	460 W
VL-35X0-16x128-20-A or RGB	1'9" x 8'10" x 8"	.52 x 2.70 x .21	2/25	130	59	390 W	500 W
VL-35X0-16x144-20-A or RGB	1'9" x 9'11" x 8"	.52 x 3.01 x .21	2/29	140	64	450 W	570 W
VL-35X0-16x160-20-A or RGB	1'9" x 10'11" x 8"	.52 x 3.33 x .21	2/32	160	73	480 W	610 W
VL-35X0-16x176-20-A or RGB	1'9" x 12'0" x 8"	.52 x 3.65 x .21	2/35	170	78	540 W	690 W
VL-35X0-16x192-20-A or RGB	1'9" x 13'0" x 8"	.52 x 3.96 x .21	2/38	180	82	570 W	730 W
VL-35X0-16x208-20-A or RGB	1'9" x 14'1" x 8"	.52 x 4.28 x .21	2/41	200	91	590 W	770 W
VL-35X0-16x224-20-A or RGB	1'9" x 15'1" x 8"	.52 x 4.60 x .21	2/44	210	96	620 W	810 W
VL-35X0-16x240-20-A or RGB	1'9" x 16'2" x 8"	.52 x 4.91 x .21	2/48	230	105	680 W	880 W
VL-35X0-16x256-20-A or RGB	1'9" x 17'2" x 8"	.52 x 5.23 x .21	2/51	240	109	710 W	930 W
VL-35X0-32x48-20-A or RGB	2'9" x 3'8" x 8"	.84 x 1.11 x .21	4/9	90	41	300 W	390 W
VL-35X0-32x64-20-A or RGB	2'9" x 4'9" x 8"	.84 x 1.43 x .21	4/12	110	50	390 W	500 W
VL-35X0-32x80-20-A or RGB	2'9" x 5'9" x 8"	.84 x 1.74 x .21	4/16	130	59	480 W	610 W
VL-35X0-32x96-20-A or RGB	2'9" x 6'9" x 8"	.84 x 2.06 x .21	4/19	160	73	530 W	700 W
VL-35X0-32x112-20-A or RGB	2'9" x 7'10" x 8"	.84 x 2.38 x .21	4/22	180	82	620 W	810 W
VL-35X0-32x128-20-A or RGB	2'9" x 8'10" x 8"	.84 x 2.70 x .21	4/25	200	91	680 W	900 W
VL-35X0-32x144-20-A or RGB	2'9" x 9'11" x 8"	.84 x 3.01 x .21	4/29	230	105	730 W	980 W
VL-35X0-32x160-20-A or RGB	2'9" x 10'11" x 8"	.84 x 3.33 x .21	4/32	250	114	820 W	1,090 W
VL-35X0-32x176-20-A or RGB	2'9" x 12'0" x 8"	.84 x 3.65 x .21	4/35	270	123	910 W	1,210 W
VL-35X0-32x192-20-A or RGB	2'9" x 13'0" x 8"	.84 x 3.96 x .21	4/38	300	137	960 W	1,290 W
VL-35X0-32x208-20-A or RGB	2'9" x 14'1" x 8"	.84 x 4.28 x .21	4/41	320	146	1,050 W	1,400 W
VL-35X0-32x224-20-A or RGB	2'9" x 15'1" x 8"	.84 x 4.60 x .21	4/44	340	155	1,110 W	1,490 W
VL-35X0-32x240-20-A or RGB	2'9" x 16'2" x 8"	.84 x 4.91 x .21	4/48	370	168	1,200 W	1,600 W
VL-35X0-32x256-20-A or RGB	2'9" x 17'2" x 8"	.84 x 5.23 x .21	4/51	390	177	1,250 W	1,690 W
VL-35X0-48x48-20-A or RGB	3'10" x 3'8" x 8"	1.15 x 1.11 x .21	6/9	120	55	420 W	540 W
VL-35X0-48x64-20-A or RGB	3'10" x 4'9" x 8"	1.15 x 1.43 x .21	6/12	150	69	500 W	700 W
VL-35X0-48x80-20-A or RGB	3'10" x 5'9" x 8"	1.15 x 1.74 x .21	6/16	180	82	650 W	850 W
VL-35X0-48x96-20-A or RGB	3'10" x 6'9" x 8"	1.15 x 2.06 x .21	6/19	210	96	730 W	1,010 W
VL-35X0-48x112-20-A or RGB	3'10" x 7'10" x 8"	1.15 x 2.38 x .21	6/22	250	114	820 W	1,170 W
VL-35X0-48x128-20-A or RGB	3'10" x 8'10" x 8"	1.15 x 2.70 x .21	6/25	280	128	900 W	1,290 W
VL-35X0-48x144-20-A or RGB	3'10" x 9'11" x 8"	1.15 x 3.01 x .21	6/29	310	141	1,020 W	1,450 W
VL-35X0-48x160-20-A or RGB	3'10" x 10'11" x 8"	1.15 x 3.33 x .21	6/32	340	155	1,130 W	1,600 W
VL-35X0-48x176-20-A or RGB	3'10" x 12'0" x 8"	1.15 x 3.65 x .21	6/35	370	168	1,250 W	1,760 W
VL-35X0-48x192-20-A or RGB	3'10" x 13'0" x 8"	1.15 x 3.96 x .21	6/38	410	186	1,360 W	1,910 W
VL-35X0-48x208-20-A or RGB	3'10" x 14'1" x 8"	1.15 x 4.28 x .21	6/41	440	200	1,450 W	2,070 W
VL-35X0-48x224-20-A or RGB	3'10" x 15'1" x 8"	1.15 x 4.60 x .21	6/44	470	214	1,530 W	2,190 W
VL-35X0-48x240-20-A or RGB	3'10" x 16'2" x 8"	1.15 x 4.91 x .21	6/48	500	227	1,620 W	2,350 W
VL-35X0-48x256-20-A or RGB	3'10" x 17'2" x 8"	1.15 x 5.23 x .21	6/51	530	241	1,700 W	2,480 W
VL-35X0-64x48-20-A or RGB	4'10" x 3'8" x 8"	1.47 x 1.11 x .21	8/9	150	69	530 W	670 W
VL-35X0-64x64-20-A or RGB	4'10" x 4'9" x 8"	1.47 x 1.43 x .21	8/12	190	87	650 W	830 W
VL-35X0-64x80-20-A or RGB	4'10" x 5'9" x 8"	1.47 x 1.74 x .21	8/16	230	105	820 W	1,030 W
VL-35X0-64x96-20-A or RGB	4'10" x 6'9" x 8"	1.47 x 2.06 x .21	8/19	270	123	930 W	1,200 W
VL-35X0-64x112-20-A or RGB	4'10" x 7'10" x 8"	1.47 x 2.38 x .21	8/22	310	141	1,080 W	1,390 W
VL-35X0-64x128-20-A or RGB	4'10" x 8'10" x 8"	1.47 x 2.70 x .21	8/25	350	159	1,190 W	1,560 W
VL-35X0-64x144-20-A or RGB	4'10" x 9'11" x 8"	1.47 x 3.01 x .21	8/29	390	177	1,330 W	1,730 W
VL-35X0-64x160-20-A or RGB	4'10" x 10'11" x 8"	1.47 x 3.33 x .21	8/32	430	196	1,480 W	1,920 W
VL-35X0-64x176-20-A or RGB	4'10" x 12'0" x 8"	1.47 x 3.65 x .21	8/35	480	218	1,620 W	2,120 W
VL-35X0-64x192-20-A or RGB	4'10" x 13'0" x 8"	1.47 x 3.96 x .21	8/38	520	236	1,760 W	2,290 W
VL-35X0-64x208-20-A or RGB	4'10" x 14'1" x 8"	1.47 x 4.28 x .21	8/41	560	255	1,910 W	2,460 W
VL-35X0-64x224-20-A or RGB	4'10" x 15'1" x 8"	1.47 x 4.60 x .21	8/44	600	273	2,020 W	2,620 W
VL-35X0-64x240-20-A or RGB	4'10" x 16'2" x 8"	1.47 x 4.91 x .21	8/48	640	291	2,160 W	2,820 W
VL-35X0-64x256-20-A or RGB	4'10" x 17'2" x 8"	1.47 x 5.23 x .21	8/51	680	309	2,270 W	3,020 W
VL-35X0-80x48-20-A or RGB	5'11" x 3'8" x 8"	1.78 x 1.11 x .21	10/9	180	82	590 W	790 W
VL-35X0-80x64-20-A or RGB	5'11" x 4'9" x 8"	1.78 x 1.43 x .21	10/12	230	105	730 W	1,000 W
VL-35X0-80x80-20-A or RGB	5'11" x 5'9" x 8"	1.78 x 1.74 x .21	10/16	280	128	900 W	1,270 W
VL-35X0-80x96-20-A or RGB	5'11" x 6'9" x 8"	1.78 x 2.06 x .21	10/19	330	150	1,040 W	1,480 W
VL-35X0-80x112-20-A or RGB	5'11" x 7'10" x 8"	1.78 x 2.38 x .21	10/22	380	173	1,180 W	1,690 W
VL-35X0-80x128-20-A or RGB	5'11" x 8'10" x 8"	1.78 x 2.70 x .21	10/25	430	196	1,350 W	1,890 W
VL-35X0-80x144-20-A or RGB	5'11" x 9'11" x 8"	1.78 x 3.01 x .21	10/28	480	218	1,490 W	2,130 W
VL-35X0-80x160-20-A or RGB	5'11" x 10'11" x 8"	1.78 x 3.33 x .21	10/32	530	241	1,630 W	2,370 W
VL-35X0-80x176-20-A or RGB	5'11" x 12'0" x 8"	1.78 x 3.65 x .21	10/35	580	264	1,800 W	2,610 W
VL-35X0-80x192-20-A or RGB	5'11" x 13'0" x 8"	1.78 x 3.96 x .21	10/38	630	286	1,940 W	2,850 W
VL-35X0-80x208-20-A or RGB	5'11" x 14'1" x 8"	1.78 x 4.28 x .21	10/41	680	309	2,080 W	3,060 W
VL-35X0-80x224-20-A or RGB	5'11" x 15'1" x 8"	1.78 x 4.60 x .21	10/44	730	332	2,220 W	3,270 W
VL-35X0-80x240-20-A or RGB	5'11" x 16'2" x 8"	1.78 x 4.91 x .21	10/48	780	354	2,430 W	3,470 W
VL-35X0-80x256-20-A or RGB	5'11" x 17'2" x 8"	1.78 x 5.23 x .21	10/51	830	377	2,600 W	3,680 W

NOTE

Because Daktronics continuously improves its products, all of the specifications on this document are subject to change without notice. Please contact Daktronics for the most current specifications.

Nominal character heights and number of lines that fit on each DMS are calculated using 7-pixel-high fonts. Many other font sizes are available.

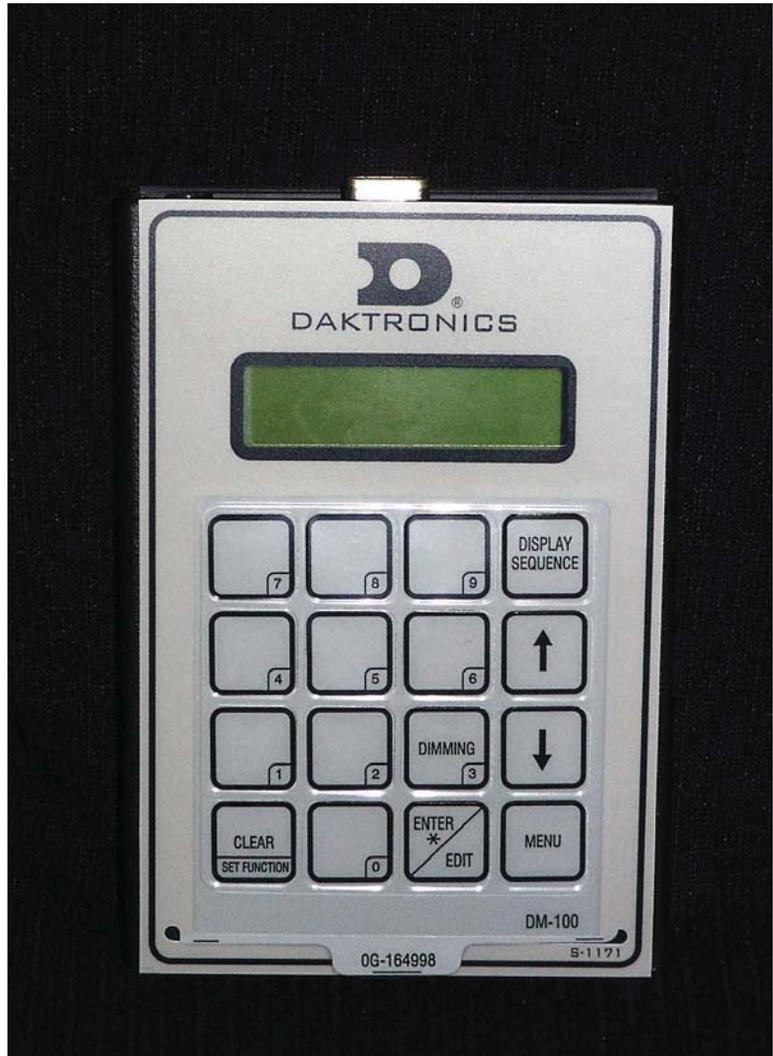
Contact Daktronics for details about other fonts.

117 Prince Drive PO Box 5120
Brookings, SD 57006
tel 605-697-4061
toll free 888-325-8726
www.daktronics.com
transportation@daktronics.com
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DAKTRONICS

DM-100 Console ■ DataMaster 2000 Series



Technical Specifications

Dimensions:

Height 6", Width 4", Depth 1.25
(152 mm, 103 mm, 32 mm)

Weight:

.5 lb (.2268 kg)

Power:

2 W maximum, 12 V AC

LCD Viewing Area:

Height .625", Width 2.4" (16 mm,
61 mm)

LCD Character:

Height .220", Width .145"
(5.6 mm, 3.6 mm)

Operating Temperatures:

32 to 110 degrees Fahrenheit
(0 to 43 degrees Celsius)

Communication Protocol:

Venus 1500

Applications:

DF-2200 series displays

Above: DM-100 Console

DM-100 Controller Capabilities:

The DM-100 hand-held control device is a multi-purpose controller. It can be used to control several different types of standard displays. This control console contains several basic types of programs. One of these programs must be chosen when the device is initially powered. After a program has been chosen, the device will automatically return to that program every time power is re-connected. A different control program can be chosen any time the unit is powered, but there is a narrow window of time to choose another program during the power up sequenced. The user must determine which program is required to control their particular sign type. Also, within each program, there may be parameters that must be set to make sure the controller matches the actual display.

Time and Temperature mode:

Display digits are fixed XX:XX

User Inputs: Current Time and Date

Options/Settings: 12/24 hour time format, Temperature display format (°C, °F),

Daylight Savings Time (Automatically adjusts on date), Temp Offset.

Petroleum Price Mode:

Display digits are fixed X.XX9/10

User Inputs: Prices for up to 5 products, all products have same digit format above

Option/Settings: Point of Sale (POS) interface, currently we have interfaces for Verifone, Autogas, PAM 1000, Allied, G-Site

Rate Display Mode:

Digits are fixed 2, 4 or 6 digits

User Inputs: Prices for up to 5 lines, must have same digit format on all 5 lines

Options/Settings: Display format options, based on number of digits in display

XX.XX, X.XXX, .XXXX, XXXX.XX, XXX.XX, XX, XXX.X

Lottery Mode:

Displays are fixed 3-digit format X.XX

User Inputs: Amounts for up to 5 lines, each line can have different format

Options/Settings: Display format options, decimal and number of digits shown

Event Counter Mode:

Displays are fixed digit with 2 – 12 digits

User Inputs: Start Time, End Time

Options/Settings: Skip certain days of the week (i.e. weekend days), Expire Event can be set to Do Nothing, Blank Sign, Re-Start, Trigger Relay, Trigger/Blank, Trigger/Re-Start

Event Timer Mode:

Displays are fixed digit with several format options

User Inputs: Start Time, End Time

Options/Settings: Expire Event can be set to Do Nothing, Blank Sign, Re-Start, Trigger Relay, Trigger/Blank, Trigger/Re-Start

Display Format options: DDD HH:MM:SS.s, DDD HH:MM:SS, DDD HH:MM, DDD HH, HH:MM:SS.s, HH:MM:SS, MM:SS.s, MM:SS, SS.s



iCLASS SE[®] Readers



HIGHLY ADAPTABLE AND SECURE HIGH FREQUENCY ACCESS CONTROL SOLUTION

- **Powerfully Secure** – Provides layered security beyond the card media for added protection to identity data using SIOs.
- **Adaptable** – Interoperable with a growing range of technologies and form factors including mobile devices utilizing Seos[®].
- **Interoperable** – Open Supervised Device Protocol (OSDP) for secure, bidirectional communication.
- **Versatile** - Extended read range is available for applications such as parking and gate control solutions.

HID Global's iCLASS SE[®] platform goes beyond the traditional smart card model to offer a secure, standards-based and flexible platform that has become the new benchmark for highly adaptable, interoperable and secure access control solutions.

Supervised Device Protocol (OSDP) standard which also ensures secure transmission of data from the reader to the controller.

Additionally, iCLASS SE readers support mobile devices utilizing Seos, enabling a new class of portable identity credentials that can be securely provisioned and safely embedded into both fixed and mobile devices.

Manage, Upgrade and Configure via Mobile App

iCLASS SE[®] Readers can be easily and securely managed in-field through the HID Reader Manager Mobile App. With the addition of our Bluetooth Smart Module or Bluetooth Smart/OSDP upgrade kit, you can update firmware, LED color, beeper response and credential keys or upgrade existing readers to support HID Mobile Access[®].

As part of HID Global's iCLASS SE platform for advanced security, the readers utilize state-of-the-art authentication through the platform's Secure Identity Object (SIO) data model for trusted and secure communication between the card and reader to prevent unauthorized access. The iCLASS SE reader line is built on the Security Industry Association (SIA) Open

POWERFULLY SECURE:

- Multi-Layered Security – Ensures data authenticity and privacy through the multi-layered security of HID's SIO.
- EAL5+ Certified Secure Element Hardware – Provides tamper-proof protection of keys/cryptographic operations.
- Secured communications using OSDP with Secure Channel Protocol.
- Expanded iCLASS Elite™ Program – Extends private security by protecting uniquely keyed credentials, SIOs and programming keys.

HIGHLY ADAPTABLE:

- Mobile device support using iCLASS Seos - enabling HID access control.
- Flexible to support future technologies.
- Field Programmable Readers - Provides secure upgrades for migration and extended lifecycle.

SUSTAINABILITY AND MANAGEMENT:

- Intelligent Power Management (IPM) – Reduces reader power consumption by as much as 75% compared to standard operating mode.
- Recycled Content – Contributes toward building LEED credits.

INTEROPERABLE:

- SIO Media Mapping – Simplifies deployment of third-party objects to multiple types of credentials.
- Industry standard communications using OSDP.
- Custom programming support to read models on MIFARE and MIFARE DESFire EV1 credentials



SPECIFICATIONS

Model Name	R10	R15	R40	RK40	R90
Base Part Number	900N	910N	920N	921N	940N
Typical Read Range ¹	13.56 MHz Single Technology ID-1 Cards - SIO Data Model				
	iCLASS Seos: 2.4" (6 cm) iCLASS: 3.6" (9 cm) MIFARE Classic: 2.4" (6 cm) MIFARE DESFire EV1: 2.4" (6 cm)	iCLASS Seos: 2.4" (6 cm) iCLASS: 3.6" (9 cm) MIFARE Classic: 2.4" (6 cm) MIFARE DESFire EV1: 2.4" (6 cm)	iCLASS Seos: 3.2" (8 cm) iCLASS: 5.2" (13 cm) MIFARE Classic: 3.9" (10 cm) MIFARE DESFire EV1: 3.2" (8 cm)	iCLASS Seos: 2.0" (5 cm) iCLASS: 5.5" (14 cm) MIFARE Classic: 5.1" (13 cm) MIFARE DESFire EV1: 2.0" (5 cm)	iCLASS Seos: 4.7" (12 cm) iCLASS: 14.2" (36 cm) MIFARE Classic: 9.4" (24 cm) MIFARE DESFire EV1: 5.9" (15 cm)
	13.56 MHz Single Technology Tags/Fobs - SIO data Model				
	iCLASS: 1.6" (4 cm) MIFARE Classic: 1.2" (3 cm)	iCLASS: 1.6" (4 cm) MIFARE Classic: 1.2" (3 cm)	iCLASS: 2.8" (7 cm) MIFARE Classic: 2.0" (5 cm)	iCLASS: 3.1" (8 cm) MIFARE Classic: 2.0" (5 cm)	iCLASS: 6.7" (17 cm) MIFARE Classic: 3.1" (8 cm)
Mounting	Ideally suited for mullion-mounted door installations or any flat surface			Wall Switch Size; designed to mount and cover single gang switch boxes primarily used in the Americas and includes a slotted mounting plate for European and Asian back box spacing	Metal gooseneck pedestal, without a metal back plate. See Installation Guide for details.
Color	Black				
Keypad	No			Yes (4x3)	No
Dimensions	1.9" x 4.1" x 0.9" 4.8 cm x 10.3 cm x 2.3 cm	1.9" x 6.0" x 0.9" 4.8 cm x 15.3 cm x 2.3 cm	3.3" x 4.8" x 1.0" 8.4 cm x 12.2 cm x 2.4 cm	3.3" x 4.8" x 1.1" 8.5 cm x 12.2 cm x 2.8 cm	13.1" x 13.1" x 1.55" 33.3cm x 33.3cm x 3.9cm
Product Weight (Pigtail)	3.9 oz (113g)	5.3 oz (151g)	7.7 oz (220g)	9.0 oz (256g)	N/A
Product Weight (Terminal Strip)	2.9 oz (84g)	4.2 oz (120g)	7.5 oz (215g)	8.0oz (226g)	4lb 1oz (1844g)
Operating Voltage Range	5-16 VDC			5-16 VDC	12 VDC or 24 VDC
Current Draw - Standard Power Mode ² (mA)	60 @ 16V	60 @ 16V	65 @ 16V	85 @ 16V	110 @ 12V
Current Draw - Intelligent Power Management (IPM) Mode ² (mA)	35 @ 16V	35 @ 16V	40 @ 16V	60 @ 16V	30 @ 12V
Peak Current Draw - Standard Power or IPM Mode ² (mA)	200 @ 16V	200 @ 16V	200 @ 16V	220 @ 16V	300 @ 12V
NSC ³ Power Consumption - Standard Power Mode	1.0 @ 16V	1.0 @ 16V	1.0 @ 16V	1.4 @ 16V	1.3 @ 12V
NSC ³ Power Consumption - w/ IPM	0.6 @ 16V	0.6 @ 16V	0.6 @ 16V	1 @ 16V	.4 @ 12V
Operating Temperature	-31° to 150° F (-35° to 65° C)				
Storage Temperature	-67° to 185° F (-55° to 85° C)				
Operating Humidity	5% to 95% relative humidity non-condensing				
Environmental Rating	Indoor/Outdoor IP55; IP65 if installed with optional gasket				IP65
Transmit Frequency	13.56 MHz				
13.56 MHz Card Compatibility	Secure Identity Object™ (SIO) on iCLASS Seos, iCLASS SE/SR, MIFARE DESFire EV1 and MIFARE Classic (On by Default) - MIFARE Classic and MIFARE DESFire EV1 custom data models - standard iCLASS Access Control Application (order with Standard interpreter) - ISO14443A (MIFARE) CSN, ISO14443B CSN, ISO15693 CSN - FeliCa™ CSN, CEPAS ⁴ CSN or CAN				
Communications	Wiegand, Clock-and-Data, Open Supervised Device Protocol (OSPD) via RS485				
Panel Connection	Pigtail or Terminal Strip				Terminal Strip
Reader Management	HID Reader Manager Mobile App for HID Mobile Access / OSDP infield upgrade, configuration, firmware upgrade and diagnostics				
Certifications	UL294/cUL (US), FCC Certification (US), IC (Canada), CE (EU), RCM (Australia, New Zealand), SRRR (China), KCC (Korea), NCC (Taiwan), iDA (Singapore), RoHS, MIC (Japan) ⁴				
Crypto Processor Hardware Common Criteria Rating	EAL5+				
Patents	www.hidglobal.com/patents				
Housing Material	UL94 Polycarbonate				
Manufactured with % of recycled content (Pigtail)	10.5%	11.0%	10.5%	10.9%	N/A
Manufactured with % of recycled content (Terminal Strip)	11.0%	11.5%	11.0%	12.4%	11.00%
UL Ref Number	R10E	R15E	R40E	RK40E	R90E
Warranty	Limited Lifetime				

¹ Read range listed is statistical mean rounded to nearest whole centimeter. HID Global testing occurs in open air. Some environmental conditions, including metallic mounting surface, can significantly degrade read range and performance; plastic or ferrite spacers are recommended to improve performance on metallic mounting surfaces.

² Measured in accordance with UL294 standards; See Installation Guide for Details

³ NSC = Normal Standby Current; See Installation Guide for Details

⁴ Not available on R90 Model



hidglobal.com

North America: +1 512 776 9000

Toll Free: 1 800 237 7769

Europe, Middle East, Africa: +44 1440 714 850

Asia Pacific: +852 3160 9800

Latin America: +52 55 5081 1650

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2018-10-20-pacs-i-class-se-reader-family-ds-en PLT-00230

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ASSA ABLOY

APPENDIX I

PANEL SCHEDULE

General Information

Panel ID Booth Sub-panel - Typical for Lanes 12,11,10 (Same Booth sub-panels for Lanes 3,2,1)
 Panel Location Toll Booth 12,11,10 and 3,2,1
 Fed From DP#1 and DP #3 in Tunnel

Breaker Details

Main Breaker 60 AMP

Phase Type Three Phase
 Voltage Type 120/208

Pole	Amps	Description	Amps	Description	Pole
2	30	Booth Heat Pump	1	2 Under Counter Heater Fan	1
2	30	Booth Heat Pump	3	4 DP receptacles (Strip)	1
1	20	Flashing Yellow Beacon	5	6 Booth lights	1
1	20	Canopy Override Switch	7	8 canopy lights	1
1	20	Canopy Drain De-icing Tape (as needed)	9	10 DP receptacles (Quads)	1
1	20	Lane Use Sign (VMS) Lane 10,3	11	12 Canopy Sign Lights	1
		Spare	13	14 Spare	
		Spare	15	16 Spare	
		Spare	17	18 Spare	
		Spare	19	20 Spare	
		Spare	21	22 Spare	
		Spare	23	24 Spare	
		Spare	25	26 Spare	
		Spare	27	28 Spare	
		Spare	29	30 Spare	

Panel Schedule

General Information

Panel ID Sub-panel Tunnel DP #1 Booth sub panels 12,11,10 (Same DF #3 for Booths 3,2,1) Phase Type Three Phase Voltage Type 120/208
 Panel Location Tunnel
 Fed From Utility Building - Main Power Panel

Breaker Details		Breaker Details	
Pole	Description	Amps	Description
3	Booth Sub Panel 12 (1)	60	1 2 Booth Sub Panel 10 (3)
3	Booth Sub Panel 12 (1)	60	3 4 Booth Sub Panel 10 (3)
3	Booth Sub Panel 12 (1)	60	5 6 Booth Sub Panel 10 (3)
3	Booth Sub Panel 11 (2)	60	7 8 AVI Reader Dirty Power
3	Booth Sub Panel 11 (2)	60	9 10 Spare
3	Booth Sub Panel 11 (2)	60	11 12 Spare
	Spare		13 14 Spare
	Spare		15 16 Spare
	Spare		17 18 Spare
	Spare		19 20 Spare
	Spare		21 22 Spare
	Spare		23 24 Spare
	Spare		25 26 Spare
	Spare		27 28 Spare
	Spare		29 30 Spare

Main Breaker 150 AMP

EXIT 103 - 2019.03

Panel Schedule

General Information

Panel ID Sub-panel Tunnel CP #1 Lanes 12,11,10 (Same for CP #3 for Lanes 3,2,1) Breaker Details Three Phase Voltage Type 120/208
 Panel Location Tunnel
 Fed From UPS / Bypass Switch Main Breaker 60 AMP

Pole	Amps	Description	Decription	Amps	Pole
1	20	Lane Controller #12 (Quad)	1	20	1
1	20	Booth CP Receptacles #12	3	20	1
1	20	Lane Controller #10 (Quad)	5	20	1
1	20	Booth CP Receptacles #10	7	20	1
		Spare	9		
		Spare	11		
		Spare	13		
		Spare	15		
		Spare	17		
		Spare	19		
		Spare	21		
		Spare	23		
		Spare	25		
		Spare	27		
		Spare	29		
		Lane Controller #11 (Quad)	2		
		Booth CP Receptacles #11	4		
		Clean Power AVI Reader	6		
		Spare	8		
		Spare	10		
		Spare	12		
		Spare	14		
		Spare	16		
		Spare	18		
		Spare	20		
		Spare	22		
		Spare	24		
		Spare	26		
		Spare	28		
		Spare	30		

EXIT 103 - 2019.03

Panel Schedule

General Information

Panel ID Sub-panel Tunnel DP-#2 ORT
 Panel Location Utility Room
 Fed From Utility Building - Main Power Panel

Breaker Details

Main Breaker 100 AMP

Phase Type

Three Phase

Voltage Type

120/208

Pole	Amps	Description	Amps	Pole
1	20	NB Space Frame Lights 1	20	1
1	20	NB Space Frame Lights 2	20	2
1	20	NB Space Frame Lights 3	20	3
1	20	NB Space Frame Lights 4	20	4
1	20	NB Variable SL Sign	20	5
1	20	NB Reader Dirty Power	20	6
1	20	Spare	20	7
1	20	Spare	20	8
1	20	Spare	20	9
1	20	Spare	20	10
1	20	Spare	20	11
1	20	Spare	20	12
1	20	Spare	20	13
1	20	Spare	20	14
1	20	Spare	20	15
1	20	Spare	20	16
1	20	Spare	20	17
1	20	Spare	20	18
1	20	Spare	20	19
1	20	Spare	20	20
1	20	Spare	20	21
1	20	Spare	20	22
1	20	Spare	20	23
1	20	Spare	20	24
1	20	Spare	20	25
1	20	Spare	20	26
1	20	Spare	20	27
1	20	Spare	20	28
1	20	Spare	20	29
1	20	Spare	20	30

Panel Schedule

General Information

Panel ID Sub-panel Tunnel CP#2 ORT
 Panel Location Utility Room
 Fed From UPS / Bypass Switch

Breaker Details

Main Breaker 100 AMP

Phase Type

Three Phase

Voltage Type

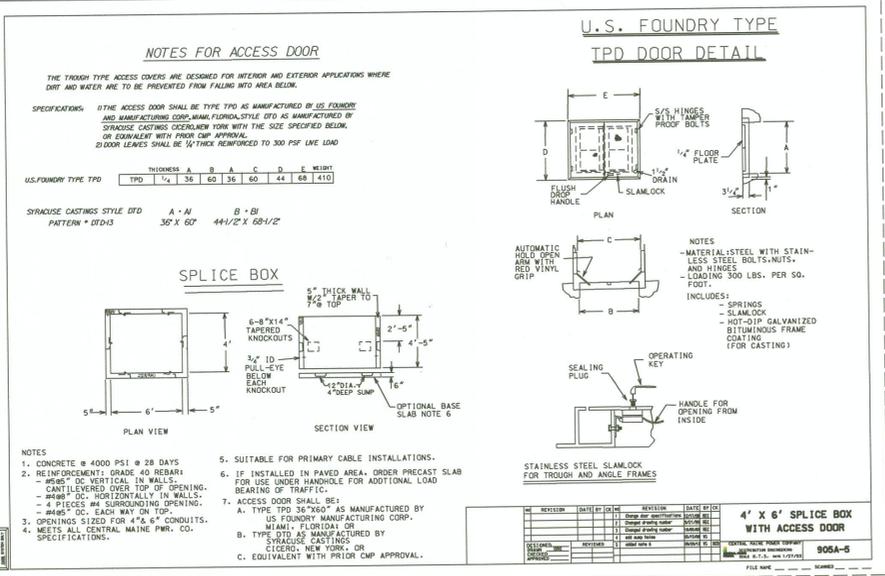
120/208

Pole	Amps	Description	Amps	Description	Pole
1	20	NB OPUS Lane #4	20	2 SB OPUS Lane #7	1
1	20	NB OPUS Lane #5	20	4 SB OPUS Lane #8	1
1	20	NB OPUS Lane #6	20	6 SB OPUS Lane #9	1
1	20	NB VCARS Lane #4	20	8 SB VCARS Lane #7S	1
1	20	NB VCARS Lane #5	20	10 SB VCARS Lane #7	1
1	20	NB VCARS Lane #6	20	12 SB VCARS Lane #8	1
1	20	NB VCARS Lane #6S	20	14 SB VCARS Lane #9	1
1	20	NB DVAS Lane #4	20	16 SB DVAS Lane #7S	1
1	20	NB DVAS Lane #6S	20	18 SB DVAS Lane #9	1
1	20	NB Clean Power AVI Reader	20	20 SB Clean Power AVI Reader	1
1	20	NB ORT LC Cabinet Quad Receptacle 1	20	22 SB ORT LC Cabinet Quad Receptacle 1	1
1	20	NB ORT LC Cabinet Quad Receptacle 2	20	24 SB ORT LC Cabinet Quad Receptacle 2	1
1	20	NB ORT LC Cabinet Quad Receptacle 3	20	26 SB ORT LC Cabinet Quad Receptacle 3	1
		Spare		27 Spare	
		Spare		28 Spare	
				29 Spare	

APPENDIX J

CMP DESIGN PLANS AND SPECIFICATIONS

This document and any attachments are considered:
BUSINESS CONFIDENTIAL
PROTECTED CRITICAL INFRASTRUCTURE INFORMATION



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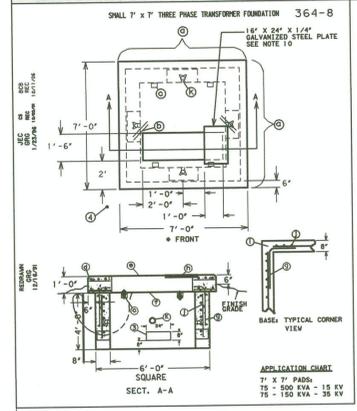
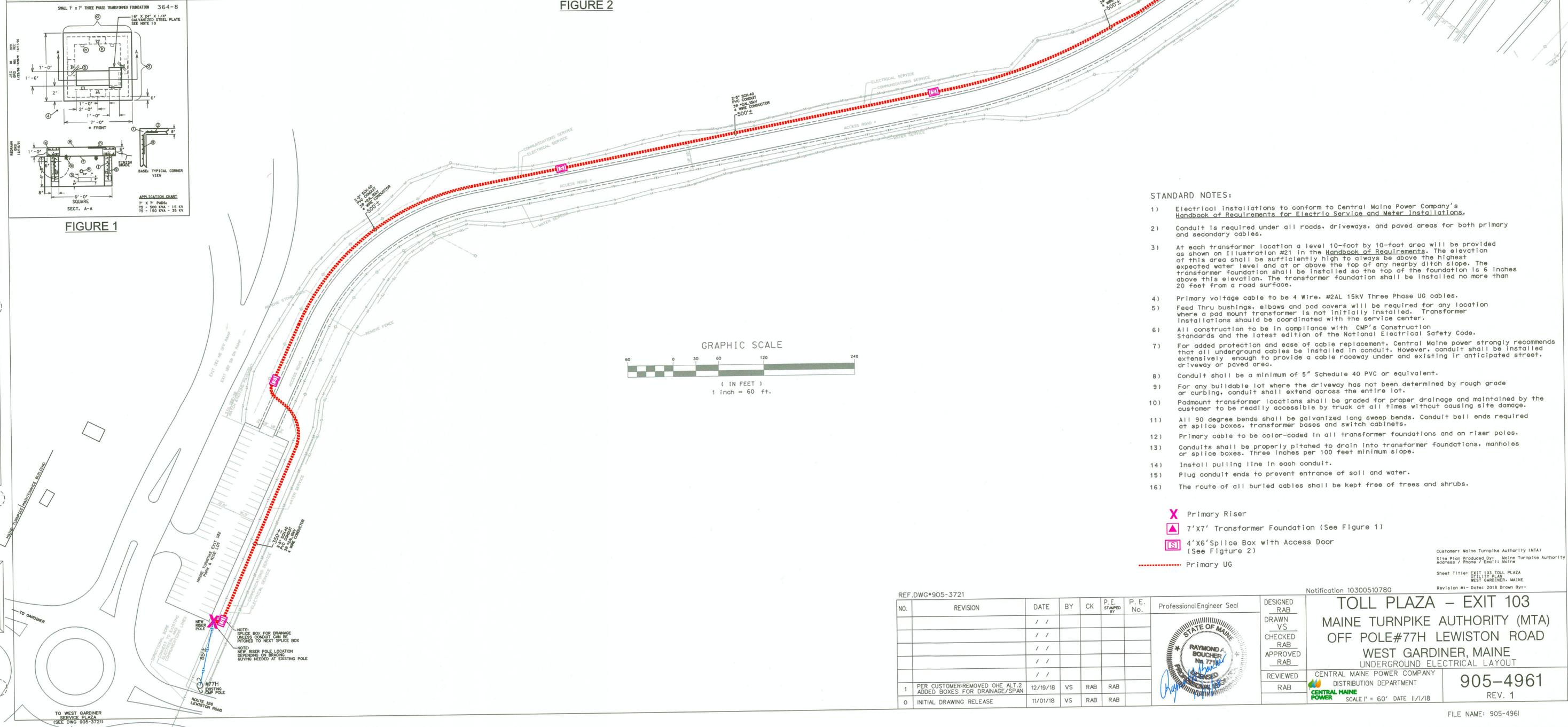


FIGURE 1

FIGURE 2

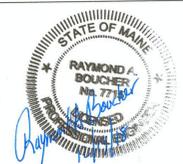


- STANDARD NOTES:
- Electrical installations to conform to Central Maine Power Company's Handbook of Requirements for Electric Service and Meter Installations.
 - Conduit is required under all roads, driveways, and paved areas for both primary and secondary cables.
 - At each transformer location a level 10-foot by 10-foot area will be provided as shown in illustration #21 in the Handbook of Requirements. The elevation of this area shall be sufficiently high to always be above the highest expected water level and at or above the top of any nearby ditch slope. The transformer foundation shall be installed so the top of the foundation is 6 inches above this elevation. The transformer foundation shall be installed no more than 20 feet from a road surface.
 - Primary voltage cable to be 4 Wire, #2AL 15kV Three Phase UG cables.
 - Feed Thru bushings, elbows and pad covers will be required for any location where a pad mount transformer is not initially installed. Transformer Installations should be coordinated with the service center.
 - All construction to be in compliance with CMP's Construction Standards and the latest edition of the National Electrical Safety Code.
 - For added protection and ease of cable replacement, Central Maine power strongly recommends that all underground cables be installed in conduit. However, conduit shall be installed extensively enough to provide a cable raceway under and existing or anticipated street, driveway or paved area.
 - Conduit shall be a minimum of 5" Schedule 40 PVC or equivalent.
 - For any buildable lot where the driveway has not been determined by rough grade or curbing, conduit shall extend across the entire lot.
 - Padmount transformer locations shall be graded for proper drainage and maintained by the customer to be readily accessible by truck at all times without causing site damage.
 - All 90 degree bends shall be galvanized long sweep bends. Conduit bell ends required at splice boxes, transformer bases and switch cabinets.
 - Primary cable to be color-coded in all transformer foundations and on riser poles.
 - Conduits shall be properly pitched to drain into transformer foundations, manholes or splice boxes. Three inches per 100 feet minimum slope.
 - Install pulling line in each conduit.
 - Plug conduit ends to prevent entrance of soil and water.
 - The route of all buried cables shall be kept free of trees and shrubs.

- X Primary Riser
- 7'X7' Transformer Foundation (See Figure 1)
- 4'X6' Splice Box with Access Door (See Figure 2)
- Primary UG

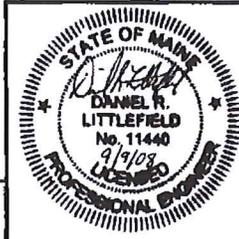
Customer: Maine Turnpike Authority (MTA)
 Site Plan Produced By: Maine Turnpike Authority
 Address / Phone / Email: Maine
 Sheet Title: EXIT 103 TOLL PLAZA UTILITY PLAN
 WEST GARDINER, MAINE
 Revision #: - Date: 2018 Drawn By:-

NO.	REVISION	DATE	BY	CK	P. E. STAMPED BY	P. E. No.	Professional Engineer Seal	DESIGNED RAB	DRAWN VS	CHECKED RAB	APPROVED RAB	REVIEWED RAB	NOTIFICATION	PROJECT TITLE	SCALE	DATE	CONTACT
1	PER CUSTOMER-REMOVED ONE ALT.2 ADDED BOXES FOR DRAINAGE/SPAN	12/19/18	VS	RAB	RAB								Notification 10300510780	TOLL PLAZA - EXIT 103 MAINE TURNPIKE AUTHORITY (MTA) OFF POLE #77H LEWISTON ROAD WEST GARDINER, MAINE UNDERGROUND ELECTRICAL LAYOUT	905-4961	11/1/18	905-4961
0	INITIAL DRAWING RELEASE	11/01/18	VS	RAB	RAB										SCALE 1" = 60'	DATE 11/1/18	REV. 1

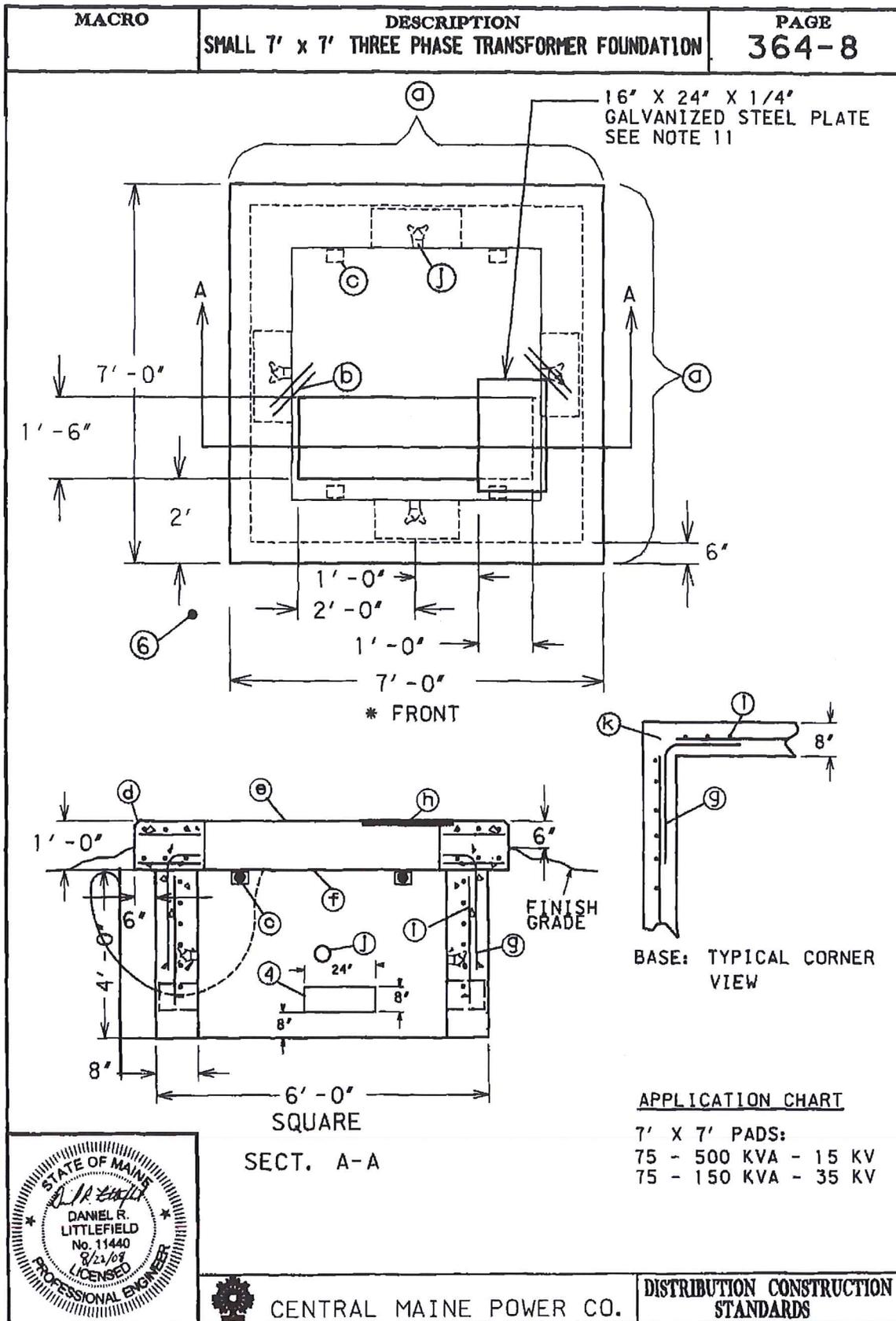


THIS DRAWING SHALL BE REVISED ON THE CAD SYSTEM ONLY

XII. ILLUSTRATION No. 24

PAGE 364-7	DESCRIPTION SMALL (7' X 7') THREE PHASE TRANSFORMER FOUNDATION	MACRO
<p>NOTES:</p> <ol style="list-style-type: none"> 1. * FRONT denotes the side on which the access doors are located. The concrete base shall be set on a suitable gravel base and located so the FRONT is accessible by truck and suitably protected from plow and traffic damage. 2. Before installing or requiring any active drainage structure (e.g., drain pipe) into the foundation or pad, the contractor, CMP Line Supervisor, or CMP Distribution Engineer must contact Central Maine Power Company's Environmental Services Department at 623-3521 ext. 3479 to request a site inspection. 3. Finish grade shall be graded in such manner to allow surface water to flow away from the pad. 4. Provide 8' x 24' cable holes (bond outs) 8' up the wall from the base. Locate one cable hole per wall, more if necessary. Line up cable holes with trench. 5. Conduits entering concrete structures shall be set back from the inside wall 1 to 2 inches and the space within the knockout surrounding the conduits completely filled with mortar to prevent soil from entering structure. Inside the structure the mortar shall be finished and beveled from the conduit ends to the inside wall face to cover and smooth the edges of the knockouts. 6. A 3/4" x 8' galvanized ground rod is to be installed six inches in front of the left FRONT corner of the foundation. The top of the ground rod is to be 6 inches below final grade. 7. A ground wire shall be installed from the ground rod through the cable hole at the bottom of the pad. 10 feet of ground wire shall be provided so that it can be installed through the two grounding lugs and connected to the neutral spade. 8. Concrete compressive strength shall be 4000 PSI @ 28 days. For cast-in-place early high strength may be used with a minimum of seven day cure time. 9. Reinforcing steel to have: FY = 60 KSI. 10. For precast units: The precast supplier shall provide lifting lugs in the slab (foundation) and base; the precast supplier shall assemble the slab to the base prior to shipping to the site to ensure that the slab and base fit properly (with no rocking of the slab evident). 11. A 16' x 24' x 1/4" galvanized steel plate to cover a portion of the cable hole when the transformer does not completely cover it. Cut the steel plate to fit, if necessary. <ol style="list-style-type: none"> a. 7-#5 Rebar evenly spaced each way top to bottom. b. 2-#4 Corner diagonal rebar 2'-0" long top and bottom. c. 4' x 4' x 1/2" angle 6' long with 2-3/4" diameter expansion anchors typical - 4 places (two piece precast only). d. Chamfer typical e. 2' Concrete cover over top rebar. f. 3' Concrete cover over bottom rebar. g. #5 L-Bar @ 12" (cast-in-place only) h. 16' x 24' x 1/4" galvanized steel plate. MID#6000621790 i. #5 Rebar on 12" centers. j. Pulling eye insert, for use with 3/4" national course thread eye-bolt, (Richmond LCB-1 or equivalent). Located opposite each cable hole and 2' (two feet) from the bottom. k. All rebar ends to be covered by 1' of concrete, minimum. 		
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XII. ILLUSTRATION No. 24



XII. ILLUSTRATION No. 19

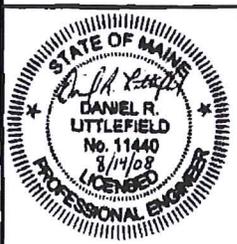
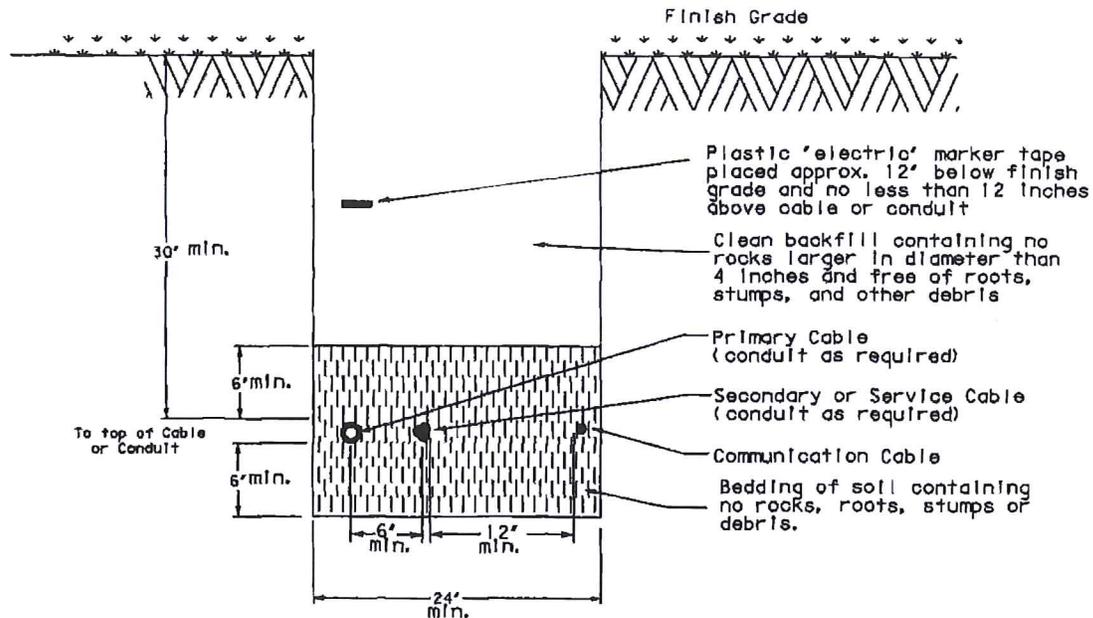
MACRO	DESCRIPTION	PAGE
	UNDERGROUND CABLE INSTALLATION JOINTLY USED TRENCH HORIZONTAL SEPARATION	363-4

UNDERGROUND CABLE INSTALLATION

JOINTLY USED TRENCH - HORIZONTAL SEPARATION

IN SITUATIONS WHERE THE TRENCH IS TO BE SHARED
AGREEMENT MUST BE OBTAINED BETWEEN JOINT USERS

Trench shall be a minimum of 24' wide



CENTRAL MAINE POWER CO.

DISTRIBUTION CONSTRUCTION
STANDARDS

XII. ILLUSTRATION No. 20

PAGE 363-5	DESCRIPTION UNDERGROUND CABLE INSTALLATION JOINTLY USED TRENCH VERTICAL SEPARATION	MACRO
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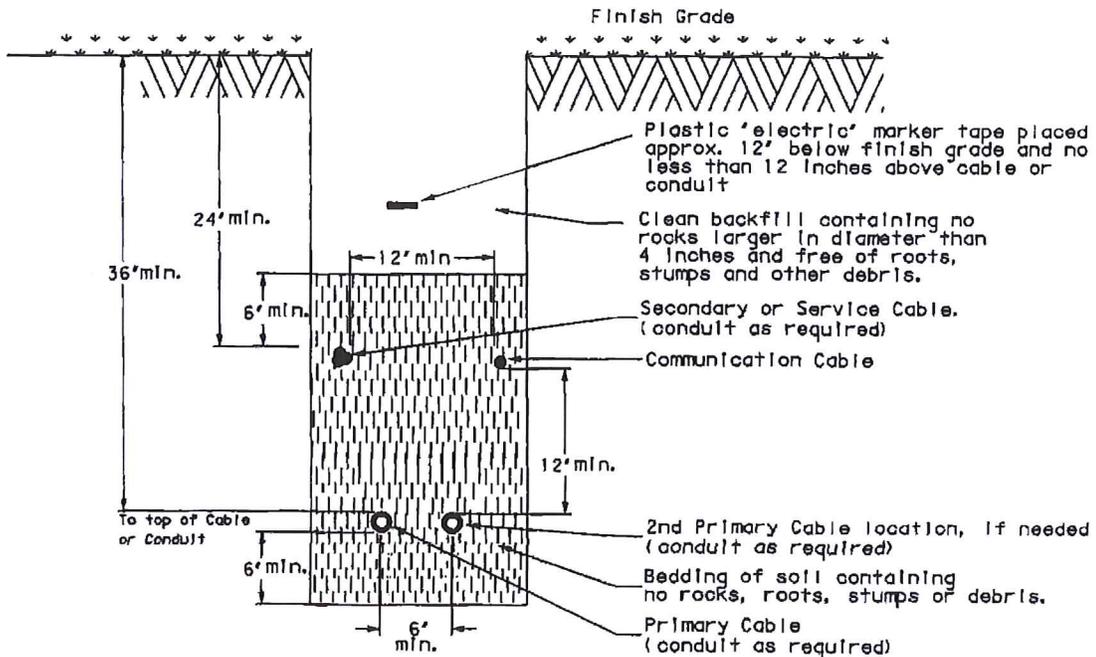
UNDERGROUND CABLE INSTALLATION

JOINTLY USED TRENCH - VERTICAL SEPARATION

IN SITUATIONS WHERE THE TRENCH IS TO BE SHARED
AGREEMENT MUST BE OBTAINED BETWEEN JOINT USERS

NOTES:

1. Installation should not allow the inter-twining of cables.
2. Bedding and backfill shall be free of roots, stumps and other debris.
3. Communication cable and power cable shall have no less than 12 inches of radial separation.



**DISTRIBUTION CONSTRUCTION
STANDARDS**

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