Maine Medical Center

Congress Street

22 Bramhall Street, Portland, ME

PROJECT MANUAL VOLUME 3

Specification Divisions 21 - 33

Conformed Set, 02 Oct 2020

Project # 152189.000

PERKINS+WILL

TABLE OF CONTENTS

VOLUME 1

DIVISION 00 - 01 DOCUMENTS

COVER PAGE VOLUME 1
TABLE OF CONTENTS

DIVISION 00 - PROCUREMENT AND CONTRACTING REQUIREMENTS

		ADDENDUM ISSUED
00 26 00	PROCUREMENT SUBSTITUTION PROCEDURES	
00 31 32	GEOTECHNICAL DATA	
00 73 16	INSURERS REQUIREMENTS	
00 91 13.01	ADDENDUM 01 – CONGRESS STREET (Cover pages)	ADD 1
00 91 13.02	ADDENDUM 02 – CONGRESS STREET (Cover pages)	ADD 2

DIVISION 01 – GENERAL REQUIREMENTS

01 10 00	SUMMARY	
01 21 00	ALLOWANCES	
01 22 00	UNIT PRICES	
01 23 00	ALTERNATES	
01 25 00	SUBSTITUTION PROCEDURES	
01 25 13	SUBSTITUTION REQUEST FORM	
01 26 00	CONTRACT MODIFICATION PROCEDURES	
01 29 00	PAYMENT PROCEDURES	
01 31 00	PROJECT MANAGEMENT AND COORDINATION	
01 32 00	CONSTRUCTION PROGRESS DOCUMENTATION	
01 32 33	PHOTOGRAPHIC DOCUMENTATION	
01 33 00	SUBMITTAL PROCEDURES	
01 40 00	QUALITY REQUIREMENTS	
01 42 00	REFERENCES	
01 43 39	ROOM MOCKUPS	
01 45 33	NON-STRUCTURAL TESTS AND SPECIAL INSPECTIONS	
01 45 34	MOCKUPS FOR EXTERIOR ENVELOPE SYSTEMS	ADD 1
01 45 35	QUALITY CONTROL AND ASSURANCE FOR AIR BARRIER SYSTEMS	ADD 1
01 50 00	TEMPORARY FACILITIES AND CONTROLS	
01 60 00	PRODUCT REQUIREMENTS	
01 73 00	EXECUTION	
01 74 19	CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL	
01 77 00	CLOSEOUT PROCEDURES	
01 78 23	OPERATION AND MAINTENANCE DATA	
01 78 39	PROJECT RECORD DOCUMENTS	ADD 1
01 79 00	DEMONSTRATION AND TRAINING	
01 81 13	SUSTAINABLE DESIGN REQUIREMENTS - LEED v4 FOR HEALTH CARE FACILITIES	

01 91 00 COMMISSIONING
01 91 13 GENERAL COMMISSIONING REQUIREMENTS
01 91 19 BUILDING ENCLOSURE COMMISSIONING
01 91 19A BUILDING ENCLOSURE COMMISSIONING APPENDIX A ADD 1

VOLUME 1A

MEDICAL EQUIPMENT APPENDIX

(Not included with this set)

COVER PAGE VOLUME 1A
TABLE OF CONTENTS
EQUIPMENT REPORT BY DEPARTMENT
MEDICAL EQUIPMENT CUTBOOK

VOLUME 2

DIVISION 02 THROUGH 14 SPECIFICATIONS

COVER PAGE VOLUME 2
TABLE OF CONTENTS

DIVISION 02 - EXISTING CONDITIONS
02 41 16 STRUCTURE DEMOLITION
02 41 19 SELECTIVE DEMOLITION

DIVISION 03 - CONCRETE
03 30 00 CAST IN PLACE CONCRETE ADD 1
03 30 35 UNDER-SLAB SHEET VAPOR RETARDERS ADD 1
03 33 00 ARCHITECTURAL CONCRETE
03 49 00 GLASS-FIBER-REINFORCED CONCRETE (GFRC)
03 54 16 HYDRAULIC CEMENT UNDERLAYMENT

DIVISION 04 - MASONRY
04 20 00 UNIT MASONRY
04 42 00 STONE CLADDING ADD 2

DIVISION 05 - METALS
05 12 00 STRUCTURAL STEEL ADD 1
05 31 00 STEEL DECKING ADD 1
05 40 00 COLD-FORMED METAL FRAMING ADD 1
05 50 00 METAL FABRICATIONS
05 51 13 METAL PAN STAIRS
05 51 19 METAL GRATING STAIRS
05 52 13 PIPE AND TUBE RAILINGS
05 70 00 DECORATIVE METAL
05 71 00 DECORATIVE METAL STAIRS

05 73 00	DECORATIVE METAL RAILINGS	ADD 1
05 73 13	GLAZED DECORATIVE METAL RAILINGS	
05 75 00	DECORATIVE FORMED METAL	

DIVISION 06 - WOOD, PLASTICS, AND COMPOSITES

06 10 53	MISCELLANEOUS ROUGH CARPENTRY	
06 16 00	SHEATHING	
06 41 13	WOOD-VENEER-FACED ARCHITECTURAL CABINETS	
06 41 16	PLASTIC-LAMINATE-FACED ARCHITECTURAL CABINETS	ADD 1
06 42 16	FLUSH WOOD PANELING	
06 83 16	FIBERGLASS REINFORCED PLASTIC LAMINATE PANELING	

DIVISION 07 - THERMAL AND MOISTURE PROTECTION

07 13 26	SELF-ADHERING SHEET WATERPROOFING	
07 18 00	TRAFFIC COATING	
07 21 00	THERMAL INSULATION	
07 24 19	WATER-DRAINAGE EXTERIOR INSULATION AND FINISH SYSTEM (EIFS)	ADD 1
07 27 13	MODIFIED BITUMINOUS AND NONBITUMINOUS SHEET AIR BARRIERS	
07 42 13.13	FORMED METAL WALL PANELS	
07 42 13.19	INSULATED METAL WALL PANELS	
07 42 13.23	METAL-COMPOSITE-MATERIAL WALL PANELS	
07 44 56	MINERAL-FIBER-REINFORCED CEMENTITIOUS PANELS	
~~07 53 23~~	~~ETHYLENE-PROPYLENE-DIENE-MONOMER (EPDM) ROOFING~~	ADD 2
07 54 23	THERMOPLASTIC POLYOLEFIN (TPO) ROOFING	ADD 2
07 55 58	VEGETATED FLUID-APPLIED PROTECTED MEMBRANE ROOFING	ADD 2
07 62 00	SHEET METAL FLASHING AND TRIM	
07 72 00	ROOF ACCESSORIES	
07 81 00	APPLIED FIREPROOFING	
07 81 23	INTUMESCENT FIREPROOFING	
07 84 13	PENETRATION FIRESTOPPING	
07 84 43	JOINT FIRESTOPPING	
07 92 00	JOINT SEALANTS	
07 95 00	EXPANSION CONTROL	

DIVISION 08 - OPENINGS

08 11 13	HOLLOW METAL DOORS AND FRAMES	
08 11 16	ALUMINUM DOORS AND FRAMES	
08 14 16	FLUSH WOOD DOORS	ADD 1
08 31 13	ACCESS DOORS AND FRAMES	
08 31 83	ELEVATOR DOOR SMOKE CONTAINMENT SYSTEM	
08 33 23	OVERHEAD COILING DOORS	
08 33 33	SIDE COILING FIRE DOORS	CONFORMED
08 37 00	HORIZONTAL-SLIDING ACCORDION FIRE DOOR	CONFORMED
08 41 13	ALUMINUM-FRAMED ENTRANCES AND STOREFRONTS	ADD 1

08 42 29	AUTOMATIC ENTRANCES	
08 42 29.13	FOLDING AUTOMATIC ENTRANCES	
08 42 43	INTENSIVE CARE UNIT/CRITICAL CARE UNIT (ICU/CCU) ENTRANCES	ADD 2
~~08 42 46~~	~~EXAM ROOM SLIDING ENTRANCES~~	ADD 2
08 42 49	RADIATION SHIELDING INTENSIVE CARE UNIT/CRITICAL CARE UNIT (ICU/CCU) ENTRANCES	
08 43 29	SLIDING FOLDING STOREFRONTS	
08 44 23	STRUCTURAL-SEALANT-GLAZED CURTAIN WALLS	
08 71 00	DOOR HARDWARE	ADD 2
08 80 00	GLAZING	
08 81 13	DECORATIVE GLASS GLAZING	
08 83 00	MIRRORS	
08 88 36	VISION CONTROL GLASS GLAZING	
08 91 19	FIXED LOUVERS	

DIVISION 09 - FINISHES

09 05 61.13	MOISTURE VAPOR EMISSION CONTROL	
09 21 16	GYPSUM BOARD SHAFT WALL ASSEMBLIES	
09 22 16	NON-STRUCTURAL METAL FRAMING	
09 27 13	GLASS-FIBER-REINFORCED GYPSUM FABRICATIONS	
09 29 00	GYPSUM BOARD	
09 30 13	CERAMIC TILING	
09 51 13	ACOUSTICAL PANEL CEILINGS	
09 51 33	ACOUSTICAL METAL PANEL CEILINGS	
09 54 53	ACOUSTICAL WOOD WALL UNITS	ADD 2
09 58 13	MONOLITHIC ACOUSTICAL CEILING SYSTEM	
09 61 00	CONCRETE FLOOR TREATMENT	
09 65 13	RESILIENT BASE AND ACCESSORIES	
09 65 16	RESILIENT SHEET AND TILE FLOORING	
09 65 36	STATIC-CONTROL RESILIENT FLOORING	
09 68 13	TILE CARPETING	
09 72 00	WALL COVERINGS	ADD 1
09 75 23	SOLID-SURFACING WALL FACING	
09 77 13	STRETCHED-FABRIC SYSTEMS	
09 81 29	SPRAYED ACOUSTIC INSULATION	ADD 1
09 91 13	EXTERIOR PAINTING	
09 91 23	INTERIOR PAINTING	
09 96 00	HIGH-PERFORMANCE COATINGS	

DIVISION 10 - SPECIALTIES

10 11 00	VISUAL DISPLAY UNITS
10 21 13.15	STAINLESS-STEEL TOILET COMPARTMENTS
10 21 23	CUBICLE CURTAINS AND TRACKS
10 22 13	WIRE MESH PARTITIONS AND GATES
10 22 39	SLIDING-FOLDING GLASS PARTITIONS
10 26 00	WALL PROTECTION

10 28 00	TOILET ACCESSORIES	
10 44 00	FIRE-PROTECTION SPECIALTIES	CONFORMED
10 44 45	PHOTOLUMINESCENT EXIT PATH MARKINGS	
10 51 13	METAL LOCKERS	
10 81 13	BIRD CONTROL	

DIVISION 11 - EQUIPMENT

11 24 29	FACILITY FALL PROTECTION	
11 31 00	APPLIANCES	
11 70 05	MEDICAL EQUIPMENT	

DIVISION 12 - FURNISHINGS

12 24 13	ROLLER WINDOW SHADES	
12 36 23	PLASTIC-LAMINATE-CLAD COUNTERTOPS	
~~12 36 40~~	~~STONE COUNTERTOPS~~	ADD 2
12 36 61	SIMULATED STONE COUNTERTOPS	ADD 2
12 48 13	ENTRANCE FLOOR MATS AND FRAMES	
12 48 16	ENTRANCE FLOOR GRILLES	
12 93 13	BICYCLE RACKS	

DIVISION 13 – SPECIAL CONSTRUCTION

13 34 13	GLAZED SPECIALTY STRUCTURES	ADD 2
13 49 00	RADIATION PROTECTION	

DIVISION 14 - CONVEYING EQUIPMENT

14 21 23	ELECTRIC TRACTION ELEVATORS	ADD 2
14 24 00	HYDRAULIC ELEVATORS	
14 91 35	LAUNDRY AND TRASH CHUTES	
14 92 00	PNEUMATIC TUBE SYSTEM	

VOLUME 3

DIVISION 21 THROUGH 33 SPECIFICATIONS

COVER PAGE VOLUME 3
TABLE OF CONTENTS

DIVISION 21 - FIRE PROTECTION

21 00 00	FIRE PROTECTION GENERAL PROVISIONS	
21 05 00	COMMON WORK RESULTS FOR FIRE SUPPRESSION	
21 05 13	COMMON MOTOR REQUIREMENTS FOR FIRE SUPPRESSION EQUIPMENT	
21 05 48	VIBRATION AND SEISMIC CONTROLS FOR FIRE-SUPPRESSION PIPING AND EQUIPMENT	
21 10 00	WATER-BASED FIRE-SUPPRESSION SYSTEMS	
~~21 22 00~~	~~CLEAN-AGENT FIRE EXTINGUISHING SYSTEM~~	ADD 2
21 31 13	ELECTRIC-DRIVE, CENTRIFIGAL FIRE PUMPS	

DIVISION 22 - PLUMBING

22 00 00	PLUMBING GENERAL PROVISIONS	
22 05 00	COMMON WORK RESULTS FOR PLUMBING	ADD 2
22 05 13	COMMON MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT	
22 05 16	EXPANSION FITTINGS AND LOOPS FOR PLUMBING PIPING	
22 05 19	METERS AND GAGES FOR PLUMBING PIPING	ADD 2
22 05 23	GENERAL-DUTY VALVES FOR PLUMBING PIPING	
22 05 29	HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT	
22 05 48	VIBRATION AND SEISMIC CONTROLS FOR PLUMBING PIPING AND EQUIPMENT	
22 05 53	IDENTIFICATION FOR PLUMBING AND PIPING EQUIPMENT	
22 07 00	PLUMBING INSULATION	ADD 2
22 11 16	DOMESTIC WATER PIPING	
22 11 19	DOMESTIC WATER PIPING SPECIALTIES	ADD 2
22 11 23	DOMESTIC WATER PUMPS	
22 11 23.13	DOMESTIC-WATER PACKAGED BOOSTER PUMPS	
22 13 16	SANITARY WASTE, VENT PIPING AND STORM DRAINAGE	
22 13 19	SANITARY WASTE PIPING SPECIALTIES	
22 13 29	SANITARY SEWERAGE PUMPS	
22 14 23	STORM DRAINAGE PIPING SPECIALTIES	
22 14 29	SUMP PUMPS	
22 32 00	DOMESTIC WATER FILTRATION EQUIPMENT	
22 35 00	DOMESTIC WATER HEAT EXCHANGERS	ADD 2
22 40 00	PLUMBING FIXTURES	ADD 1
22 61 13	COMPRESSED-AIR PIPING FOR HEALTHCARE FACILITIES	
~~22 61 19~~	~~COMPRESSED-AIR EQUIPMENT FOR HEALTHCARE FACILITIES~~	ADD 2
22 62 13	VACUUM PIPING FOR HEALTHCARE FACILITIES	ADD 1
~~22 62 19~~	~~VACUUM EQUIPMENT FOR HEALTHCARE FACILITIES~~	ADD 2
22 63 13	MEDICAL GAS PIPING FOR HEALTHCARE FACILITIES	

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

23 00 00	GENERAL PROVISIONS FOR HEATING, VENTILATING AND AIR CONDITIONING	
23 00 01	SUPPLEMENTAL CONDITIONS FOR MECHANICAL, ELECTRICAL, PLUMBING AND AIR CONDITIONING	
23 05 00	COMMON WORK RESULTS FOR HVAC	ADD 1
23 05 12	BEARING PROTECTION RING FOR MOTORS	
23 05 13	COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT	ADD 2
23 05 14	ENCLOSED CONTROLLERS	
23 05 15	VARIABLE-FREQUENCY MOTOR CONTROLLERS	ADD 2
23 05 16	EXPANSION FITTINGS AND LOOPS FOR HVAC PIPING	
23 05 19	METERS AND GAGES FOR HVAC PIPING	

23 05 23	GENERAL-DUTY VALVES FOR HVAC PIPING	ADD 2
23 05 29	HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT	
23 05 33	HEAT TRACING FOR HVAC PIPING	
23 05 48	MECHANICAL VIBRATION ISOLATION AND SEISMIC RESTRAINT SYSTEMS	
23 05 49	NOISE CONTROL AND ACOUSTICAL PERFORMANCE	
23 05 53	IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT	ADD 2
23 05 93	TESTING, ADJUSTING, AND BALANCING FOR HVAC	
23 07 00	HVAC INSULATION	ADD 2
23 08 00	COMMISSIONING OF HVAC	
23 09 00	HVAC INSTRUMENTATION AND CONTROLS	ADD 2
23 09 93	SEQUENCE OF OPERATIONS	ADD 2
23 21 13	HYDRONIC PIPING	ADD 2
23 21 23	HYDRONIC PUMPS	
23 22 13	STEAM AND CONDENSATE HEATING PIPING	ADD 2
23 22 23	STEAM CONDENSATE PUMPS	
23 25 00	HVAC WATER TREATMENT	
23 31 13	METAL DUCTS	ADD 2
23 33 00	AIR DUCT ACCESSORIES	
23 34 16	CENTRIFUGAL HVAC FANS	
23 34 23	HVAC POWER VENTILATORS	
23 36 00	AIR TERMINAL UNITS	ADD 2
23 37 13	DIFFUSERS, REGISTERS, AND GRILLES	ADD 1
23 57 00	HEAT EXCHANGERS FOR HVAC	
23 64 23	SCROLL WATER CHILLERS	
23 73 14	CUSTOM PACKAGED CENTRAL-STATION AIR-HANDLING UNITS	ADD 2
23 81 23	COMPUTER ROOM AIR CONDITIONERS	
23 82 19	FAN COIL UNITS	
23 82 33	CONVESTORS	
23 82 39	UNIT HEATERS	
23 83 16	HYDRONIC RADIANT SNOW MELT SYSTEM	
23 83 23	RADIANT-HEATING PANELS	
23 84 13	HUMIDIFIERS	

DIVISION 26 - ELECTRICAL

26 00 00	GENERAL PROVISIONS FOR ELECTRICAL WORK	
26 00 01	SUPPLEMENTARY CONDITIONS FOR MECHANICAL, ELECTRICAL, PLUMBING AND FIRE PROTECTION WORK	
26 05 00	COMMON WORK RESULTS FOR ELECTRICAL	
26 05 13	MEDIUM VOLTAGE CABLES	
26 05 19	LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES	ADD 2
26 05 26	GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS	
26 05 29	HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS	ADD 1
26 05 33	RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS	ADD 2

26 05 43	UNDERGROUND DUCTS AND RACEWAY FOR ELECTRICAL SYSTEMS	ADD 2
26 05 53	IDENTIFICATION FOR ELECTRICAL SYSTEMS	
26 05 73	OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY	
26 09 23	LIGHTING CONTROL DEVICES	
26 11 16	SINGLE ENDED SECONDARY UNIT SUBSTATION	ADD 1
26 11 17	DOUBLE ENDED SECONDARY UNIT SUBSTATION	ADD 1
26 22 00	LOW-VOLTAGE TRANSFORMERS	
26 23 00	LOW VOLTAGE SWITCHGEAR	ADD 1
26 24 16	PANELBOARDS	
26 24 17	ISOLATED POWER SYSTEMS	
26 27 26	WIRING DEVICES	
26 28 16	ENCLOSED SWITCHES AND CIRCUIT BREAKERS	
26 29 33	FIRE PUMP SERVICE ENTRANCE SWITCHBOARD	
26 33 53	CENTRAL UPS SYSTEM	ADD 2
26 33 63	CENTRAL IT UPS SYSTEM	
26 36 00	TRANSFER SWITCHES	
26 41 13	LIGHTNING PROTECTION SYSTEM	
26 43 13	SURGE PROTECTION FOR LOW VOLTAGE ELECTRICAL POWER CIRCUITS	
26 51 00	INTERIOR LIGHTING	ADD 1
26 56 00	EXTERIOR LIGHTING	ADD 1

DIVISION 27 - COMMUNICATIONS

27 00 00	COMMUNICATIONS – STRUCTURED CABLING
27 05 00	COMMON WORK RESULTS FOR COMMUNICATIONS
27 05 26	GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS
27 11 00	COMMUNICATIONS EQUIPMENT ROOM FITTINGS
27 13 00	COMMUNICATIONS BACKBONE CABLING
27 15 00	COMMUNICATIONS HORIZONTAL CABLING
27 40 00	PUBLIC ADDRESS SYSTEM
27 52 23	NURSE CALL SYSTEM
27 53 19	DISTRIBUTED ANTENNA SYSTEM

DIVISION 28 - ELECTRONIC SAFETY AND SECURITY

28 10 00	SECURITY SYSTEM
28 31 11	FIRE ALARM
28 31 11.11	BI-DIRECTIONAL ANTENNA SYSTEM
28 41 11	AREA OF RESCUE ASSISTANCE INTERCOM SYSTEM
28 41 14	GPS WIRELESS CLOCK SYSTEMS/ELAPSED TIMER

DIVISION 31 - EARTHWORK

31 10 00	SITE CLEARING
31 20 00	EARTH MOVING
31 23 19	DEWATERING

31 50 00 EXCAVATION SUPPORT AND PROTECTION

DIVISION 32 - EXTERIOR IMPROVEMENTS

32 12 16	ASPHALT PAVING	ADD 1
32 13 13	CONCRETE PAVING	
32 16 13.43	GRANITE CURBING	
32 39 13	VEHICLE BARRIER BOLLARDS	ADD 2
32 93 00	PLANTS	ADD 1

DIVISION 33 - UTILITIES

33 05 13	MANHOLES AND CATCH BASINS
33 05 16	UTILITY STRUCTURES
33 11 00	WATER UTILITY DISTRIBUTION PIPING
33 31 00	SANITARY UTILITY SEWERAGE PIPING
33 41 00	STORM UTILITY DRAINAGE PIPING
33 42 01	STORMWATER TREATMENT SYSTEM
33 46 00	SUBDRAINAGE
33 47 13	POND AND RESERVOIR LINERS

END OF TABLE OF CONTENTS

This page is intentionally left blank.

SECTION 21 00 00

FIRE PROTECTION GENERAL PROVISIONS

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

A. Work under this Section as shown or specified shall be in accordance with the requirements of the Contract Documents.

1.2 DEFINITIONS

A. "Provide": to supply, install and make complete, safe, and operable, the particular work referred to unless specifically indicated otherwise.

B. "Install": to erect, mount, and make complete with all related accessories.

C. "Furnish" or "supply": to purchase, procure, acquire, and deliver complete with related accessories.

D. "Work": labor, materials, equipment, services, and all related accessories necessary for the proper and complete installation of complete systems.

E. "Piping": pipe, tube, fittings, flanges, valves, controls, strainers, hangers, supports, unions, traps, drains, insulation and all related accessories.

F. "Wiring": raceway, fittings, wire, boxes and all related accessories.

G. "Indicated," "shown" or "noted": as indicated, shown, or noted on drawings or specifications.

H. "Similar" or "equal": of base bid manufacturer, equal in quality materials, weight, size, performance, design, and efficiency of specified product, conforming with "Base Bid Manufacturers".

I. "Reviewed" "satisfactory," "accepted", or "directed": as reviewed, satisfactory, accepted, or directed by Architect and/or Engineer.

J. "Motor Controllers": manual or magnetic starters with or without switches, individual pushbuttons or hand-off-automatic (HOA) switches controlling the operation of motors.

K. "Control or Actuating Devices": automatic sensing and switching devices such as thermostats, pressure, float, flow operation of equipment.

L. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawl spaces, and tunnels.

M. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

N. Exposed, Exterior Installations: Exposed to view outdoors, or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

O. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.

P. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants, but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

Q. The following are industry abbreviations for plastic materials:
1. ABS: Acrylonitrile-butadiene-styrene plastic.
2. CPVC: Chlorinated polyvinyl chloride plastic.
3. NP: Nylon plastic.
4. PE: Polyethylene plastic.
5. PVC: Polyvinyl chloride plastic.

R. The following are industry abbreviations for rubber materials:
1. CR: Chlorosulfonated polyethylene synthetic rubber.
2. EPDM: Ethylene propylene diene terpolymer rubber.

1.3 WORK INCLUDED

A. The work covered by this section includes the construction described in the Contract Documents including all labor necessary to perform and complete such construction, all materials and equipment incorporated or to be incorporated in such construction, and all services, facilities, tools and equipment necessary or used to perform and complete such construction. The work includes, but is not limited to the following:
1. Sprinkler Systems and Equipment.
2. Piping, Valves and Fittings.
3. Identification System.
4. Hydraulic Calculations.
5. Cutting, Patching and Equipment Painting.
6. Hangers, Supports and Guides.
7. Alarm Wiring, except for Fire Alarm.
8. Rigging of Equipment.
9. Furnishing access Doors and Frames to be installed under another section.
10. Fire Stopping for Pipe Penetration.
11. Pipe Penetration.
12. Alarm Initiating Devices.

B. Related Work not Included in this Division but Specified Elsewhere
1. Fire Alarm Wiring.
2. Finish painting, except for pre-finished equipment or as otherwise specified.
3. Concrete work, except equipment inertia and floating bases.
4. Base flashing for piping.
5. Waterproofing.
6. Power wiring for motors and motor controllers.
7. Installation of access doors and frames.

1.4 COORDINATION OF WORK

A. The fire protection drawings show the general arrangement of piping and appurtenances. Follow these drawings as closely as the actual construction will permit. Conform the fire protection work to the requirements shown on the drawings. Provide offsets, fittings, and accessories, which may be required but not shown on the drawings. Investigate the site, structural and finish ground conditions

affecting the work, and arrange the work accordingly. Provide such work and accessories as may be required to meet such conditions.

B. Certain materials will be provided by other trades. Examine the Contract Documents to ascertain these requirements.

C. Carefully check space requirements with other trades to insure that all material can be installed in the spaces allotted thereto including finished suspended ceilings.

D. Transmit to other trades all information required for work to be provided under their sections, in ample time for installation.

E. Wherever work interconnects with work of other trades, coordinate with the General Contractor to insure that necessary information is presented so all the necessary connections and equipment may be properly installed. Identify all items (valves, piping, equipment, etc.) In order that the General Contractor will know where to install access doors and panels.

F. Consult with other trades regarding equipment so that, wherever possible, motors, motor controls, pumps and valves are of the same manufacturer.

G. Furnish and set all sleeves for passage of pipes and conduits through structural masonry and concrete walls and floors and elsewhere as will be required for the proper protection of each pipe passing through building surfaces.

H. Provide required supports and hangers for piping and equipment, designed so as not to exceed allowable loadings of structures.

I. Examine and compare the contract drawings and specifications with the drawings and specifications of other disciplines and report any discrepancies between them to the General Contractor and obtain from him written instructions for changes necessary in the work of this section. Install and coordinate the work of this section in cooperation with the General Contractor installing interrelated work. Before installation, take proper provisions to avoid interferences. All changes required in the work of the contractor, caused by his neglect to do so, are to be made by him at his own expense.

J. Wherever the work is of sufficient complexity, prepare additional detail drawings to scale similar to that of the design drawings, prepared on tracing medium of the same size as contract drawings. With these layouts, coordinate the work with the work of the General Contractor. Such detailed work is to be clearly identified on the drawings as to the area to which it applies. Submit these drawings to the Engineer for review. At completion, however, include a set of such drawings with each set of as-built drawings. When directed by the Engineer, submit drawings for review, clearly showing the work of this section and its relation to the work of other disciplines before commencing shop fabrication or erection in the field.

K. Before commencing work, examine all adjoining work on which this work is in any way dependent for perfect workmanship and report any conditions, which prevent performance of first class work. Become thoroughly familiar with actual existing conditions to which connections must be made or which must be changed or altered.

L. Provide required anchor bolts, sleeves, inserts and supports. Direct location of anchor bolts, sleeves, inserts and supports to insure that they are properly installed. Any expense resulting from the improper location or installation of anchor bolts, sleeves, inserts and supports to be paid for by the contractor.

M. Slots, chases, openings and recesses through floors, walls, ceilings, and roofs will be provided by the various trades in their respective materials. Properly locate such

openings and be responsible for any cutting and patching caused by the neglect to do so.

N. Adjust location of pipes, panels, equipment, etc., to accommodate the work to prevent interferences, both anticipated and encountered. Determine the exact route and location of each pipe prior to fabrication.
   1. Right-of-Way: Lines that pitch have the right-of-way over those that do not pitch, i.e., plumbing drains. Lines whose elevations cannot be changed have right-of-way over lines whose elevations can be changed.
   2. Make offsets, transitions and changes in direction in pipes as required to maintain proper head room and pitch on sloping lines whether or not indicated on the drawings. Furnish and install all air vents, drains, etc., as required to affect these offsets, transitions and changes in direction.

O. Install all fire protection work to permit removal (without damage to other parts) of all other parts requiring periodic replacement or maintenance. Arrange pipes and equipment to permit access to valves, cocks, starters, motors, and control components, and to clear the openings of swinging doors and access panels.

P. Provide access panels in equipment as required for inspection and maintenance of internal parts, etc.

Q. This contractor shall coordinate his work with the work of other trades.

R. Coordinated Composite Drawings
   1. The Contractor shall prepare full coordinated composite drawings for the mechanical, electrical and fire protection trades. The Contractor shall overlay each trade's work (in separate colors) on a sepia set of sheetmetal drawings. All conflicts and potential conflicts shall be clearly identified on the sepia sheetmetal drawings. This shall include but not be limited to conflicts with lights, equipment, piping, ductwork and supports of other trades, as well as conflicts with architectural and structural walls, columns, ceilings and structural beams. Contractor shall have representatives of each trades, as well as conflicts with architectural and structural walls, columns, ceilings and structural beams. Contractor shall have representatives of each trade attend a weekly job site coordination meeting in the Contractor's field office. All trades shall resolve conflicts at these meetings and sign off each sepia sheetmetal drawing indicating acceptance and satisfactory resolution to all conflicts. All conflicts that cannot be resolved shall be brought to the attention of the Engineer for resolution.

1.5 USE OF SITE AND LOAD LIMITATIONS

A. The contractor shall review all available data on the location and types of pipelines and other underground utilities. The contractor shall not operate equipment over the facilities and shall take care not to damage them or otherwise impair their use. The contractor shall make investigation to verify the location of these facilities before proceeding with construction and/or operations in their vicinity.

1.6 CONTRACTOR'S RESPONSIBILITY FOR EVALUATION

A. The Engineer and Owner make no representations, regarding the character or extent of the subsoils, water levels, existing structural, mechanical and electrical installations, above or below ground or other subsurface conditions which may be encountered during the Work. The contractor must make his own evaluation of

existing conditions, which may affect methods or cost of performing the Work, based on his own examination of the facility or other information. Failure to examine the drawings or other information shall not relieve the contractor of his responsibility for satisfactory accomplishment of the Work.

B. The locations of existing services are believed to be as indicated on the drawings. The contractor shall verify the actual location of these services and notify the Engineer of any discrepancies prior to commencing work.

1.7 ACCESS TO FIRE PROTECTION EQUIPMENT

A. The contractor shall not interfere with access to hydrants, fire exits, fire hose stations, fire extinguishers, and fire alarm pull stations. In no case shall the contractor's material or equipment be within twenty-five (25) feet of a hydrant or fire alarm pull station.

1.8 EQUIPMENT AND MATERIALS

A. If products and materials are specified or indicated on the drawings for a specific item or system, the contractor shall use those products or materials. If products and materials are not listed in either of the above, use first class products and materials, in accordance with shop drawings.

B. All products and materials shall be new, clean, free of defects and free of damage and corrosion.

C. No permanent equipment shall be used to provide temporary services during construction.

D. Ship and store all products and materials in a manner which will protect them from damage, weather and entry of debris. If items are damaged, do not install, but take immediate steps to obtain replacement or repair.

E. Make certain that all materials selected directly, or by suppliers, conform to the requirements of the contract drawings and specification. Transmittal of such specifications and drawings, information to persons manufacturing and supplying materials to the project, and rigid adherence thereto, is the contractor's responsibility. Acceptance of a manufacturer's name by the Engineer does not release the contractor of the responsibility for providing materials, which comply in all respects with the requirements in the Contract Documents.

F. Applicable equipment and materials to be listed by Underwriters' Laboratories and Manufactured in accordance with ASME, AWWA, NFPA or ANSI standards, and as approved by the local authorities having jurisdiction.

G. Fully lubricate all equipment when installed and prior to final acceptance.

H. Locate valves, access doors, etc., to be easily accessible, either in mechanical spaces or through access panels specified herein.

I. Follow manufacturers' instructions for installing, connecting, and adjusting all equipment. Provide one copy of such instructions to the Engineer before installing any equipment. Provide a copy of such instructions at the equipment during any work on the equipment. Provide all special valves, piping, wiring and accessories.

1.9 QUALITY ASSURANCE

A. Codes Standards and Fees:
   1. Codes and Standards:
      a. Comply with all current governing codes, ordinances and regulations, as well as with requirements of NFPA, UL and all other applicable codes.
      b. Comply with the requirements of the State adopted Building Code, NFPA and other agencies or authorities having jurisdiction over any part of the Work and secure all necessary permits.
      c. Where codes or standards are listed herein, the applicable portions apply.
      d. Plans, specifications, codes and standards are all minimum requirements. Where requirements differ, apply the more stringent.
      e. Should any change in plans or specifications be required to comply with governing regulations, the contractor is to notify the Engineer at the time of submitting his bid.
      f. The codes and standards listed in the Specifications can be obtained from the organizations listed as follows:
         1) OSHA Occupational Safety and Health Act
         2) ANSI American National Standard Institute, Inc.
         3) ASME American Society of Mechanical Engineers
         4) ASTM American Society for Testing and Materials
         5) AWWA American Water Works Association
         6) UL Underwriters Laboratories, Inc.
         7) ASHRAE American Society of Heating, Refrigerating and Air Conditioning Engineers
         8) NFPA National Fire Protection Association
         9) NEMA National Electrical Manufacturers Association
         10) AIA American Insurance Association
         11) AWS American Welding Society
         12) ASA American Standards Association
         13) IEEE Institute of Electrical and Electronics Engineers
         14) NEC National Electrical Code
      g. The particular specification will be identified by appropriate prefix and number only with the latest revision being applicable unless otherwise noted.
   2. Fees
      a. Pay all required permit and/or inspection fees.
      b. Pay royalties or fees required in connection with the use of patented devices and systems.
   3. Furnish all materials and equipment new, free from defects and with listings or labels of Underwriter's Laboratories, Inc. or other nationally approved testing laboratory.
   4. All items of a given type shall be the product of the same manufacturer.
   5. All materials and equipment shall be the product of manufacturers regularly engaged in their manufacture.

1.10 SHOP DRAWINGS

A. Prepare and submit detailed shop drawings for piping work and other distribution services, including locations and sizes of all openings in floor walls and roofs.

B. The work described in any shop drawing submission to be carefully checked for all clearances (including those required for maintenance and servicing), field conditions,

maintenance of architectural conditions and proper coordination with all trades on the job.

C. Each submitted shop drawing to include a certification that all related job conditions have been checked and that no conflict exists.

D. All drawings are to be submitted sufficiently in advance of field requirements to allow ample time for checking. All submittals to be complete and contain all required and detailed information. Shop drawings with multiple parts to be submitted as a package.

E. If submittals differ from the Contract Document requirements, make specific mention of such difference in a letter of transmittal, with request for substitution, together with reasons for same.

F. Review of any submitted data or shop drawings for material, equipment, apparatus, devices, arrangement and layout shall not relieve the contractor from responsibility of furnishing same of proper dimensions and weight, capacities, sizes, quantity, quality and installation details to efficiently perform the requirements and intent of the Work. Such review shall not relieve the contractor from responsibility for errors, omissions or inadequacies of any sort on submitted data or shop drawings.

G. Each shop drawing to contain job title, the names and phone numbers of the General Contractor and the contractor reference to the applicable design drawing or specification article, date and scale.

H. Within 15 days after award of Contract, submit for review, a list of all material and equipment manufacturers whose products are proposed, as well as names of all subcontractors whom the General Contractor proposes to employ.

I. Within three (3) weeks after award of Contract, submit a list of all shop drawings, which will be submitted in the course of the project. List to show disposition of each item, including date of submission, review, and the like. List to be kept up-to-date throughout entire construction period.

J. Submit shop drawings and manufacturer's data for the following items in accordance with the Contract Documents:
   1. Coordinated, detailed shop layout drawings of all mechanical rooms, services and distribution systems, including plans, profiles and sections.
   2. Details of piping supports, elbows, anchors and miscellaneous appurtenances.
   3. Hangers, supports, inserts, anchors, guides and foundations.
   4. Valves.
   5. Pressure gauges.
   6. Corrosion protective coatings.
   7. Equipment and piping layouts at 3/8 in. scale for the building.
   8. Location and size of sleeves for openings in floors and walls.
   9. Schedule of pipe and fittings, materials and application, valves, escutcheons, air vents, valve tags and schedules, strainers, and water specialties.
   10. Access doors.
   11. Sound insulation, thermal insulation and vibration isolation.
   12. Flashing.
   13. Equipment identification and certificates.
   14. Sprinkler heads and accessories.
   15. Other shop drawings and submittals as requested within the specification.

1.11 SAMPLES

A. Submit samples of all items with exposed finishes for review.

B. Allow sufficient time for consideration without interfering with job schedule.

C. Duplicate quality and finish to type to be supplied under contract.

D. Identify similar to shop drawings.

1.12 ELECTRONIC COPIES OF AKF DRAWINGS

A. Upon award of contract, contractor shall submit list of drawings that they will require. AKF will provide drawings in (.PDF) format only.

B. If the contractor requires (.dwg) format, there will be a charge of $200 for each drawing supplied plus shipping and handling for preparation and processing. After preparation the drawings will be forwarded only upon receipt of signed acceptance of terms form. Permission from the architect must first be obtained for AKF to include the architectural background as reference. The contractor is to obtain the architects latest drawings directly from the architect.

C. These files are being issued for the convenience of the contractor and the contractor remains responsible for all contract requirements related to the normal shop drawing preparation process.

1.13 SUBMISSIONS:

A. Provide all coordination drawings and shop drawings in ‘AutoCad” format, version compatible with owner. All catalog cuts and submittals to be provided in electronic “PDF” format the architect will forward all submissions to the engineer.

B. If paper submissions are to be provided the following shall be adhered to.
   1. Submissions 11 in. X 17 in. or smaller: If the submission is a catalog cut, then the contractor shall submit one original and one copy. Otherwise, they shall submit two copies. The architect will forward the original and one copy (two copies when no original is received) to the engineer. All catalog cuts shall be complete.
   2. Submissions larger than 11 in. X 17 in.: submit two copies to the architect. The architect will forward to the engineer.

C. Indicate on each submission: project name and location, architect and engineer, item identification and approval stamp of prime contractor, subcontractor names and phone numbers, reference to the applicable design drawing or specification article, date and scale.

D. The work described in all shop drawing submission shall be carefully checked for all clearances (including those required for maintenance and servicing), field conditions, maintenance of architectural conditions and proper coordination with all trades on the job.

E. Each submitted shop drawing is to include a certification that all related job conditions have been checked and verified and that there are no conflicts.

F. All shop drawings are to be submitted to allow ample time for checking in advance of field requirements. All submittals to be complete and contain all required and detailed information. Shop drawings with multiple parts shall be submitted as a package.

G. If submittals differ from the contract document requirements, make specific mention of such difference in a letter of transmittal, with request for substitution, together with reasons for same.

1.14 AS-BUILTS AND EQUIPMENT OPERATION INSTRUCTIONS

A. Provide all coordination drawings and shop drawings in AutoCad format, version compatible with owner. All catalog cuts and submittals to be provided in electronic “PDF” format the architect will forward all submissions to the engineer.

B. On completion and acceptance of work, this contractor shall furnish written instructions, equipment manuals and demonstrate to the owner the proper operation and maintenance of all equipment and apparatus furnished under this contract.

C. The contractor shall give one copy of the instructions to the owner and one copy to the engineer. .

D. Final “as-built” drawings indicating as installed conditions shall be provided to the architect and engineer after completion of the installation.

1.15 ACCESS DOORS IN FINISHED CONSTRUCTION

A. Furnish access doors as required for operation and maintenance of concealed equipment and coordinate their delivery with the installing trade.

B. Coordinate and prepare a location, size and function schedule of access doors required and deliver to the General Contractor and the Architect for review.

C. Doors shall be of a size required for operating and repacking valves, and shall be as manufactured by Karp Associates, Nystrom Inc. or Mifab.

D. Unless otherwise indicated, minimum size to be 18" x 18".

E. Furnish color coded buttons or tabs to indicate location of valves or other equipment located above removable type ceilings where access doors are not required.

1.16 SYSTEMS IDENTIFICATION

A. Piping:
   1. All exposed fire protection piping shall be finish painted red in color unless otherwise directed.
   2. All piping, exposed or concealed, shall be identified as to its service in accordance with OSHA and ANSI Standards by one of the following methods:
      a. Installation of manufactured adhesive band type identification markers, similar to "Quick-Label" by W.H. Brady Company.
   3. Piping identification markings shall be installed as follows:
      a. In each room.
      b. All valve locations.
      c. At shaft walls.
      d. Every 40 feet on continuous runs.

B. Valves:
   1. Valves shall be identified by tag system utilizing brass tags at 2-inch minimum diameter and attached to the valves using brass chain.
      a. The new valve tag identification numbers shall be permanently added to all existing valve tag charts.

2. The service and function of all fire protection valves shall be identified at the valve by signs, similar to Potter Roemer Series 6300, attached to the valves by brass chains.

C. Equipment:
1. Identify all controls such as motor starters not in motor control centers, float switches, and alarms.

1.17 OPERATING & MAINTENANCE INSTRUCTION

A. Prepare an operating and maintenance instruction manual which includes the following:
1. Alphabetical list of all system components, with the name, address, and 24-hour phone number of the company responsible for servicing each item during the first year of operation.
2. Operating instructions for complete system, including:
   a. Normal starting, operating, and shut-down.
   b. Emergency procedures for fire or failure of major equipment.
   c. Summer and winter special procedures.
   d. Day and night special procedures.
3. Maintenance instructions, including:
   a. Valve tag list and equipment tag list.
   b. Proper lubricants and lubricating instructions for each piece of equipment, and date when lubricated.
   c. Required cleaning, replacement and/or adjustment schedule.
4. Manufacturer's data on each piece of equipment, including:
   a. Installation instructions.
   b. Drawings and specifications.
   c. Parts list, including recommended items to be stocked.
   d. Complete wiring and temperature control diagrams.
   e. Marked or revised prints locating all concealed parts and all variations from the original system design.
   f. Test and inspection certificates.
5. Specific equipment data including, but not limited to, the following:
   a. Piping.
   b. Valves.
   c. Accessories.
   d. Sprinkler heads.
   e. Tamper switches.
   f. Flow switches.
   g. Electric wiring.
   h. Controllers.
6. For Automatic Control System
   a. Drawings and description of system controlled.
   b. Sequence of operation for each system.
   c. Data on components.
   d. Wiring and piping, schematic any layout, for panels and panelboards.
   e. System operating manual, including set points.

B. Provide instruction of operating personnel.
1. Instruct Owner's operating personnel in proper starting sequences, operation, shutdown, and maintenance procedures, including normal and emergency procedures.

2. Instruction to be by personnel skilled in operation of equipment. Instructions for major equipment to be by equipment manufacturers' representatives.
3. Make arrangements to give instructions by system and not by building areas.
4. Provide five (5) instruction sessions not to exceed six (6) hours each.
5. Instructions on automatic controls to be by manufacturer's representative.

C. Submittals.
1. Shop Drawings: Submit three copies for review prior to final issuance.
2. Provide 6 copies of each operation and maintenance manual.
   a. Manuals to be 8-1/2" x 11" size in hard-back, 3-ring loose-leaf binders. Use more than one volume if required. Do not overfill binders.
   b. Manuals to be completed and delivered to the Engineer for approval at least 20 days prior to instruction of operating personnel.
3. Prepare separate manuals for the fire protection systems.

1.18 TOOLS FOR OPERATION, ADJUSTMENT AND MAINTENANCE

A. Deliver to Owner's representative all special tools needed for proper operation, adjustment and maintenance of equipment.

1.19 RECORD DRAWINGS

A. The contractor shall maintain a complete set of “Record Drawings” reflecting an accurate dimensional record of all work. These drawings shall be marked up to show the precise location of concealed work and equipment, including concealed piping and valves and all changes and deviations in the plumbing work from that shown on the contract drawings. This requirement shall not be construed as authorization for the contractor to make changes in the layout or work without written definite instruction from the Architect or Engineer.

B. Record dimensions shall clearly and accurately delineate the work as installed; location shall be suitably identified by at least two dimensions to permanent structures.

C. The contractor shall stamp all “Record Drawings” and certify for correctness by signing and dating them.

D. Record drawings submitted to Owner shall consist of 1 set of mylars and 1 set of compact disk’s (CD’s) with all work provided on Autocad 2000 format.

E. Prior to final acceptance, contractor shall submit certified “Record Drawings” to the Architect/Engineer for review and make changes, corrections or additions as noted by Architect/Engineer. After this review, the drawing shall be delivered to the Owner.

PART 2 - PRODUCTS

NOT USED.

PART 3 - EXECUTION

NOT USED.

END OF SECTION

SECTION 21 05 00

COMMON WORK RESULTS FOR FIRE SUPPRESSION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:
   1. Piping materials and installation instructions common to most piping systems.
   2. Mechanical sleeve seals.
   3. Sleeves.
   4. Escutcheons.
   5. Equipment installation requirements common to equipment sections.
   6. Painting and finishing.
   7. Supports and anchorages.

1.3 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

F. The following are industry abbreviations for rubber materials:
   1. EPDM: Ethylene-propylene-diene terpolymer rubber.
   2. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS

A. Product Data: For the following:
   1. Mechanical sleeve seals.
   2. Escutcheons.

B. Welding certificates.

1.5 QUALITY ASSURANCE

A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."

B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
   1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
   2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

C. Electrical Characteristics for Fire-Suppression Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.7 COORDINATION

A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for fire-suppression installations.

B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

C. Coordinate requirements for access panels and doors for fire-suppression items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

2.2 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 21 piping Sections for pipe, tube, and fitting materials and joining methods.

B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.3 JOINING MATERIALS

A. Refer to individual Division 21 piping Sections for special joining materials not listed below.

B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
   1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch (3.2-mm) maximum thickness unless thickness or specific material is indicated.
      a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
      b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
   2. AWWA C110, rubber, flat face, 1/8 inch (3.2 mm) thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

D. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

E. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.

F. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.4 MECHANICAL SLEEVE SEALS

A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
   1. Manufacturers:
      a. Thunderline
      b. Calpico, Inc.
      c. Metraflex Co.
   2. Sealing Elements: EPD Minterlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
   3. Pressure Plates: Plastic. Include two for each sealing element.
   4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.5 SLEEVES

A. Galvanized-Steel Sheet: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.

B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.

C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
   1. Underdeck Clamp: Clamping ring with set screws.

E. Molded PE: Reusable, PE, tapered-cup shaped, and smooth-outer surface with nailing flange for attaching to wooden forms.

2.6 ESCUTCHEONS

A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.

B. One-Piece, Cast-Brass Type: With set screw.
   1. Finish: Polished chrome-plated .

C. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.
   1. Finish: Polished chrome-plated .

D. One-Piece, Floor-Plate Type: Cast-iron floor plate.

E. Split-Casting, Floor-Plate Type: Cast brass with concealed hinge and set screw.

PART 3 - EXECUTION

3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 21 Sections specifying piping systems.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping to permit valve servicing.

G. Install piping at indicated slopes or as required to facilitate positive drainage of piping.

H. Install piping free of sags and bends.

I. Install fittings for changes in direction and branch connections.

J. Install piping to allow application of insulation.

K. Select system components with pressure rating equal to or greater than system operating pressure.

L. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
   1. New Piping:

a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
b. Insulated Piping: One-piece, stamped-steel type with spring clips.
c. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
d. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece , cast-brass type with polished chrome-plated finish.
e. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with polished chrome-plated finish.
f. Bare Piping in Equipment Rooms: One-piece, cast-brass type.
g. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.

M. Sleeves are not required for core-drilled holes.

N. Permanent sleeves are not required for holes formed by removable PE sleeves.

O. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.

P. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
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 (50 mm) above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
3. Install sleeves that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
a. SteelPipe Sleeves: For pipes smaller than NPS 6 (DN 150).
b. Steel Sheet Sleeves: For pipes NPS 6 (DN 150) and larger, penetrating gypsum-board partitions.
c. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches (50 mm) above finished floor level. Refer to Division 07 Section "Sheet Metal Flashing and Trim" for flashing.
1) Seal space outside of sleeve fittings with grout.
4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.

Q. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.
1. Install steel pipe for sleeves smaller than 6 inches (150 mm) in diameter.
2. Install cast-iron "wall pipes" for sleeves 6 inches (150 mm) and larger in diameter.
3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space

between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

R. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section "Penetration Firestopping" for materials.

S. Verify final equipment locations for roughing-in.

T. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.2 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 21 Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. 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.

E. 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.

F. 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.

G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.3 PAINTING

A. Painting of fire-suppression systems, equipment, and components is specified in Division 09 Sections "Interior Painting" and "Exterior Painting."

B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.4 ERECTION OF METAL SUPPORTS AND ANCHORAGES

A. Refer to Division 05 Section "Metal Fabrications" for structural steel.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor fire-suppression materials and equipment.

C. Field Welding: Comply with AWS D1.1.

END OF SECTION

This page is intentionally left blank.

SECTION 21 05 13

COMMON MOTOR REQUIREMENTS FOR FIRE SUPPRESSION EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.3 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 requirements in this Section except when stricter requirements are specified in fire suppression equipment schedules or Sections.

B. Comply with NEMA MG 1 unless otherwise indicated.

C. Comply with IEEE 841 for severe-duty motors.

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: Energy 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. Multispeed Motors: Separate winding for each speed.

F. Rotor: Random-wound, squirrel cage.

G. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.

H. Temperature Rise: Match insulation rating.

I. Insulation: [Class F] <Insert class>.

J. Code Letter Designation:
   1. Motors [15] <Insert number> HP and Larger: NEMA starting Code F or Code G.
   2. Motors Smaller than [15] <Insert number> HP: Manufacturer's standard starting characteristic.

K. Enclosure Material: Cast iron for motor frame sizes [324T] <Insert number> and larger; rolled steel for motor frame sizes smaller than [324T] <Insert number>.

2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

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. Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor.

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

This page is intentionally left blank.

SECTION 21 05 48

VIBRATION AND SEISMIC CONTROLS FOR FIRE-SUPPRESSION PIPING AND EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:
   1. Isolation pads.
   2. Isolation mounts.
   3. Restrained elastomeric isolation mounts.
   4. Restraining braces.

1.3 DEFINITIONS

A. IBC: International Building Code.

B. ICC-ES: ICC-Evaluation Service.

C. OSHPD: Office of Statewide Health Planning and Development for the State of California.

1.4 PERFORMANCE REQUIREMENTS

A. Seismic-Restraint Loading:
   1. Site Class as Defined in the IBC: [A] [B] [C] [D] [E] [F].
   2. Assigned Seismic Use Group or Building Category as Defined in the IBC: [I] [II] [III].
      a. Component Importance Factor: [1.0] [1.5] <Insert value>.
      b. Component Response Modification Factor: [1.5] [2.5] [3.5] [5.0] <Insert value>.
      c. Component Amplification Factor: [1.0] [2.5] <Insert value>.
   3. Design Spectral Response Acceleration at Short Periods (0.2 Second): <Insert percent>.
   4. Design Spectral Response Acceleration at 1-Second Period: <Insert percent>.

1.5 SUBMITTALS

A. Product Data: For the following:
   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 seismic-restraint component used.
   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.

B. Delegated-Design Submittal: For vibration isolation and seismic-restraint details 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. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation, seismic forces required to select vibration isolators, seismic restraints, and for designing vibration isolation bases.
   2. 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. 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).

C. Welding certificates.

D. Qualification Data: For [professional engineer] [and] [testing agency].

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (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 and NFPA 13 unless requirements in this Section are more stringent.

C. Welding: 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 not available, 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 VIBRATION ISOLATORS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

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

C. Basis-of-Design Product: Subject to compliance with requirements, provide [the product indicated on Drawings] <Insert manufacturer's name; product name or designation> or a comparable product by one of the following:
   1. Ace Mountings Co., Inc.
   2. Amber/Booth Company, Inc.
   3. California Dynamics Corporation.
   4. Isolation Technology, Inc.
   5. Kinetics Noise Control.
   6. Mason Industries.
   7. Vibration Eliminator Co., Inc.
   8. Vibration Isolation.
   9. Vibration Mountings & Controls, Inc.
   10. <Insert manufacturer's name>.

D. Pads <Insert drawing designation>: Arranged in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.
   1. Resilient Material: Oil- and water-resistant [neoprene] [rubber] [hermetically sealed compressed fiberglass].

E. Mounts <Insert drawing designation>: Double-deflection type, with molded, oil-resistant rubber, hermetically sealed compressed fiberglass, or neoprene isolator elements with factory-drilled, encapsulated top plate for bolting to equipment and with baseplate for bolting to structure. Color-code or otherwise identify to indicate capacity range.

   1. Materials: Cast-ductile-iron or welded steel housing containing two separate and opposing, oil-resistant rubber or neoprene elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.

   2. Neoprene: Shock-absorbing materials compounded according to the standard for bridge-bearing neoprene as defined by AASHTO.

F. Restrained Mounts <Insert drawing designation>: All-directional mountings with seismic restraint.
   1. Materials: Cast-ductile-iron or welded steel housing containing two separate and opposing, oil-resistant rubber or neoprene elements that prevent central

threaded element and attachment hardware from contacting the housing during normal operation.

2. Neoprene: Shock-absorbing materials compounded according to the standard for bridge-bearing neoprene as defined by AASHTO.

2.2 SEISMIC-RESTRAINT DEVICES

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

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

C. Basis-of-Design Product: Subject to compliance with requirements, provide [the product indicated on Drawings] <Insert manufacturer's name; product name or designation> or a comparable product by one of the following:
1. Amber/Booth Company, Inc.
2. California Dynamics Corporation.
3. Cooper B-Line, Inc.; a division of Cooper Industries.
4. Hilti, Inc.
5. Kinetics Noise Control.
6. Loos & Co.; Cableware Division.
7. Mason Industries.
8. TOLCO Incorporated; a brand of NIBCO INC.
9. Unistrut; Tyco International, Ltd.
10. <Insert manufacturer's name>.

D. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by [an evaluation service member of ICC-ES] [OSHPD] [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] <Insert number> times the maximum seismic forces to which they will be subjected.

E. Channel Support System: MFMA-3, shop- or field-fabricated support assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other matching components and with corrosion-resistant coating; and rated in tension, compression, and torsion forces.

F. Hanger Rod Stiffener: [Steel tube or steel slotted-support-system sleeve with internally bolted connections] [Reinforcing steel angle clamped] to hanger rod.

G. 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.

H. 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.

I. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

J. 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. Minimum length of eight times diameter.

K. Adhesive Anchor Bolts: Drilled-in and capsule anchor system containing polyvinyl 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.

2.3 FACTORY FINISHES

A. Finish: Manufacturer's standard prime-coat finish ready for field painting.

B. Finish: Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.
   1. Powder coating on springs and housings.
   2. All hardware shall be galvanized. Hot-dip galvanize metal components for exterior use.
   3. Baked enamel or powder coat for metal components on isolators for interior use.
   4. Color-code or otherwise mark vibration isolation and seismic-control devices to indicate capacity range.

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.

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 evaluation service member of ICC-ES] [OSHPD] [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 will be adequate to carry present and future static and seismic loads within specified loading limits.

3.3 VIBRATION-CONTROL AND SEISMIC-RESTRAINT DEVICE INSTALLATION

A. Equipment Restraints:
   1. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.
   2. Install seismic-restraint devices using methods approved by [an evaluation service member of ICC-ES] [OSHPD] [an agency acceptable to authorities having jurisdiction] providing required submittals for component.

B. Piping Restraints:
   1. Comply with requirements in MSS SP-127 and NFPA 13.
   2. Space lateral supports a maximum of [40 feet] <Insert dimension> o.c., and longitudinal supports a maximum of [80 feet] <Insert dimension> o.c.
   3. Brace a change of direction longer than 12 feet

C. Install cables so they do not bend across edges of adjacent equipment or building structure.

D. Install seismic-restraint devices using methods approved by [an evaluation service member of ICC-ES] [OSHPD] [an agency acceptable to authorities having jurisdiction] providing required submittals for component.

E. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.

F. 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.

G. 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.

H. 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 Division 13 Section "Water-Based Fire-Suppression Systems" for piping flexible connections.

3.5 FIRE-SUPPRESSION VIBRATION-CONTROL AND SEISMIC-RESTRAINT DEVICE SCHEDULE

A. Supported or Suspended Equipment: <Insert name and drawing designation>.
   1. Equipment Location: <Insert room number>.
   2. Pads:
      a. Material: [Neoprene] [Rubber] [Hermetically sealed compressed fiberglass].
      b. Thickness: <Insert inches>.
      c. Number of Pads: <Insert number> thick.
   3. Isolator Type: <Insert generic name or designation used in Part 2>.
   4. Minimum Deflection: <Insert inches>.
   5. Component Importance Factor: [1.0] [1.5].
   6. Component Response Modification Factor: [1.5] [2.5] [3.5] [5.0].
   7. Component Amplification Factor: [1.0] [2.5].

END OF SECTION

This page is intentionally left blank.

SECTION 21 10 00

WATER-BASED FIRE-SUPPRESSION SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following fire-suppression piping inside the building:
   1. Wet-pipe sprinkler systems.

B. Related Sections include the following:
   1. Division 10 Section "Fire Extinguisher Cabinets" and "Fire Extinguishers" for cabinets and fire extinguishers.
   2. Division 28 Section "Fire Detection and Alarm" for alarm devices not specified in this Section.

1.3 DEFINITIONS

A. CR: Chlorosulfonated polyethylene synthetic rubber.

B. High-Pressure Piping System: Fire-suppression piping system designed to operate at working pressure higher than standard 175 psig (1200 kPa).

C. PE: Polyethylene plastic.

D. Underground Service-Entrance Piping: Underground service piping below the building.

1.4 SYSTEM DESCRIPTIONS

A. Combined Standpipe and Sprinkler System: Fire-suppression system with both standpipe and sprinkler systems. Sprinkler system is supplied from standpipe system.

B. Wet-Pipe Sprinkler System: Automatic sprinklers are attached to piping containing water and that is connected to water supply. Water discharges immediately from sprinklers when they are opened. Sprinklers open when heat melts fusible link or destroys frangible device. Hose connections are included if indicated.

1.5 PERFORMANCE REQUIREMENTS

A. Standard Piping System Component Working Pressure: Listed for at least 175 psig (1200 kPa).

B. High-Pressure Piping System Component Working Pressure: Listed for 300 psig (2070 kPa).

C. Fire-suppression standpipe system design shall be approved by authorities having jurisdiction.
   1. Minimum residual pressure at each hose-connection outlet is the following:
      a. NPS 2-1/2 (DN 65) Hose Connections: 100 psig (690 kPa).
   2. Unless otherwise indicated, the following is maximum residual pressure at required flow at each hose-connection outlet:
      a. NPS 2-1/2 (DN 65) Hose Connections: 175 psig (1200 kPa).

D. Fire-suppression sprinkler system design shall be approved by authorities having jurisdiction.
   1. Margin of Safety for Available Water Flow and Pressure: 10 percent, including losses through water-service piping, valves, and backflow preventers.
   2. Sprinkler Occupancy Hazard Classifications:
      a. Building Service Areas: Ordinary Hazard, Group 1.
      b. Electrical Equipment Rooms: Ordinary Hazard, Group 1.
      c. General Storage Areas: Ordinary Hazard, Group 1.
      d. Mechanical Equipment Rooms: Ordinary Hazard, Group 1.
      e. Office and Public Areas: Light Hazard.
      f. Patient Areas: Light Hazard
   3. Minimum Density for Automatic-Sprinkler Piping Design:
      a. Light-Hazard Occupancy: 0.10 gpm over 1500-sq. ft. (6.3 mL/s over 139-sq. m) area.
      b. Ordinary-Hazard, Group 1 Occupancy: 0.15 gpm over 2000-sq. ft. (9.5 mL/s over 139-sq. m) area.
      c. Ordinary-Hazard, Group 2 Occupancy: 0.20 gpm over 2000-sq. ft. (12.6 mL/s over 139-sq. m) area.
      d. Extra-Hazard, Group 1 Occupancy: 0.30 gpm over 2500-sq. ft. (18.9 mL/s over 232-sq. m) area.
      e. Extra-Hazard, Group 2 Occupancy: 0.40 gpm over 2500-sq. ft. (25.2 mL/s over 232-sq. m) area.
      f. Special Occupancy Hazard: As determined by authorities having jurisdiction.
   4. Maximum Protection Area per Sprinkler:
      a. Office Spaces and Patient Areas: 225 sq. ft. (20.9 sq. m).
      b. Storage Areas: 130 sq. ft. (12.1 sq. m).
      c. Mechanical Equipment Rooms: 130 sq. ft. (12.1 sq. m).
      d. Electrical Equipment Rooms: 130 sq. ft. (12.1 sq. m).
      e. Other Areas: According to NFPA 13 recommendations, unless otherwise indicated.
   5. Total Combined Hose-Stream Demand Requirement: According to NFPA 13, unless otherwise indicated:
      a. Light-Hazard Occupancies: 100 gpm (6.3 L/s) for 30 minutes.
      b. Ordinary-Hazard Occupancies: 250 gpm (15.75 L/s) for 60 to 90 minutes.
      c. Extra-Hazard Occupancies: 500 gpm (31.5 L/s) for 90 to 120 minutes.

E. Seismic Performance: Fire-suppression piping shall be capable of withstanding the effects of earthquake motions determined according to NFPA 13 and IBC 2006.

1.6 SUBMITTALS

A. Product Data: For the following:
   1. Piping materials, including sprinkler specialty fittings.
   2. Pipe hangers and supports, including seismic restraints.
   3. Valves, including listed fire-protection valves, unlisted general-duty valves, and specialty valves and trim.
   4. Sprinklers, escutcheons, and guards. Include sprinkler flow characteristics, mounting, finish, and other pertinent data.
   5. Hose connections, including size, type, and finish.
   6. Hose stations, including size, type, and finish of hose connections; type and length of fire hoses; finish of fire hose couplings; type, material, and finish of nozzles; and finish of rack.
   7. Fire department connections, including type; number, size, and arrangement of inlets; caps and chains; size and direction of outlet; escutcheon and marking; and finish.
   8. Alarm devices, including electrical data.

B. Shop Drawings: Diagram power, signal, and control wiring.

C. Fire-hydrant flow test report.

D. Approved Sprinkler Piping Drawings: Working plans, prepared according to NFPA 13, that have been approved by authorities having jurisdiction, including hydraulic calculations, if applicable.

E. Field Test Reports and Certificates: Indicate and interpret test results for compliance with performance requirements and as described in NFPA 13 and NFPA 14. Include "Contractor's Material and Test Certificate for Aboveground Piping" and "Contractor's Material and Test Certificate for Underground Piping."

F. Welding certificates.

G. Field quality-control test reports.

H. Operation and Maintenance Data: For standpipe and sprinkler specialties to include in emergency, operation, and maintenance manuals.

1.7 QUALITY ASSURANCE

A. Installer Qualifications:
   1. Installer's responsibilities include designing, fabricating, and installing fire-suppression systems and providing professional engineering services needed to assume engineering responsibility. Base calculations on results of fire-hydrant flow test.
      a. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a qualified professional engineer.

B. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.

C. NFPA Standards: Fire-suppression-system equipment, specialties, accessories, installation, and testing shall comply with the following:
   1. NFPA 13, "Installation of Sprinkler Systems."
   2. NFPA 14, "Installation of Standpipe, Private Hydrant, and Hose Systems."
   3. NFPA 24, "Installation of Private Fire Service Mains and Their Appurtenances."

1.8 COORDINATION

A. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies.

1.9 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Sprinkler Cabinets: Finished, wall-mounting, steel cabinet with hinged cover, with space for minimum of six spare sprinklers plus sprinkler wrench. Include number of sprinklers required by NFPA 13 and sprinkler wrench. Include separate cabinet with sprinklers and wrench for each type of sprinkler on Project.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

2.2 STEEL PIPE AND FITTINGS

A. Threaded-End, Standard-Weight Steel Pipe: ASTM A 53/A 53M, ASTM A 135, or ASTM A 795, hot-dip galvanized where indicated and with factory- or field-formed threaded ends.
   1. Cast-Iron Threaded Flanges: ASME B16.1.
   2. Malleable-Iron Threaded Fittings: ASME B16.3.
   3. Gray-Iron Threaded Fittings: ASME B16.4.
   4. Steel Threaded Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106, Schedule 40, seamless steel pipe hot-dip galvanized where indicated. Include ends matching joining method.
   5. Steel Threaded Couplings: ASTM A 865 hot-dip galvanized-steel pipe where indicated.

B. Plain-End, Standard-Weight Steel Pipe: ASTM A 53/A 53M, ASTM A 135, or ASTM A 795.
   1. Steel Welding Fittings: ASTM A 234/A 234M, and ASME B16.9 or ASME B16.11.
   2. Steel Flanges and Flanged Fittings: ASME B16.5.

C. Grooved-End, Standard-Weight Steel Pipe: ASTM A 53/A 53M, ASTM A 135, or ASTM A 795, hot-dip galvanized where indicated and with factory- or field-formed, roll-grooved ends.
   1. Grooved-Joint Piping Systems:
      a. Manufacturers:
         1) National Fittings, Inc.

2) Victaulic Co. of America.
3) Ward Manufacturing.

b. Grooved-End Fittings: UL-listed, ASTM A 536, ductile-iron casting with OD matching steel-pipe OD.

c. Grooved-End-Pipe Couplings: UL 213 and AWWA C606, rigid pattern, unless otherwise indicated; gasketed fitting matching steel-pipe OD. Include ductile-iron housing with keys matching steel-pipe and fitting grooves, prelubricated rubber gasket listed for use with housing, and steel bolts and nuts.

2.3 DIELECTRIC FITTINGS

A. Assembly shall be copper alloy, ferrous, and insulating materials with ends matching piping system.

B. Dielectric Unions: Factory-fabricated assembly, designed for 250-psig (1725-kPa) minimum working pressure at 180 deg F (82 deg C). Include insulating material that isolates dissimilar materials and ends with inside threads according to ASME B1.20.1.

1. Manufacturers:
   a. Epco Sales, Inc.
   b. Watts Industries, Inc.; Water Products Div.
   c. Zurn Industries, Inc.; Wilkins Div.

C. Dielectric Flanges: Factory-fabricated companion-flange assembly, for 175-psig (1200-kPa) minimum working-pressure rating as required for piping system.

1. Manufacturers:
   a. Epco Sales, Inc.
   b. Watts Industries, Inc.; Water Products Div.

D. Dielectric Flange Insulation Kits: Components for field assembly shall include CR or phenolic gasket, PE or phenolic bolt sleeves, phenolic washers, and steel backing washers.

1. Manufacturers:
   a. Calpico, Inc.
   b. Central Plastics Company.
   c. Pipeline Seal and Insulator, Inc.

2.4 SPRINKLER SPECIALTY FITTINGS

A. Sprinkler specialty fittings shall be UL listed or FMG approved, with 175-psig (1200-kPa) minimum working-pressure rating, and made of materials compatible with piping. Sprinkler specialty fittings shall have 300-psig (2070-kPa) working-pressure rating if fittings are components of high-pressure piping system.

B. Outlet Specialty Fittings:

1. Manufacturers:
   a. National Fittings, Inc.
   b. Star Pipe Products; Star Fittings Div.
   c. Victaulic Co. of America.
   d. Ward Manufacturing.
2. Mechanical-T and -Cross Fittings: UL 213, ductile-iron housing with gaskets, bolts and nuts, and threaded, locking-lug, or grooved outlets.

C. Sprinkler Drain and Alarm Test Fittings: Cast- or ductile-iron body; with threaded or locking-lug inlet and outlet, test valve, and orifice and sight glass.
   1. Manufacturers:
      a. Central Sprinkler Corp.
      b. Fire-End and Croker Corp.
      c. Viking Corp.
      d. Victaulic Co. of America.

D. Sprinkler Inspector's Test Fitting: Cast- or ductile-iron housing with threaded inlet and drain outlet and sight glass.
   1. Manufacturers:
      a. AGF Manufacturing Co.
      b. G/J Innovations, Inc.

2.5 LISTED FIRE-PROTECTION VALVES

A. Valves shall be UL listed or FMG approved, with 175-psig (1200 kPa) minimum pressure rating. Valves shall have 300-psig (2070-kPa) pressure rating if valves are components of high-pressure piping system.

B. Gate Valves with Wall Indicator Posts:
   1. Gate Valves: UL 262, cast-iron body, bronze mounted, with solid disc, nonrising stem, operating nut, and flanged ends.
   2. Indicator Posts: UL 789, horizontal-wall type, cast-iron body, with hand wheel, extension rod, locking device, and cast-iron barrel.
   3. Manufacturers:
      a. Grinnell Fire Protection.
      b. McWane, Inc.; Kennedy Valve Div.
      c. NIBCO.
      d. Stockham.

C. Ball Valves: Comply with UL 1091, except with ball instead of disc.
   1. NPS 1-1/2 (DN 40) and Smaller: Bronze body with threaded ends.
   2. NPS 2 and NPS 2-1/2 (DN 50 and DN 65): Bronze body with threaded ends or ductile-iron body with grooved ends.
   3. NPS 3 (DN 80): Ductile-iron body with grooved ends.
   4. Manufacturers:
      a. NIBCO.
      b. Milwaukee
      c. Stockham
   5. NPS 2-1/2 (DN 65) and Larger: Bronze, cast-iron, or ductile-iron body; wafer type or with flanged or grooved ends.
      a. Manufacturers:
         1) McWane, Inc.; Kennedy Valve Div.
         2) Mueller Company.
         3) NIBCO.
         4) Milwaukee

D. Check Valves NPS 2 (DN 50) and Larger: UL 312, swing type, cast-iron body with flanged or grooved ends.
   1. Manufacturers:
      a. Crane Co.; Crane Valve Group; Crane Valves.
      b. Crane Co.; Crane Valve Group; Jenkins Valves.

c. Grinnell Fire Protection.
d. Hammond Valve.
e. McWane, Inc.; Kennedy Valve Div.
f. Mueller Company.
g. NIBCO.
h. Stockham.

E. Gate Valves: UL 262, OS&Y type.
1. NPS 2 (DN 50) and Smaller: Bronze body with threaded ends.
a. Manufacturers:
1) Crane Co.; Crane Valve Group; Crane Valves.
2) Hammond Valve.
3) NIBCO.
2. NPS 2-1/2 (DN 65) and Larger: Cast-iron body with flanged ends.
a. Manufacturers:
1) Crane Co.; Crane Valve Group; Crane Valves.
2) Crane Co.; Crane Valve Group; Jenkins Valves.
3) Milwaukee Valve Company.
4) Mueller Company.
5) NIBCO.

F. Indicating Valves: UL 1091, with integral indicating device and ends matching connecting piping.
1. Indicator: Electrical, 115-V ac, prewired, 2-circuit, supervisory switch Visual.
2. NPS 2 (DN 50) and Smaller: Ball or butterfly valve with bronze body and threaded ends.
a. Manufacturers:
1) Milwaukee Valve Company.
2) NIBCO.
3) Victaulic Co. of America.
3. NPS 2-1/2 (DN 65) and Larger: Butterfly valve with cast- or ductile-iron body; wafer type or with flanged or grooved ends.
a. Manufacturers:
1) McWane, Inc.; Kennedy Valve Div.
2) Milwaukee Valve Company.
3) NIBCO.

2.6 UNLISTED GENERAL-DUTY VALVES

A. Ball Valves NPS 2 (DN 50) and Smaller: MSS SP-110, 2-piece copper-alloy body with chrome-plated brass ball, 600-psig (4140-kPa) minimum CWP rating, blowout-proof stem, and threaded ends.

B. Check Valves NPS 2 (DN 50) and Smaller: MSS SP-80, Type 4, Class 125 minimum, swing type with bronze body, nonmetallic disc, and threaded ends.

C. Gate Valves NPS 2 (DN 50) and Smaller: MSS SP-80, Type 2, Class 125 minimum, with bronze body, solid wedge, and threaded ends.

D. Globe Valves NPS 2 (DN 50) and Smaller: MSS SP-80, Type 2, Class 125 minimum, with bronze body, nonmetallic disc, and threaded ends.

2.7 SPECIALTY VALVES

A. Sprinkler System Control Valves: UL listed or FMG approved, cast- or ductile-iron body with flanged or grooved ends, and 175-psig (1200-kPa) minimum pressure rating. Control valves shall have 300-psig (2070-kPa) pressure rating if valves are components of high-pressure piping system.
   1. Manufacturers:
      a. Grinnell Fire Protection.
      b. Reliable Automatic Sprinkler Co., Inc.
      c. Star Sprinkler Inc.
      d. Victaulic Co. of America.
      e. Viking Corp.
   2. Alarm Check Valves: UL 193, designed for horizontal or vertical installation, with bronze grooved seat with O-ring seals, single-hinge pin, and latch design. Include trim sets for bypass, drain, electrical sprinkler alarm switch, pressure gages, and fill-line attachment with strainer.
      a. Drip Cup Assembly: Pipe drain without valves and separate from main drain piping.

2.8 SPRINKLERS

A. Sprinklers shall be UL listed or FMG approved, with 175-psig (1200-kPa) minimum pressure rating. Sprinklers shall have 300-psig (2070-kPa) pressure rating if sprinklers are components of high-pressure piping system.

B. Manufacturers:
   1. Grinnell Fire Protection.
   2. Reliable Automatic Sprinkler Co., Inc.
   3. Star Sprinkler Inc.
   4. Viking Corp.

C. Automatic Sprinklers: With heat-responsive element complying with the following:
   1. UL 199, for nonresidential applications.
   2. UL 1626, for residential applications.
   3. UL 1767, for early-suppression, fast-response applications.

D. Sprinkler Types and Categories: Nominal 1/2-inch (12.7-mm) orifice for "Ordinary" temperature classification rating, unless otherwise indicated or required by application.

E. Sprinkler types, features, and options as follows:
   1. Concealed ceiling sprinklers, including cover plate.
   2. Flush ceiling sprinklers, including escutcheon.
   3. Pendent sprinklers.
   4. Pendent, dry-type sprinklers.
   5. Quick-response sprinklers.
   6. Recessed sprinklers, including escutcheon.
   7. Sidewall sprinklers.
   8. Sidewall, dry-type sprinklers.
   9. Upright sprinklers.

F. Sprinkler Finishes: Chrome plated, bronze, and painted.

G. Special Coatings: Wax, lead, and corrosion-resistant paint.

H. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers.
   1. Ceiling Mounting: Chrome-plated steel, 2 piece, with 1-inch (25-mm) vertical adjustment.
   2. Sidewall Mounting: Chrome-plated steel, one piece, flat.

I. Sprinkler Guards: Wire-cage type, including fastening device for attaching to sprinkler.

2.9 FIRE DEPARTMENT CONNECTIONS

A. Manufacturers:
   1. Elkhart Brass Mfg. Co., Inc.
   2. Fire-End and Croker Corp.
   3. Potter-Roemer; Fire-Protection Div.
   4. Reliable Automatic Sprinkler Co., Inc.

B. Wall-Type, Fire Department Connection: UL 405, 300-psig minimum pressure rating; with corrosion-resistant-metal body with brass inlets, brass wall escutcheon plate, brass lugged caps with gaskets and brass chains, and brass lugged swivel connections. Include inlets with threads according to NFPA 1963 and matching local fire department sizes and threads, outlet with pipe threads, extension pipe nipples, check devices or clappers for inlets, and escutcheon plate with marking similar to "AUTO SPKR."
   1. Type: Flush, with one (Stor2 Type) inlet and square or rectangular escutcheon plate.
   2. Finish: Polished chrome-plated.

2.10 ALARM DEVICES

A. Alarm-device types shall match piping and equipment connections.

B. Water-Motor-Operated Alarm: UL 753, mechanical-operation type with pelton-wheel operator with shaft length, bearings, and sleeve to suit wall construction and 10-inch- (250-mm-) diameter, cast-aluminum alarm gong with red-enamel factory finish. Include NPS 3/4 (DN 20) inlet and NPS 1 (DN 25) drain connections.
   1. Manufacturers:
      a. Grinnell Fire Protection.
      b. Reliable Automatic Sprinkler Co., Inc.
      c. Star Sprinkler Inc.
      d. Viking Corp.

C. Electrically Operated Alarm: UL 464, with 6-inch- (150-mm-) minimum- diameter, vibrating-type, metal alarm bell with red-enamel factory finish and suitable for outdoor use.
   1. Manufacturers:
      a. Potter Electric Signal Company.
      b. System Sensor.

D. Water-Flow Indicator: UL 346, electrical-supervision, paddle-operated-type, water-flow detector with 250-psig (1725-kPa) pressure rating and designed for horizontal or vertical installation. Include two single-pole, double-throw circuit switches for isolated alarm and auxiliary contacts, 7 A, 125-V ac and 0.25 A, 24-V dc; complete

with factory-set, field-adjustable retard element to prevent false signals and tamperproof cover that sends signal if removed.
1. Manufacturers:
   a. Grinnell Fire Protection.
   b. Potter Electric Signal Company.
   c. System Sensor.
   d. Viking Corp.

E. Pressure Switch: UL 753, electrical-supervision-type, water-flow switch with retard feature. Include single-pole, double-throw, normally closed contacts and design that operates on rising pressure and signals water flow.
1. Manufacturers:
   a. Grinnell Fire Protection.
   b. Potter Electric Signal Company.
   c. System Sensor.
   d. Viking Corp.

F. Valve Supervisory Switch: UL 753, electrical, single-pole, double-throw switch with normally closed contacts. Include design that signals controlled valve is in other than fully open position.
1. Manufacturers:
   a. McWane, Inc.; Kennedy Valve Div.
   b. Potter Electric Signal Company.
   c. System Sensor.

G. Indicator-Post Supervisory Switch: UL 753, electrical, single-pole, double-throw switch with normally closed contacts. Include design that signals controlled indicator-post valve is in other than fully open position.
1. Manufacturers:
   a. Potter Electric Signal Company.
   b. System Sensor.

2.11 PRESSURE GAGES

A. Manufacturers:
1. AMETEK, Inc.; U.S. Gauge.
2. Dresser Equipment Group; Instrument Div.
3. Marsh Bellofram.
4. WIKA Instrument Corporation.

B. Description: UL 393, 3-1/2- to 4-1/2-inch- (90- to 115-mm-) diameter, dial pressure gage with range of 0 to 300 psig (0 to 2070 kPa).
1. Water System Piping: Include caption "WATER" or "AIR/WATER" on dial face.
2. Air System Piping: Include retard feature and caption "AIR" or "AIR/WATER" on dial face.

PART 3 - EXECUTION

3.1 PREPARATION

A. Perform fire-hydrant flow test according to NFPA 13, NFPA 14, and NFPA 291. Use results for system design calculations required in Part 1 "Quality Assurance" Article.

B. Report test results promptly and in writing.

3.2 EARTHWORK

A. Refer to Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.

3.3 EXAMINATION

A. Examine roughing-in for hose connections and stations to verify actual locations of piping connections before installation.

B. Examine walls and partitions for suitable thicknesses, fire- and smoke-rated construction, framing for hose-station cabinets, and other conditions where hose connections and stations are to be installed.

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

3.4 PIPING APPLICATIONS, GENERAL

A. Shop weld pipe joints where welded piping is indicated.

B. Do not use welded joints for galvanized-steel pipe.

C. Flanges, flanged fittings, unions, nipples, and transition and special fittings with finish and pressure ratings same as or higher than system's pressure rating may be used in aboveground applications, unless otherwise indicated.

D. Piping between Fire Department Connections and Check Valves: Galvanized, standard-weight steel pipe with threaded ends; cast- or malleable-iron threaded fittings; and threaded joints.

E. Underground Service-Entrance Piping: Ductile-iron, mechanical-joint pipe and fittings and restrained joints. Include corrosion-protective encasement.

3.5 SPRINKLER SYSTEM PIPING APPLICATIONS

A. Standard-Pressure, Wet-Pipe Sprinkler System, 175-psig (1200-kPa) Maximum Working Pressure:
   1. NPS 2”and Smaller: Threaded-end, black, standard-weight steel pipe; cast- or malleable-iron threaded fittings; and threaded joints.
   2. NPS 2 ½” and larger: Grooved-end, black, Schedule 10 steel pipe; grooved-end fittings; grooved-end-pipe couplings; and grooved joints.

3.6 VALVE APPLICATIONS

A. Drawings indicate valve types to be used. Where specific valve types are not indicated, the following requirements apply:
   1. Listed Fire-Protection Valves: UL listed and FMG approved for applications where required by NFPA 13 and NFPA 14.
      a. Shutoff Duty: Use ball, butterfly, or gate valves.
   2. Unlisted General-Duty Valves: For applications where UL-listed and FMG-approved valves are not required by NFPA 13 and NFPA 14.
      a. Shutoff Duty: Use ball, butterfly, or gate valves.

b. Throttling Duty: Use ball alves.

3.7 JOINT CONSTRUCTION

A. Refer to Division 21 Section "Common Work Results for Fire Suppression" for basic piping joint construction.

B. Threaded Joints: Comply with NFPA 13 for pipe thickness and threads. Do not thread pipe smaller than NPS 8 (DN 200) with wall thickness less than Schedule 40 unless approved by authorities having jurisdiction and threads are checked by a ring gage and comply with ASME B1.20.1.

C. Grooved Joints: Assemble joints with listed coupling and gasket, lubricant, and bolts.
   1. Ductile-Iron Pipe: Radius-cut-groove ends of piping. Use grooved-end fittings and grooved-end-pipe couplings.
   2. Steel Pipe: Groove piping as indicated. Use grooved-end fittings and rigid, grooved-end-pipe couplings, unless otherwise indicated.
   3. Dry-Pipe Systems: Use fittings and gaskets listed for dry-pipe service.

D. Dissimilar-Metal Piping Joints: Construct joints using dielectric fittings compatible with both piping materials.
   1. NPS 2 (DN 50) and Smaller: Use dielectric unions, couplings, or nipples.
   2. NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Use dielectric flanges.
   3. NPS 5 (DN 125) and Larger: Use dielectric flange insulation kits.

3.8 SERVICE-ENTRANCE PIPING

A. Connect fire-suppression piping to water-service piping of size and in location indicated for service entrance to building. Refer to Division 22 Section "Facility Water Distribution Piping" for exterior piping.

B. Install shutoff valve, backflow preventer, pressure gage, drain, and other accessories indicated at connection to water-service piping. Refer to Division 22 Section "Facility Water Distribution Piping" for backflow preventers.

C. Install shutoff valve, check valve, pressure gage, and drain at connection to water service.

3.9 PIPING INSTALLATION

A. Refer to Division 21 Section "Common Work Results for Fire Suppression" for basic piping installation.

B. Locations and Arrangements: Drawing plans, schematics, and diagrams indicate general location and arrangement of piping. Install piping as indicated, as far as practical.
   1. Deviations from approved working plans for piping require written approval from authorities having jurisdiction. File written approval with Architect before deviating from approved working plans.

C. Install underground ductile-iron service-entrance piping according to NFPA 24 and with restrained joints. Encase piping in corrosion-protective encasement.

D. Use approved fittings to make changes in direction, branch takeoffs from mains, and reductions in pipe sizes.

E. Install unions adjacent to each valve in pipes NPS 2 (DN 50) and smaller. Unions are not required on flanged devices or in piping installations using grooved joints.

F. Install flanges or flange adapters on valves, apparatus, and equipment having NPS 2-1/2 (DN 65) and larger connections.

G. Install "Inspector's Test Connections" in sprinkler system piping, complete with shutoff valve, sized and located according to NFPA 13.

H. Install sprinkler piping with drains for complete system drainage.

I. Install sprinkler zone control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.

J. Install drain valves on standpipes.

K. Install ball drip valves to drain piping between fire department connections and check valves. Drain to floor drain or outside building.

L. Install alarm devices in piping systems.

M. Hangers and Supports: Comply with NFPA 13 for hanger materials.
   1. Install standpipe system piping according to NFPA 14.
   2. Install sprinkler system piping according to NFPA 13.

N. Earthquake Protection: Install piping according to NFPA 13 to protect from earthquake damage.

O. Install pressure gages on riser or feed main, at each sprinkler test connection. Include pressure gages with connection not less than NPS 1/4 (DN 8) and with soft metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal, and install where they will not be subject to freezing.

P. Fill wet-pipe sprinkler system piping with water.

3.10 VALVE INSTALLATION

A. Install listed fire-protection valves, unlisted general-duty valves, specialty valves and trim, controls, and specialties according to NFPA 13 and NFPA 14 and authorities having jurisdiction.

B. Install listed fire-protection shutoff valves supervised-open, located to control sources of water supply except from fire department connections. Install permanent identification signs indicating portion of system controlled by each valve.

C. Valves for Wall-Type Fire Hydrants: Install nonrising-stem gate valve in water-supply pipe.

D. Install check valve in each water-supply connection. Install backflow preventers instead of check valves in potable-water supply sources.

E. Specialty Valves:
   1. Alarm Check Valves: Install in vertical position for proper direction of flow, including bypass check valve and retarding chamber drain-line connection.

3.11 SPRINKLER APPLICATIONS

A. Drawings indicate sprinkler types to be used. Where specific types are not indicated, use the following sprinkler types:
   1. Rooms without Ceilings: Upright sprinklers.
   2. Rooms with Suspended Ceilings: Concealed sprinklers.
   3. Wall Mounting: Sidewall sprinklers.
   4. Spaces Subject to Freezing: Pendent, dry sprinklers.
   5. Sprinkler Finishes:
      a. Upright, Pendent, and Sidewall Sprinklers: Chrome plated in finished spaces exposed to view; rough bronze in unfinished spaces not exposed to view; wax coated where exposed to acids, chemicals, or other corrosive fumes.
      b. Concealed Sprinklers: Rough brass, with factory-painted cover plate, Color by Architect
      c. Flush Sprinklers: Bright chrome, with painted white escutcheon.
      d. Recessed Sprinklers: Bright chrome, with bright chrome escutcheon.

3.12 SPRINKLER INSTALLATION

A. Install sprinklers in suspended ceilings in center of acoustical ceiling panels and tiles.

B. Do not install pendent or sidewall, wet-type sprinklers in areas subject to freezing. Use dry-type sprinklers with water supply from heated space.

3.13 FIRE DEPARTMENT CONNECTION INSTALLATION

A. Install wall-type, fire department connections in vertical wall.

B. Install ball drip valve at each check valve for fire department connection.

3.14 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment to allow service and maintenance.

C. Connect water-supply piping to fire-suppression piping. Include backflow preventer between potable-water piping and fire-suppression piping. Refer to Division 22 Section "Domestic Water Piping Specialties" for backflow preventers.

D. Install ball drip valves at each check valve for fire department connection. Drain to floor drain or outside building.

E. Connect piping to specialty valves, hose valves, specialties, fire department connections, and accessories.

F. Electrical Connections: Power wiring is specified in Division 26.

G. Connect alarm devices to fire alarm.

H. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

I. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

J. 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 and UL 486B.

3.15 LABELING AND IDENTIFICATION

A. Install labeling and pipe markers on equipment and piping according to requirements in NFPA 13 and NFPA 14.

3.16 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:
   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. Energize circuits to electrical equipment and devices.
   4. Start and run air compressors.
   5. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.
   6. Flush, test, and inspect standpipe systems according to NFPA 14, "System Acceptance" Chapter.
   7. Coordinate with fire alarm tests. Operate as required.
   8. Coordinate with fire-pump tests. Operate as required.
   9. Verify that equipment hose threads are same as local fire department equipment.

B. Report test results promptly and in writing to Architect and authorities having jurisdiction.

3.17 CLEANING AND PROTECTION

A. Clean dirt and debris from sprinklers.

B. Remove and replace sprinklers with paint other than factory finish.

C. Protect sprinklers from damage until Substantial Completion.

3.18 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain specialty valves. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION

This page is intentionally left blank.

SECTION 21 31 13

ELECTRIC-DRIVE, CENTRIFUGAL FIRE PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes electric-drive, split-case centrifugal fire pumps and the following:
   1. Full -service fire-pump controllers and automatic transfer switches.
   2. Fire-pump accessories and specialties.
   3. Pressure-maintenance pumps, controllers, accessories, and specialties.
   4. Alarm panels.
   5. Flowmeter systems.

1.3 PERFORMANCE REQUIREMENTS

A. Pump, Equipment, Accessory, Specialty, and Piping Pressure Rating: 175-psig (1200-kPa) minimum working-pressure rating, unless otherwise indicated.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, certified pump performance curves with each selection point indicated, operating characteristics, and furnished accessories and specialties for each fire pump and pressure-maintenance pump.

B. Shop Drawings: For fire pumps and drivers, fire-pump controllers, fire-pump accessories and specialties, pressure-maintenance pumps, pressure-maintenance-pump controllers, and pressure-maintenance-pump accessories and specialties. Include plans, elevations, sections, details, and attachments to other work.
   1. For installed products indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
   2. Wiring Diagrams: Power, signal, and control wiring.

C. Manufacturer Seismic Qualification Certification: Submit certification that fire pumps and drivers and fire-pump controllers, pressure-maintenance pumps, accessories, and specialties will withstand seismic forces defined in Division 21 Section "Vibration and Seismic Controls for Fire-Suppression Piping and Equipment." Include the following:
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
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 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.

D. Product Certificates: For each type of fire pump and fire-pump controller, signed by product manufacturer.

E. Source quality-control test reports.

F. Field quality-control test reports.

G. Operation and Maintenance Data: For fire pumps and drivers, pressure-maintenance pumps, controllers, accessories and specialties, alarm panels, and flowmeter systems to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain fire pumps, pressure-maintenance pumps, and controllers through one source from a single manufacturer for each type of equipment.

B. Product Options: Drawings indicate size, profiles, and dimensional requirements of fire pumps, pressure-maintenance pumps, and controllers and are based on specific systems indicated. Refer to Division 01 Section "Product Requirements."

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. Comply with standards of authorities having jurisdiction pertaining to materials, hose threads, and installation.

E. Comply with NFPA 20, "Stationary Pumps for Fire Protection," for fire pumps, drivers, controllers, accessories, and their installation.

1.6 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

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

2.2 CENTRIFUGAL FIRE PUMP

A. Furnish and install, where shown on plans, a fire pump system complete with pump, driver, controller and accessories. The pumping unit shall be listed by Underwriters' Laboratories, Inc. and shall be fully approved by the Associated Factory Mutual Fire Insurance Companies, where applicable. The pumping unit shall meet all requirements of the National Fire Protection Association Pamphlet No. 20.

B. Fire Pump:
   1. The Fire Pump shall be a Peerless Pump model 5AEF11G, horizontal split case base mounted, bronze fitted, single stage, double suction, centrifugal pump as supplied by Gustavo Preston, 978-250-3333.
   2. Static Suction Pressure is X PSIG. Residual Suction Pressure is 50 PSIG.
   3. The pump shall be designed to deliver 1000 G.P.M. when producing a differential pressure of 150 PSIG.
   4. The pump shall deliver not less than 150% of rated capacity at a pressure not less than 65% of the rated pressure.
   5. The shut off pressure shall not exceed 111% of rated pressure.
   6. The pump casing shall be cast iron with 6" 125 pound ANSI rated suction and 5”, 250 pound ANSI rated discharge flanges machined to American National Standards Institute (ANSI) dimensions.
   7. The driver shall be a 125 Hp / 3550 RPM horizontal, foot mounted, open drip-proof, ball bearing type, AC, induction, squirrel cage motor: wound for 480 volts, 3 phase, 60 Hertz. The motor shall be of such capacity that 115% of the full-load ampere rating shall not be exceeded at any condition of pump load. Locked rotor current shall not exceed the values specified in NFPA Pamphlet No. 20.
   8. Pump and motor shall be mounted on a common fabricated steel baseplate. The pump and driver shall be connected by a UL Listed coupling for fire service. Pump and motor shall be checked for alignment after the pump base has been installed, and also, after the base has been grouted in place, final alignment shall be laser alignment by pump manufacturer’s representation, provide before and after alignment reports for installation and operations manuals. The pump manufacturer’s representative company shall employ its own service group with 24/7 service capabilities.
   9. Casings shall be of cast iron having a minimum tensile strength of 35,000 P.S.I. Bearing housing supports, and suction and discharge flanges shall be integrally cast with the lower half of the casing. Removal of the upper half of the casing must allow the rotating element to be removed without disconnecting the suction and discharge flanges. Impellers shall be of the enclosed type and shall be of vacuum cast bronze. Impellers shall be dynamically balanced, keyed to the shaft, and held in place with threaded shaft sleeves.
   10. The pump shaft shall be made of SAE 1045 steel or equal, accurately machined to give a true running rotating element. Shaft shall be protected by stainless steel sleeves, key locked and threaded so that the sleeves tighten with the rotation of the shaft. An O-Ring shall seal between the impeller hub and the shaft sleeve to protect the pump shaft.

11. Pump shall be equipped with renewable bronze casing rings so designed that hydraulic pressure will seat them against a shoulder in the pump case around the full periphery of the wearing ring. The wearing rings will be locked by doweling to prevent rotation. The rotating element uses heavy-duty grease lubricated ball bearings and shall be equipped with water slingers. Bearing housings shall be so designed to flush lubricant through the bearing.
12. All pumps where the suction pressure is expected to average 40 P.S.I. or below, shall be provided with a lantern ring connected to the pressure side of the pump by a tee atop the pump casing. Stuffing boxes shall be equipped with split, cast stainless steel packing glands designed for easy removal for packing inspection and maintenance.
13. The fire pump unit shall include the following accessories, as required by NFPA 20 standards:
    a. (1) Liquid filled Suction pressure gauge
    b. (1) Liquid filled Discharge pressure gauge
    c. (1) ½" Automatic air release valve rated 300 PSI
    d. (1) ¾" Cla-Val casing relief valve rated 100 PSI to 300 PSI
    e. (1) Eccentric Suction Reducer
    f. (1) Concentric Discharge Reducer
    g. (1) Hose valve head, with angle hose valves, caps and chains
    h. (1) Flow meter

C. Jockey Pump:
1. Contractor shall furnish and install a vertical multistage Grundfos Jockey Pump Model CR3-15 with a rated capacity of 10 US GPM against a total head of 160 PSI.
2. The pump shall coupled to a motor rated 3.0 Hp 460 Volt, 60 Hz 3 Phase, Totally Enclosed Fan Cooled enclosure which is built to NEMA standards.
3. The pump shall have stainless steel diffusers and cast iron adapter with registered fits to maintain axial alignment, stainless steel enclosed impellers, PTFE neck ring, steel shaft coupling; stainless steel shaft. The impellers shall conform to shaft shape to prevent damage due to reverse rotation and to maintain proper interstage lateral setting.
4. Pump shall be designed for and equipped with a mechanical seal type stuffing box. A vent tap shall be provided for mechanical seal units to relieve entrapped air. Pump shall be provided with cast iron base with drain plug.
5. Where jockey pump churn pressures may exceed system design pressures, a casing relief valve shall be installed before the jockey check valve.

D. Main Fire Pump Controller
1. The main fire pump controller shall be a factory assembled, wired and tested unit and shall conform to all the requirements of the latest edition of NFPA 20, Standard for the Installation of Stationary Pumps for Fire Protection and NFPA 70, National Electrical Code. The controller shall be listed by Underwriters Laboratories, Inc., in accordance with UL218, Standard for Fire Pump Controllers, CSA, and Canadian Standards Association CSA-C22.2, Standard for Industrial Control Equipment (cULus), approved by Factory Mutual and approved by the City of New York for fire pump service.
2. Starting Method
    a. The controller shall be of the combined manual and automatic type designed for Solid State Soft Starting of the fire pump motor having the horsepower, voltage, phase and frequency rating shown on the plans

and drawings. The controller components shall be housed in a NEMA Type 2 (IEC IP11) drip-proof, wall mounted enclosure.

3. Withstand Ratings (Short Circuit Current Ratings)
   a. All controller components shall be front mounted, wired and front accessible for maintenance. The minimum withstand rating of the controllers shall not be less than 100,000 Amps RMS Symmetrical at 200-600 Volts*. If the available system fault current exceeds these ratings, the controllers shall be supplied with a withstand rating of 150,000 or 200,000 Amps RMS Symmetrical, as required.
4. Isolation Switch and Circuit Breaker
   a. The controller shall include a motor rated combination isolating disconnect switch/circuit breaker, mechanically interlocked and operated with a single, externally mounted handle. When moving the handle from OFF to ON, the interlocking mechanism shall sequence the isolating disconnect switch ON first, and then the circuit breaker. When the handle is moved from ON to OFF, the interlocking mechanism shall sequence the circuit breaker OFF first, and then the isolating disconnect switch.
5. The isolating disconnect switch/circuit breaker shall be mechanically interlocked so that the enclosure door cannot be opened with the handle in the ON position except by a hidden tool operated defeater mechanism. The isolating disconnect switch/circuit breaker shall be capable of being padlocked in the OFF position for installation and maintenance safety, and shall also be capable of being locked in the ON position without affecting the tripping characteristics of the circuit breaker. The controller door shall have a locking type handle and three-point cam and roller vault type hardware. The circuit breaker trip curve adjustment shall be factory set, tested and sealed for the full load amps of the connected motor. The circuit breaker shall be capable of being field tested to verify actual pick up, locked rotor, and instantaneous trip points after field installation without disturbing incoming line and load conductors.
6. A listed surge protection device shall be installed in or on the fire pump controller.
7. Operator Interface
   a. The fire pump controller shall feature an operator interface with user keypad. The interface shall monitor and display motor operating conditions, including all alarms, events, and pressure conditions. All alarms, events, and pressure conditions shall be displayed with a time and date stamp. The display shall be a 128 x 64 Backlit LED capable of customized graphics and Cyrillic type character display. The display and interface shall be NEMA rated for Type 2, 3R, 4, 4X, and 12 protection and shall be fully accessible without opening the controller door. The display and user interface shall utilize multiple levels of password protection for system security. A minimum of 3 password levels shall be provided.
8. Ammeter/Voltmeter
   a. The fire pump controller operator interface shall be capable of displaying true RMS digital motor voltage and current measurements for all three phases simultaneously. Displays requiring push-button and selector switches to toggle between phases or current and voltage shall not be accepted.

b. Voltage and current shall be measured by True RMS technology to provide the most accurate measurement for all sine waves, including non-sinusoidal waveforms. Average responding meters will not be accepted.

9. Data Logging
   a. The digital display shall monitor the system and log the following data:
      1) Motor Calls/Starts
      2) Elapsed Motor Run Time
         Last Trip Currents
         Elapsed Power On Time
      3) Last Breaker Trip
      4) Maximum Run Currents
      5) Minimum Voltages
      6) Minimum Run Currents
      7) Maximum Voltages
      8) Last Motor Run Time
      9) Last Phase Failure
      10) Last Start Currents
      11) Last Phase Reversal
      12) Min/Max Frequency
      13) Min/Max Pressure
10. Event Recording
   a. Memory - The controller shall record all operational and alarm events to system memory. All events shall be time and date stamped and shall include an index number. The system memory shall have the capability of storing 3000 events and allow the user access to the event log via the user interface. The user shall have the ability to scroll through the stored messages in groups of 1, 10, or 100.
   b. USB Flash Drive - The controller shall include a flash drive to save all operational and alarm events. The drive shall have the ability to store up to 10 years' worth of data (under normal operating conditions) in individual monthly files. Each event shall be time and date stamped. The controller shall also have the capability to save settings and values to memory stick through the user interface.
   c. Communications - The controller shall feature two independent communications ports to allow connectivity to computers, modems, or building management systems.
11. Solid State Pressure Transducer
   a. The controller shall be supplied with a solid state pressure transducer with a range of 0-300 PSI. The solid state transducer shall be used for both display of system pressure and control of the fire pump controller. Systems using analog pressure devices or mercury switches for operational control shall not be acceptable. The START, STOP and SYSTEM PRESSURE shall be digitally displayed on the user interface. The START and STOP settings shall adjustable on the user interface.
   b. The pressure transducer shall be mounted inside the controller to prevent accidental damage. The transducer shall be directly pipe mounted to a bulkhead coupling without any other supporting members. Field connection shall be made externally at the controller coupling to prevent distortion of the pressure transducer.
12. Seismic Certification

a. The controller shall be certified to meet or exceed the requirements of the 2006 International Building Code and the 2007 California Building Code for Importance Factor 1.5 Electrical Equipment for Sds equal to 1.88 or less severe seismic regions. Qualifications shall be based upon successful tri-axial shake-table testing in accordance with ICC-ES AC-156. Certification without testing shall be unacceptable. Controller shall be clearly labeled as rated for installation in seismic areas and a Certificate of Conformance as well as a Center of Gravity drawing shall be provided with the controller.
b. Manufacturer must have local representation with a minimum of 10 years in the fire pump controller business, and have 24/7 phone/service coverage. A reasonable amount of spare parts must be available locally.
c. Provide Spare set of contacts for Pump Run, Phase Reversal, Loss of Power, Transfer Switch open.
d. The main fire pump controller shall be Firetrol Model FTA1930/950

E. Power Transfer Switch for Gen Set/ Second Utility Emergency Power Source
1. The power transfer switch shall be housed within the fire pump controller enclosure or in a NEMA Type 2 (IEC IP11) drip-proof enclosure attached directly to the fire pump controller. Where the power transfer switch is provided in an attached enclosure, the enclosures shall be fitted so that the assembly constitutes a single unit. The fire pump controller/power transfer switch shall be factory assembled, wired and tested as a unit prior to shipment.
2. The power transfer switch shall include a motor rated combination isolating disconnect switch/circuit breaker, mechanically interlocked and operated with a single, externally mounted handle. When moving the handle from OFF to ON, the interlocking mechanism shall sequence the isolating disconnect switch closed first, and then the circuit breaker. When the handle is moved from ON to OFF, the interlocking mechanism shall sequence the circuit breaker open first, and then the isolating disconnect switch. The isolating disconnect switch/circuit breaker shall be mechanically interlocked so that the enclosure door cannot be opened with the handle in the ON position except by a hidden tool operated defeater mechanism. The isolating disconnect switch/circuit breaker shall be capable of being padlocked in the OFF position for installation and maintenance safety, and shall also be capable of being locked in the ON position without affecting the tripping characteristics of the circuit breaker. The enclosure door shall have a locking type handle and three point cam and roller type vault hardware. The circuit breaker trip curve adjustment shall be factory set, tested and sealed for the connected full load amps of the motor.
3. The fire pump controller/power transfer switch shall have data logging capability for historical operation recording and to aid in annual test, service and trouble shooting. The data logging shall be accessible by front mounted interface panel and also by saving the information via the standard USB port. The data file shall be in .txt format and easily readable by most common text editing or word processing software. The circuit breaker shall be capable of being field tested to verify actual pick up, locked rotor, and instantaneous trip points after field installation without disturbing incoming line and load conductors.
4. The automatic transfer switch shall consist of an inherently double throw power transfer switch mechanism and a microprocessor control panel to

provide automatic operation. The transfer switch and control panel shall be of the same manufacturer. The automatic transfer switch shall be an ASCO 7000 series with a group 5 control panel.

5. The transfer switch shall be electrically operated and mechanically held. The electrical operator shall be a momentarily energized, single solenoid mechanism. The switch shall be mechanically interlocked to ensure only two possible positions, normal or emergency. Switches having a neutral position shall not be permitted. The switch shall be positively locked and unaffected by momentary outages, so that contact pressure is maintained at a constant value and contact temperature rise is minimized for maximum reliability and operating life. All main contacts shall be silver composition and inspection of all contacts shall be possible from the front of the switch without disassembly of operating linkages and without disconnection of power.
   a. NOTE: Designs utilizing components of molded case circuit breakers, contactors, or parts thereof, which are not intended for continuous duty, repetitive switching or transfer between two active power sources, are not acceptable.
6. The transfer switch control panel shall have a 4 line, 20 character LCD display and keypad for viewing all available data and setting desired operational parameters. Voltage and frequency on both the normal and emergency sources shall be continuously monitored. The normal source pick up shall be set at 95% of nominal voltage and the emergency source pick up set at 90% of nominal voltage and 95% nominal frequency. Source status screens shall be provided for both normal & emergency to provide digital readout of voltage, frequency and phase rotation on all 3 phases.
7. The transfer switch shall have visible pilot light indication for the following conditions:
   a. TRANSFER SWITCH IN NORMAL, TRANSFER SWITCH IN EMERGENCY, NORMAL SOURCE ACCEPTED, EMERGENCY SOURCE ACCEPTED and EMERGENCY ISOLATION SWITCH OPEN. Remote alarm contacts shall be supplied as standard for the following conditions: EMERGENCY SOURCE ISOLATION SWITCH OPEN, NORMAL POWER AVAILABLE, and TRANSFER SWITCH POSITION. An audible alarm shall sound if: EMERGENCY ISOLATION SWITCH OPEN and TRANSFER SWITCH IN EMERGENCY. A SILENCE ALARM push-button on the user interface shall be supplied. A selector switch shall be supplied to manually test the transfer to emergency and the retransfer to normal power.
8. The transfer switch shall be a Firetrol Model FTA950 for normal utility power and second utility emergency power.
   a. NOTE: FTA950 power transfer switches are designed for use with Firetrol electric fire pump controllers.

F. Jockey Pump Controller
1. Contractor shall furnish and install a Firetrol Model FTA550F jockey pump controller, Hand-Off-Automatic selector switch and a pressure transducer. Controller shall be rated for 3.0 HP, 3 phase, 60 cycle, 480 Volt operation. Minimum enclosure rating shall be NEMA type 2, drip-tight.
2. The auxiliary jockey pump controller, if required and specified on the plans and specifications, shall be factory assembled, wired, and tested and specifically designed for this type of service. This controller shall be UL listed, and shall be of the same manufacturer as the main fire pump controller.
   a. Starting Method

1) The controller shall incorporate a full voltage magnetic starter, main disconnect switch, HAND-OFF-AUTOMATIC selector switch and a pressure transducer.

b. Pressure Controls
   1) The pressure transducer shall have a range of 0-300 PSI. All pressure setting shall be accomplished by the main menu on the controller front. Pressure adjustments inside the controller are unacceptable.
   2) The pressure transducer shall be directly pipe mounted to a bulkhead pipe coupling without any other supporting members.

c. Disconnect Switch
   1) The disconnect switch shall be mechanically interlocked so that the enclosure door cannot be opened with the handle in the ON position except by a hidden tool operated defeater mechanism. The disconnect switch shall be capable of being padlocked in the OFF position with up to three padlocks for installation and maintenance safety.

d. Enclosure
   1) The minimum enclosure rating shall be NEMA Type 2 (IEC IP11), drip-proof.

G. Start Up:
   1. The pump manufacturer, prior to shipment, shall hook up and test the pump assembly.
   2. The pump manufacturer shall provide the services and local representation of a factory trained representative for the initial start up and to in the final acceptance tests.
   3. The controller manufacturer shall have a sales and service representative in the area with a minimum of 10 years experience with their product. 24 hour 7 day service access must be available, as well as a moderate availability of spare parts.
   4. The controller manufacturer, prior to shipment, shall hook up and test the jockey pump controller as a completed assembly. This test shall include, but not be restricted to, each function the controller may be required to perform including manual start-stop, automatic start-stop and minimum run timing.
   5. The controller manufacturer shall provide the services and local representation of a factory trained representative to the initial start up and to the final acceptance tests.
   6. Coordination of final acceptance test with underwriting authorities shall be made by the installing contractor.

H. Testing
   1. The pump and electric motor shall be thoroughly shop-tested by the respective manufacturers as required by NFPA Pamphlet No. 20. The control panel shall also be tested as a unit. All such tests shall be conducted prior to shipment.
   2. The pump, driver, controller and all accessories shall be purchased under a unit contract. The pump shall be given a complete performance test with POSITIVE SUCTION PRESSURE. A certified performance curve shall be prepared and submitted. Pumps shall also be hydrostatically tested to twice the shut off pressure, but in no case less than 250 lbs. per sq. inch.

3. The pump manufacturer shall assume unit responsibility and shall provide the services a factory trained representative to supervise and/or be available to conduct final field acceptance tests.
4. The controller manufacturer, prior to shipment, shall hook up and test the jockey pump controller as a completed assembly.
5. This test shall include, but not be restricted to, each function the controller may be required to perform including manual start-stop, automatic start-stop and minimum run timing.
6. The manufacturer shall perform a high potential test of the controller power circuits at not less than two times the rated voltage plus 1000 Volts.

I. Warranty:
1. The pump and controller manufacturers shall warranty all components against defects in workmanship and material for a period of 12 months from the time of substantial completion.

2.3 FIRE-PUMP ACCESSORIES AND SPECIALTIES

A. Match fire-pump suction and discharge ratings as required for fire-pump capacity rating. Include the following:

1. Automatic air-release valve.
2. Circulation relief valve.
3. Suction and discharge pressure gages.
4. Eccentric-tapered reducer at suction inlet.
5. Concentric-tapered reducer at discharge outlet.
6. Test-Header Manifold: Ductile-iron or brass body for hose valves. Include nozzle outlets arranged in single line; horizontal, flush-wall mounting attachment; and rectangular, roughbrass finish escutcheon plate with lettering equivalent to "PUMP TEST CONNECTION."
7. Test-Header Manifold: Ferrous body for hose valves. Manufacturer's standard finish. Include bronze or cast-iron, exposed-type valve header with nozzle outlets; and round, brass escutcheon plate with lettering equivalent to "PUMP TEST CONNECTION."
8. Hose Valves: UL 668, straightway pattern, and bronze with cap and chain. Include NFPA 1963 hose thread that complies with local fire department standards and finish same as for test-header-manifold escutcheon plate.
9. Ball Drip Valve: UL 1726.
10. Main Relief Valve: UL 1478, spring loaded.
11. Discharge Cone: Open type.
12. Finish: Manufacturer's standard factory-applied red paint unless brass or other finish is specified.

2.4 FLOWMETER SYSTEMS

A. Description: Fire-pump flowmeter system that indicates flow to not less than 175 percent of fire-pump rated capacity. Include sensor of size to match pipe, tubing, flowmeter, and fittings.
1. FMG-Approved Manufacturers:
   a. Dieterich Standard Inc.
   b. Gerand Engineering Co.
   c. Hyspan Precision Products, Inc.

d. Meriam Instruments Div.; Scott Fetzer Co.
e. Preso Meters Corporation.

2. Pressure Rating: 175-psig (1200-kPa) minimum.
3. Sensor: Venturi, annubar probe, or orifice plate, unless otherwise indicated.
4. Flowmeter: Compatible with flow sensor with dial not less than 4-1/2 inches (115 mm) in diameter or manufacturer's equivalent size.
5. Permanently Mounted Flowmeter: Suitable for wall mounting with copper tubing to connect to flow sensor.
6. Portable Flowmeter: With two 12-foot (3.7-m) hoses, in carrying case.

2.5 PRESSURE GAGES

A. Description: UL 393, 3-1/2- to 4-1/2-inch- (90- to 115-mm-) diameter dial with range of 0- to 300-psig (0- to 2070-kPa) minimum. Include caption "WATER" on dial face.
1. Manufacturers:
a. AMETEK, Inc.; U.S. Gauge.
b. Dresser Equipment Group; Instruments Div.
c. Marsh Bellofram.
d. WIKA Instrument Corporation.

2.6 GROUT

A. Description: 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 (34.5-MPa), 28-day compressive strength.

2.7 SOURCE QUALITY CONTROL

A. Test and inspect fire pumps with their controllers according to NFPA 20 for certified shop tests.

B. Verification of Performance: Rate fire pumps according to requirements indicated.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, concrete bases, and conditions, with Installer present, for compliance with requirements and other conditions affecting performance of fire pumps.

B. Examine roughing-in for fire-suppression piping to verify actual locations of piping connections before fire-pump installation.

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

3.2 CONCRETE BASES

A. Install concrete bases of dimensions indicated for fire pumps, pressure-maintenance pumps, and controllers. Refer to Division 21 Section "Common Work Results for Fire Suppression."

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around full perimeter of base.
2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to supported equipment.

B. Cast-in-place concrete materials and placement requirements are specified in Division 03.

3.3 INSTALLATION

A. Install and align fire pump, pressure-maintenance pump, and controller according to NFPA 20.

B. Install pumps and controllers to provide access for periodic maintenance including removal of motors, impellers, couplings, and accessories.

C. Set base-mounting-type pumps on concrete bases. Disconnect coupling halves before setting. Do not reconnect couplings until alignment operations have been completed.
1. Support pump baseplate on rectangular metal blocks and shims or on metal wedges having small taper, at points near anchor bolts, to provide 3/4- to 1-1/2-inch (19- to 38-mm) gap between pump base and concrete base for grouting.
2. Adjust metal supports or wedges until pump and driver shafts are level. Verify that coupling faces and pump suction and discharge flanges are level and plumb.

D. Install suction and discharge piping equal to or greater than diameter of fire-pump nozzles.

E. Install valves that are same size as piping connecting fire pumps, bypasses, test headers, and other piping systems.

F. Install pressure gages on fire-pump suction and discharge at pressure-gage tappings.

G. Support pumps and piping separately so weight of piping does not rest on pumps.

H. Install piping accessories, hangers and supports, anchors, valves, meters and gages, and equipment supports.

I. Install flowmeters and sensors where indicated. Install flowmeter-system components and make connections according to manufacturer's written instructions.

J. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted. Furnish copies of manufacturers' wiring diagram submittals to electrical Installer.

3.4 ALIGNMENT

A. Align split-case fire-pump and driver shafts after complete unit has been leveled on concrete base, grout has set, and anchor bolts have been tightened.

B. After alignment is correct, tighten anchor bolts evenly. Fill baseplate completely with grout, with metal blocks and shims or wedges in place. Tighten anchor bolts after grout has hardened. Check alignment and make required corrections.

C. Align piping connections.

D. Align pump and driver shafts for angular and parallel alignment according to HI 1.4 and to tolerances specified by manufacturer.

E. Align vertically mounted, split-case pump and driver shafts after complete unit has been made plumb on concrete base, grout has set, and anchor bolts have been tightened.

3.5 CONNECTIONS

A. Piping installation requirements are specified in Division 21 Section "Water-Based Fire-Suppression Systems." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to pumps and equipment to allow service and maintenance.

C. Connect water supply and discharge piping to fire pumps. Connect water supply and discharge piping to pressure-maintenance pumps.

D. Connect relief-valve discharge to point of disposal.

E. Connect flowmeter-system sensors and meters according to manufacturer's written instructions.

F. Connect controllers to pumps.

G. Connect fire-pump controllers to building fire-alarm system. Refer to Division 28 Section "Fire Detection and Alarm."

H. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

I. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.6 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

B. Perform field tests for each fire pump when installation is complete. Comply with operating instructions and procedures in NFPA 20 to demonstrate compliance with requirements. Where possible, field correct malfunctioning equipment, then retest to demonstrate compliance. Replace equipment that cannot be satisfactorily corrected or that does not perform as indicated, then retest to demonstrate compliance. Verify that each fire pump performs as indicated.

C. Perform the following field tests and inspections and prepare test reports:

1. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.
2. Final Checks before Startup: Perform the following preventive-maintenance operations and checks:
   a. Lubricate oil-lubrication-type bearings.
   b. Remove grease-lubrication-type bearing covers, flush bearings with kerosene, and clean thoroughly. Fill with new lubricant according to manufacturer's written instructions.
   c. Disconnect coupling and check electric motor for proper rotation. Rotation shall match direction of rotation marked on pump casing.
   d. Verify that pump is free to rotate by hand. If pump is bound or if it drags even slightly, do not operate until cause of trouble is determined and corrected.
3. Starting procedure for pumps is as follows:
   a. Prime pump by opening suction valve and closing drains, and prepare pump for operation.
   b. Open sealing-liquid supply valves if pump is so fitted.
   c. Start motor.
   d. Open discharge valve slowly.
   e. Observe leakage from stuffing boxes and adjust sealing-liquid valve for proper flow to ensure lubrication of packing. Do not tighten gland immediately, but let packing run in before reducing leakage through stuffing boxes.
   f. Check general mechanical operation of pump and motor.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
5. Furnish fire hoses in number, size, and length required to reach storm drain or other acceptable location to dispose of fire-pump test water. Fire hoses are for field-acceptance tests only and are not property of Owner.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fire pumps, drivers, controllers, and pressure-maintenance pumps. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION

SECTION 22 00 00

PLUMBING GENERAL PROVISIONS

PART 1 - GENERAL

1.1 GENERAL REQUIREMENTS

A. Work of this Section, as shown or specified, shall be in accordance with the requirements of the Contract Documents.

1.2 DEFINITIONS

A. "Provide": to supply, install, and make complete, safe, and operable, the particular work referred to unless specifically indicated otherwise.

B. "Install": to erect, mount, and make complete with all related accessories.

C. "Furnish" or "supply": to purchase, procure, acquire, and deliver complete with related accessories.

D. "Work": labor, materials, equipment, services, and all related accessories necessary for the proper and complete installation of complete systems.

E. "Piping": pipe, tube, fittings, flanges, valves, controls, strainers, hangers, supports, unions, traps, drains, insulation and all related accessories.

F. "Wiring": raceway, fittings, wire, boxes and all related accessories.

G. "Indicated," "shown," or "noted": as indicated, shown, or noted on drawings or specifications.

H. "Similar" or "equal": of base bid manufacture, equal in quality materials, weight, size, performance, design, and efficiency of specified product, conforming with "Base Bid Manufacturers."

I. "Reviewed" "satisfactory," "accepted," or "directed": as reviewed, satisfactory, accepted, or directed by Architect and/or Engineer.

J. "Motor Controllers": manual or magnetic starters with or without switches, individual pushbuttons or hand-off-automatic (HOA) switches controlling the operation of motors.

K. "Control or Actuating Devices": automatic sensing and switching devices such as thermostats, pressure, float, flow, operation of equipment.

L. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawl spaces, and tunnels.

M. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

N. Exposed, Exterior Installations: Exposed to view outdoors, or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

O. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts.

P. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants, but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

Q. The following are industry abbreviations for plastic materials:

1. ABS: Acrylonitrile-butadiene-styrene plastic.
2. CPVC: Chlorinated polyvinyl chloride plastic.
3. NP: Nylon plastic.
4. PE: Polyethylene plastic.
5. PVC: Polyvinyl chloride plastic.

R. The following are industry abbreviations for rubber materials:

1. CR: Chlorosulfonated polyethylene synthetic rubber.
2. EPDM: Ethylene propylene diene terpolymer rubber.

1.3 WORK INCLUDED

A. The work covered by this section includes the construction described in the Contract Documents including all labor necessary to perform and complete such construction, all materials and equipment incorporated or to be incorporated in such construction, and all services, facilities, tools and equipment necessary or used to perform and complete such construction. The work includes, but is not limited to the following:

1. Domestic Water Systems.
2. Soil, Waste, Vent and Storm Water Systems.
3. Piping, Valves and Fittings
4. Water Meters and Backflow Prevention Devices
5. Insulation.
6. Domestic Water Heaters.
7. Pumps.
8. Medical Vacuum Source Equipment.
9. Medical Air Source Equipment.
10. Medical Gas Pipe and Valves.
11. Medical Gas Outlets.
12. Medical Gas Alarms.
13. Pressure Tanks.
14. Identification System.
15. Excavation and Backfill.
16. Cutting, Patching and Equipment Painting.
17. Hangers, Supports and Guides.
18. Electric Motors.
19. Electric Motor Controllers.
20. Internal Wiring of Factory-Assembled Prewired Equipment.
21. Alarm Wiring, except for Fire Alarm.
22. Rigging of Equipment.
23. Furnishing access Doors and Frames to be installed by the General Contractor.
24. Fire Stopping for Pipe Penetration.
25. Pipe Penetration and Drains Counterflashing.
26. Concrete Pads for Equipment.
27. Alarm Initiating Devices.
28. Wiring between Water Meter Totalizer and Remote Reading Device.

B. Related Work not Included in this Division but Specified Elsewhere

1. Fire alarm wiring.
2. Finish painting, except for prefinished equipment or as otherwise specified.
3. Concrete work, except equipment inertia and floating bases.
4. Base flashing for piping and drains.
5. Toilet accessories.
6. Waterproofing.
7. Power wiring for motors and motor controllers.
8. Installation of access doors and frames.

1.4 COORDINATION OF WORK

A. The plumbing drawings show the general arrangement of piping and appurtenances. Follow these drawings as closely as the actual construction will permit. Conform the plumbing work to the requirements shown on the drawings. Provide offsets, fittings, and accessories, which may be required but not shown on the drawings. Investigate the site, structural and finish ground conditions affecting the work, and arrange the work accordingly. Provide such work and accessories as may be required to meet such conditions.

B. Certain materials will be provided by other trades. Examine the Contract Documents to ascertain these requirements.

C. Carefully check space requirements with other trades to insure that all material can be installed in the spaces allotted thereto including finished suspended ceilings.

D. Transmit to other trades all information required for work to be provided under their sections, in ample time for installation.

E. Wherever work interconnects with work specified of other trades, coordinate with the General Contractor to insure that all necessary information is presented so that all the necessary connections and equipment may be properly installed. Identify all items (valves, piping, equipment, etc.) in order that the General Contractor know where to install access doors and panels.

F. Consult with other trades regarding equipment so that, wherever possible, motors, motor controls, pumps and valves are of the same manufacturer.

G. Furnish and set all sleeves for passage of pipes and conduits through structural masonry and concrete walls and floors and elsewhere as will be required for the proper protection of each pipe passing through building surfaces.

H. Provide required supports and hangers for piping and equipment, designed so as not to exceed allowable loadings of structures.

I. Examine and compare the contract drawings and specifications with the drawings and specifications of other disciplines, and report any discrepancies between them to the General Contractor and obtain from him written instructions for changes necessary in the work of this Section. Install and coordinate the work of this section in cooperation with installing interrelated work. Before installation, take proper provisions to avoid interferences. All changes required in the work of the contractor, caused by his neglect to do so, to be made by him at his own expense.

J. Wherever the work is of sufficient complexity, prepare additional detail drawings to scale similar to that of the design drawings, prepared on tracing medium of the same size as contract drawings. With these layouts, coordinate the work with the work of the contractor. Such detailed work is to be clearly identified on the drawings as to the area to which it applies. Submit these drawings to the Engineer for review.

At completion, however, include a set of such drawings with each set of as-built drawings. When directed by the Engineer, submit drawings for review, clearly showing the work of this section and its relation to the work of other disciplines before commencing shop fabrication or erection in the field.

K. Before commencing work, examine all adjoining work on which this work is in any way dependent for perfect workmanship and report any conditions, which prevent performance of first class work. Become thoroughly familiar with actual existing conditions to which connections must be made or which must be changed or altered.

L. Provide required anchor bolts, sleeves, inserts and supports. Direct location of anchor bolts, sleeves, inserts and supports to insure that they are properly installed. Any expense resulting from the improper location or installation of anchor bolts, sleeves, inserts and supports to be paid for by the contractor.

M. Slots, chases, openings and recesses through floors, walls, ceilings, and roofs will be provided by the various trades in their respective materials. Properly locate such openings and be responsible for any cutting and patching caused by the neglect to do so.

N. Adjust location of pipes, panels, equipment, etc., to accommodate the work to prevent interferences, both anticipated and encountered. Determine the exact route and location of each pipe prior to fabrication.

1. Right-of-Way: Lines, which pitch has the right-of-way over those that do not pitch, i.e., plumbing drains. Lines whose elevations cannot be changed have right-of-way over lines whose elevations can be changed.
2. Make offsets, transitions and changes in direction in pipes as required to maintain proper head room and pitch on sloping lines whether or not indicated on the drawings. Furnish and install all traps, air vents, drains, etc., as required to affect these offsets, transitions and changes in direction.

O. Install all plumbing work to permit the removal (without damage to other parts) of water heaters and all other equipment requiring periodic replacement or maintenance. Arrange pipes and equipment to permit access to valves, cocks, starters, motors, and control components, and to clear the openings of swinging doors and access panels.

P. Provide access panels in equipment as required for inspection and maintenance of internal parts, etc.

Q. The contractor shall coordinate his work with the work of other trades.

R. Coordinated Composite Drawings

1. The Contractor shall prepare full coordinated composite drawings for the mechanical, electrical and fire protection trades. The Contractor shall overlay each trade's work (in separate colors) on a sepia set of sheetmetal drawings. All conflicts and potential conflicts shall be clearly identified on the sepia sheetmetal drawings. This shall include but not be limited to conflicts with lights, equipment, piping, ductwork and supports of other trades, as well as conflicts with architectural and structural walls, columns, ceilings and structural beams. Contractor shall have representatives of each trades, as well as conflicts with architectural and structural walls, columns, ceilings and structural beams. Contractor shall have representatives of each trade attend a weekly job site coordination meeting in the Contractor's field office. All trades shall resolve conflicts at these meetings and sign off each sepia sheetmetal drawing indicating acceptance and satisfactory resolution to all conflicts. All

conflicts that cannot be resolved shall be brought to the attention of the Engineer for resolution.

1.5 USE OF SITE AND LOAD LIMITATIONS

A. The contractor shall review all available data on the location and types of pipelines and other underground utilities. The contractor shall not operate equipment over the facilities and shall take care not to damage them or otherwise impair their use. The contractor shall make investigation to verify the location of these facilities before proceeding with construction and/or operations in their vicinity.

1.6 CONTRACTOR'S RESPONSIBILITY FOR EVALUATION

A. The Engineer and Owner make no representations, regarding the character or extent of the subsoils, water levels, existing structural, mechanical and electrical installations, above or below ground or other subsurface conditions which may be encountered during the Work. The contractor must make his own evaluation of existing conditions, which may affect methods or cost of performing the Work, based on his own examination of the facility or other information. Failure to examine the drawings or other information shall not relieve the contractor of his responsibility for satisfactory accomplishment of the Work.

B. The locations of existing services are believed to be as indicated on the plans. The contractor shall verify the location of these services prior to commencing any work and notify the Engineer of any discrepancies.

1.7 ACCESS TO FIRE PROTECTION EQUIPMENT

A. The contractor shall not interfere with access to hydrants, fire exits, fire hose stations, fire extinguishers and fire alarm pull stations. In no case shall the contractor's material or equipment be within twenty-five (25) ft of a hydrant or fire alarm pull station.

1.8 EQUIPMENT AND MATERIALS

A. If products and materials are specified or indicated on the drawings for a specific item or system, the contractor shall use those products or materials. If products and materials are not listed in either of the above, use first class products and materials, in accordance with shop drawings.

B. All products and materials shall be new, clean, free of defects and free of damage and corrosion.

C. No permanent equipment shall be used to provide temporary services during construction.

D. Ship and store all products and materials in a manner which will protect them from damage, weather and entry of debris. If items are damaged, do not install, but take immediate steps to obtain replacement or repair.

E. Make certain that all materials selected directly, or by suppliers, conform to the requirements of the contract drawings and specification. Transmittal of such specifications and drawings, information to persons manufacturing and supplying materials to the project, and rigid adherence thereto, is the Contractor's responsibility. Acceptance of a manufacturer's name by the Engineer does not

release the Contractor of the responsibility for providing materials, which comply in all respects with the requirements in the Contract Documents.

F. Applicable equipment and materials to be listed by Underwriters' Laboratories and Manufactured in accordance with ASME, AWWA, or ANSI standards, and as approved by local authorities having jurisdiction.

G. Fully lubricate all equipment when installed and prior to final acceptance.

H. Do not operate water systems until piping has been tested and cleaned.

I. Secure equipment with bolts, washers and locknuts of ample size to support equipment. Embedded anchor bolts to have bottom plate and pipe sleeves. Grout all machinery set in concrete under the entire bearing surface. After grout has set, remove all wedges, shims and jack bolts and fill space with grout.

J. Locate valves, traps, access doors, etc., to be easily accessible, either in mechanical spaces or through access panels specified herein.

K. Follow manufacturers' instructions for installing, connecting, and adjusting all equipment. Provide one copy of such instructions to the Engineer before installing any equipment. Provide a copy of such instructions at the equipment during any work on the equipment. Provide all special valves, piping, wiring and accessories.

1.9 QUALITY ASSURANCE

A. Codes, Standards and Fees

1. Codes and Standards:

a. Comply with all current governing codes, ordinances and regulations, UL and all other applicable codes.
b. Comply with the requirements of the State adopted Building Code, and other agencies or authorities having jurisdiction over any part of the Work and secure all necessary permits.
c. Where codes or standards are listed herein, the applicable portions apply.
d. Plans, specifications, codes and standards are all minimum requirements. Where requirements differ, apply the more stringent.
e. Should any change in plans or specifications be required to comply with governing regulations, the contractor is to notify the Engineer at the pre-bid meeting.
f. The codes and standards listed in the Specifications can be obtained from the organizations listed as follows:

1)	OSHA	Occupational Safety and Health Act
2)	ANSI	American National Standard Institute, Inc.
3)	ASME	American Society of Mechanical Engineers
4)	ASTM	American Society for Testing and Materials
5)	AWWA	American Water Works Association
6)	UL	Underwriters Laboratories, Inc.
7)	ASHRAE	American Society of Heating, Refrigerating and Air Conditioning Engineers
8)	NEMA	National Electrical Manufacturers Association
9)	AIA	American Insurance Association
10)	AWS	American Welding Society
11)	ASA	American Standards Association
12)	IEEE	Institute of Electrical and Electronics Engineers

13) NEC National Electrical Code

g. The particular specification will be identified by appropriate prefix and number only with the latest revision being applicable unless otherwise noted.

2. Fees

a. Pay all required fees.
b. Pay royalties or fees required in connection with the use of patented devices and systems.

B. Furnish all materials and equipment new, free from defects and with listings or labels of Underwriter's Laboratories, Inc. or other nationally approved testing laboratory.

C. All items of a given type shall be the product of the same manufacturer.

D. All materials and equipment shall be the product of manufacturers regularly engaged in their manufacture.

1.10 SHOP DRAWINGS

A. Prepare and submit detailed shop drawings for piping work and other distribution services, including locations and sizes of all openings in floor walls and roofs.

B. The work described in any shop drawing submission to be carefully checked for all clearances (including those required for maintenance and servicing), field conditions, maintenance of architectural conditions and proper coordination with all trades on the job. Each submitted shop drawing to include a certification that all related job conditions have been checked and that no conflict exists.

C. All drawings to be submitted sufficiently in advance of field requirements to allow ample time for checking. All submittals to be complete and contain all required and detailed information. Shop drawings with multiple parts to be submitted as a package.

D. If submittals differ from the Contract Document requirements, make specific mention of such difference in a letter of transmittal, with request for substitution, together with reasons for same.

E. Review of any submitted data or shop drawings for material, equipment apparatus, devices, arrangement and layout shall not relieve the contractor from responsibility of furnishing same of proper dimensions and weight, capacities, sizes, quantity, quality and installation details to efficiently perform the requirements and intent of the Work. Such review shall not relieve the contractor from responsibility for errors, omissions or inadequacies of any sort on submitted data or shop drawings.

F. Each shop drawing is to contain the job title, the names and phone numbers of the General Contractor and the contractor, references to the applicable design drawing or specification article, date and scale.

G. Within fifteen (15) days after award of Contract, submit for review, a list of all material and equipment manufacturers whose products are proposed, as well as names of all Subcontractors whom the General Contractor proposes to employ.

H. Within three (3) weeks after award of Contract, submit a list of all shop drawings, which will be submitted in the course of the project. List to show disposition of each item, including date of submission, review, and the like. List to be kept up-to-date throughout entire construction period.

I. Submit shop drawings and manufacturer's data for the following items in accordance with the Contract Documents:

1. Coordinated, detailed shop layout drawings of all mechanical rooms, services and distribution systems, including plans, profiles and sections.
2. Details of piping supports, elbows, anchors and miscellaneous appurtenances.
3. Hangers, supports, inserts, anchors, guides and foundations.
4. Valves.
5. Pressure gauges and thermometers.
6. Corrosion protective coatings.
7. Equipment and piping layouts at 3/8 in. scale for the building.
8. Location and size of sleeves for openings in floors and walls.
9. Certified equipment performance curves for pumps.
10. Schedule of pipe and fittings, materials and application, valves, escutcheons, air vents, valve tags and schedules, strainers, and water specialties.
11. Pump system, including pumps, motors and controllers.
12. Building automation systems including descriptions, instruments, and alarms.
13. Flashing.
14. Equipment identification and certificates.
15. Pressure tanks and accessories.
16. Water heaters and accessories.
17. Plumbing fixture and trim.
18. Medical Gas Equipment Outlets, Valves and Alarms.
19. Other shop drawings and submittals as requested within the specification.

1.11 SAMPLES

A. Submit samples of all items with exposed finishes for review.

B. Allow sufficient time for consideration without interfering with job schedule.

C. Duplicate quality and finish to type to be supplied under contract.

D. Identify similar to shop drawings.

1.12 ELECTRONIC COPIES OF AKF DRAWINGS

A. Upon award of contract, contractor shall submit list of drawings that they will require. AKF will provide drawings in (.PDF) format only.

B. If the contractor requires (.dwg) format, there will be a charge of $200 for each drawing supplied plus shipping and handling for preparation and processing. After preparation the drawings will be forwarded only upon receipt of signed acceptance of terms form. Permission from the architect must first be obtained for AKF to include the architectural background as reference. The contractor is to obtain the architects latest drawings directly from the architect.

C. These files are being issued for the convenience of the contractor and the contractor remains responsible for all contract requirements related to the normal shop drawing preparation process.

1.13 SUBMISSIONS:

A. Provide all coordination drawings and shop drawings in ‘AutoCad” format, version compatible with owner. All catalog cuts and submittals to be provided in electronic “PDF” format the architect will forward all submissions to the engineer.

B. If paper submissions are to be provided the following shall be adhered to.

1. Submissions 11 in. X 17 in. or smaller: If the submission is a catalog cut, then the contractor shall submit one original and one copy. Otherwise, they shall submit two copies. The architect will forward the original and one copy (two copies when no original is received) to the engineer. All catalog cuts shall be complete.
2. Submissions larger than 11 in. X 17 in.: submit two copies to the architect. The architect will forward to the engineer.

C. Indicate on each submission: project name and location, architect and engineer, item identification and approval stamp of prime contractor, subcontractor names and phone numbers, reference to the applicable design drawing or specification article, date and scale.

D. The work described in all shop drawing submission shall be carefully checked for all clearances (including those required for maintenance and servicing), field conditions, maintenance of architectural conditions and proper coordination with all trades on the job.

E. Each submitted shop drawing is to include a certification that all related job conditions have been checked and verified and that there are no conflicts.

F. All shop drawings are to be submitted to allow ample time for checking in advance of field requirements. All submittals to be complete and contain all required and detailed information. Shop drawings with multiple parts shall be submitted as a package.

G. If submittals differ from the contract document requirements, make specific mention of such difference in a letter of transmittal, with request for substitution, together with reasons for same.

1.14 AS-BUILTS AND EQUIPMENT OPERATION INSTRUCTIONS

A. Provide all coordination drawings and shop drawings in AutoCad format, version compatible with owner. All catalog cuts and submittals to be provided in electronic “PDF” format the architect will forward all submissions to the engineer.

B. On completion and acceptance of work, this contractor shall furnish written instructions, equipment manuals and demonstrate to the owner the proper operation and maintenance of all equipment and apparatus furnished under this contract.

C. The contractor shall give one copy of the instructions to the owner and one copy to the engineer. .

D. Final “as-built” drawings indicating as installed conditions shall be provided to the architect and engineer after completion of the installation.

1.15 START-UP

A. Properly lubricate all pieces of equipment.

B. Check and clean all pipes of dirt and debris, including strainers.

C. Prepare each piece of equipment in accordance with manufacturer's installation instructions and have a copy at the equipment.

D. Fill and vent all water systems.

E. Check rotation on each motor.

F. Have representatives of each manufacturer present when hereinafter specified, so that equipment will be started up by manufacturer.

1.16 ACCESS DOORS IN FINISHED CONSTRUCTION

A. Furnish access doors as required for operation and maintenance of concealed equipment, clean-outs, valves, shock absorbers, controls, etc., and coordinate their delivery with the installing trade.

B. Coordinate and prepare a location, size and function schedule of access doors required and deliver to the General Contractor and the Architect for review.

C. Doors shall be of a size required for operating and repacking valves, and shall be as manufactured by Karp Associates, Nystrom Inc., or Mifab.

D. Unless otherwise indicated, minimum size to be 18" x 18".

E. Furnish color coded buttons or tabs to indicate location of valves or other equipment located above removable type ceilings where access doors are not required.

F. Access doors shall have a fire rating compatible with the wall construction in which they are located.

1.17 SYSTEM IDENTIFICATION

A. Piping:

1. All piping, exposed or concealed shall be identified as to its service in accordance with OSHA and ANSI Standards by one of the following methods:

   a. Installation of manufactured adhesive band type identification markers, similar to "Quick-Label" by W.H. Brady Company.

2. Piping identification markings shall be installed as follows:

   a. In each room.
   b. All valve locations.
   c. At shaft walls.
   d. Every 40 feet on continuous runs.

3. Valves:

   a. Valves shall be identified by a tag system utilizing brass tags at 2 inch minimum diameter and attached to the valves using brass chain.

      1) The new valve tag identification numbers shall be permanently added to all existing valve tag charts within the building.

4. Equipment:

   a. Identify all controls such as motor starters not in motor control centers, float switches, and alarms.

1.18 OPERATING & MAINTENANCE INSTRUCTION

A. Prepare operating and maintenance instructions manual including operating instructions, maintenance instructions, manufacturer's data, specific equipment data.

B. Provide an alphabetical list of all system components, with the name, address, and 24-hour phone number of the company responsible for servicing each item during the first year of operation.

C. Provide operating instructions for complete system, including:

1. Normal starting, operating, and shut-down
2. Emergency procedures for fire or failure of major equipment

D. Provide maintenance instructions, including:

1. Valve tag list and equipment tag list
2. Proper lubricants and lubricating instructions for each piece of equipment, and date when lubricated
3. Required cleaning, replacement and/or adjustment schedule

E. Provide manufacturer's data on each piece of equipment, including:

1. Installation instructions.
2. Drawings and specifications.
3. Parts list, including recommended items to be stocked.
4. Complete wiring and temperature control diagrams.
5. Marked or revised prints locating all concealed parts and all variations from the original system design.
6. Test and inspection certificates.

F. Provide specific equipment data including, but not limited to, the following:

1. For Plumbing Systems:

a. Pumps.
b. Valves.
c. Piping.
d. Accessories.
e. Pressure reducing valves.
f. Water heaters.
g. Water meters.
h. Strainers.
i. Toilet fixtures and supports.
j. Toilet fixture trim.
k. Flow measuring devices.
l. Electric wiring.
m. Pressure tanks.
n. Medical equipment, valves outlets and alarms.

2. For Automatic Control System:

a. Drawings and description of system controlled.
b. Sequence of operation for each system.
c. Data on components.
d. Wiring and piping, schematic any layout, for panels and panelboards.
e. System operating manual, including set points.

G. Provide instruction of operating personnel.

1. Instruct Owner's operating personnel in proper starting sequences, operation, shutdown, and maintenance procedures, including normal and emergency procedures.
2. Instruction to be by personnel skilled in operation of equipment. Instructions for major equipment to be by equipment manufacturers' representatives.
3. Make arrangements to give instructions by system and not by building areas.
4. Provide five (5) instruction sessions not to exceed six (6) hours each.
5. Instructions on automatic controls to be by manufacturer's representative.

H. Submittals

1. Shop Drawings: Submit three copies for review prior to final issuance.
2. Provide six (6) copies of each operation and maintenance manual.
   a. Manuals to be 8-1/2" x 11 size in hard-back, 3-ring loose leaf binders. Use more than one volume if required. Do not overfill binders.
   b. Manuals to be completed and delivered to the Engineer for approval at least 20 days prior to instruction of operating personnel.
3. Prepare separate manuals for the Plumbing system.

1.19 TOOLS FOR OPERATION, ADJUSTMENT AND MAINTENANCE

A. Deliver to Owner's representative all special tools needed for proper operation, adjustment and maintenance of equipment.

1.20 RECORD DRAWINGS

A. The contractor shall maintain a complete set of “Record Drawings” reflecting an accurate dimensional record of all work. These drawings shall be marked up to show the precise location of concealed work and equipment, including concealed piping and valves and all changes and deviations in the plumbing work from that shown on the contract drawings. This requirement shall not be construed as authorization for the contractor to make changes in the layout or work without written definite instruction from the Architect or Engineer.

B. Record dimensions shall clearly and accurately delineate the work as installed; location shall be suitably identified by at least two dimensions to permanent structures.

C. The contractor shall stamp all “Record Drawings” and certify for correctness by signing and dating them.

D. Record drawings submitted to Owner shall consist of 1 set of mylars and 1 set of compact disk’s (CD’s) with all work provided on Autocad 2000 format.

E. Prior to final acceptance, contractor shall submit certified “Record Drawings” to the Architect/Engineer for review and make changes, corrections or additions as noted by Architect/Engineer. After this review, the drawing shall be delivered to the Owner.

PART 2 - PRODUCTS

NOT USED.

PART 3 - EXECUTION

NOT USED.

END OF SECTION

SECTION 22 05 00

COMMON WORK RESULTS FOR PLUMBING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:
1. Piping materials and installation instructions common to most piping systems.
2. Transition fittings.
3. Dielectric fittings.
4. Mechanical sleeve seals.
5. Sleeves.
6. Escutcheons.
7. Grout.
8. Plumbing demolition.
9. Equipment installation requirements common to equipment sections.
10. Painting and finishing.
11. Concrete bases.
12. Supports and anchorages.

1.3 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in chases.

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

F. The following are industry abbreviations for plastic materials:
1. ABS: Acrylonitrile-butadiene-styrene plastic.
2. CPVC: Chlorinated polyvinyl chloride plastic.
3. PE: Polyethylene plastic.
4. PVC: Polyvinyl chloride plastic.

G. The following are industry abbreviations for rubber materials:
   1. EPDM: Ethylene-propylene-diene terpolymer rubber.
   2. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS

A. Product Data: For the following:
   1. Transition fittings.
   2. Dielectric fittings.
   3. Mechanical sleeve seals.
   4. Escutcheons.

B. Welding certificates.

1.5 QUALITY ASSURANCE

A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."

B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
   1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
   2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

C. Electrical Characteristics for Plumbing Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.7 COORDINATION

A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for plumbing installations.

B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

C. Coordinate requirements for access panels and doors for plumbing items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

2.2 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 22 piping Sections for pipe, tube, and fitting materials and joining methods.

B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.3 JOINING MATERIALS

A. Refer to individual Division 22 piping Sections for special joining materials not listed below.

B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
   1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch (3.2-mm) maximum thickness unless thickness or specific material is indicated.
      a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
      b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
   2. AWWA C110, rubber, flat face, 1/8 inch (3.2 mm) thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

D. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

E. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

F. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.

G. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

H. Solvent Cements for Joining Plastic Piping:
   1. ABS Piping: ASTM D 2235.
   2. CPVC Piping: ASTM F 493.
   3. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
   4. PVC to ABS Piping Transition: ASTM D 3138.

I. Fiberglass Pipe Adhesive: As furnished or recommended by pipe manufacturer.

2.4 TRANSITION FITTINGS

A. AWWA Transition Couplings: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined.
   1. Manufacturers:
      a. Cascade Waterworks Mfg. Co.
      b. Dresser Industries, Inc.; DMD Div.
      c. Ford Meter Box Company, Incorporated (The); Pipe Products Div.
      d. JCM Industries.
   2. Underground Piping NPS 1-1/2 (DN 40) and Smaller: Manufactured fitting or coupling.
   3. Underground Piping NPS 2 (DN 50) and Larger: AWWA C219, metal sleeve-type coupling.
   4. Aboveground Pressure Piping: Pipe fitting.

2.5 DIELECTRIC FITTINGS

~~A.~~ Description: Combination fitting of copper alloy and ferrous materials with ~~threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.~~

~~B. Insulating Material: Suitable for system fluid, pressure, and temperature.~~

~~C. Dielectric Unions: Factory-fabricated, union assembly, for 250-psig (1725-kPa) minimum working pressure at 180 deg F (82 deg C).~~
   ~~1. Manufacturers:~~
      ~~a. Capitol Manufacturing Co.~~
      ~~b. Central Plastics Company.~~
      ~~c. Eclipse, Inc.~~
      ~~d. Epco Sales, Inc.~~
      ~~e. Hart Industries, International, Inc.~~
      ~~f. Watts Industries, Inc.; Water Products Div.~~
      ~~g. Zurn Industries, Inc.; Wilkins Div.~~

~~D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig (1035- or 2070-kPa) minimum working pressure as required to suit system pressures.~~
   ~~1. Manufacturers:~~
      ~~a. Capitol Manufacturing Co.~~
      ~~b. Central Plastics Company.~~
      ~~c. Epco Sales, Inc.~~
      ~~d. Watts Industries, Inc.; Water Products Div.~~

~~E. Dielectric Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.~~
   ~~1. Manufacturers:~~
      ~~a. Advance Products & Systems, Inc.~~
      ~~b. Calpico, Inc.~~
      ~~c. Central Plastics Company.~~
      ~~d. Pipeline Seal and Insulator, Inc.~~
   ~~2. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig (1035- or 2070-kPa) minimum working pressure where required to suit system pressures.~~

~~F. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig (2070-kPa) minimum working pressure at 225 deg F (107 deg C).~~

~~1. Manufacturers:~~

~~a. Calpico, Inc.~~

~~b. Lochinvar Corp.~~

~~G. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig (2070-kPa) minimum working pressure at 225 deg F (107 deg C).~~

~~1. Manufacturers:~~

~~a. Perfection Corp.~~

~~b. Precision Plumbing Products, Inc.~~

~~c. Sioux Chief Manufacturing Co., Inc.~~

~~d. Victaulic Co. of America.~~

2.6 MECHANICAL SLEEVE SEALS

A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.

1. Manufacturers:
   a. Thunderline
   b. Advance Products & Systems, Inc.
   c. Calpico, Inc.
   d. Metraflex Co.
2. Sealing Elements: EPD Minterlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
3. Pressure Plates: Plastic. Include two for each sealing element.
4. Connecting Bolts and Nuts: Carbon steel with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.7 SLEEVES

A. Galvanized-Steel Sheet: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.

B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.

C. Cast Iron: Cast or fabricated "wall pipe" equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

D. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.

1. Underdeck Clamp: Clamping ring with set screws.

2.8 ESCUTCHEONS

A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.

B. One-Piece, Cast-Brass Type: With set screw.
   1. Finish: Polished chrome-plated .

C. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.
   1. Finish: Polished chrome-plated .

D. One-Piece, Stamped-Steel Type: With set screw and chrome-plated finish.

E. Split-Plate, Stamped-Steel Type: With concealed hinge, set screw, and chrome-plated finish.

F. One-Piece, Floor-Plate Type: Cast-iron floor plate.

G. Split-Casting, Floor-Plate Type: Cast brass with concealed hinge and set screw.

2.9 GROUT

A. General Purpose Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
   1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
   2. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.
   3. Packaging: Premixed and factory packaged.

B. Pump Mounting: High flow, high strength epoxy machine-based grout: ASTM C 881, CRD-C 590.
   1. Characteristics: Two to Three-component, highly flowable, epoxy-based grout that produces high performance strength plus chemical inertness and excellent bonding properties.
   2. Design Mix: ASTM-C 579, 14,000 / 19,000 psi , 36 hours @72 degree F compressive strength.
   3. Packaging: Factory packaged for field mixing.
   4. Products: Chocfast by ITW Philadelphia resins, ESCOWELD or approved equal

PART 3 - EXECUTION

3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 22 Sections specifying piping systems.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping to permit valve servicing.

G. Install piping at indicated slopes.

H. Install piping free of sags and bends.

I. Install fittings for changes in direction and branch connections.

J. Install piping to allow application of insulation.

K. Select system components with pressure rating equal to or greater than system operating pressure.

L. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
   1. New Piping:
      a. Piping with Fitting or Sleeve Protruding from Wall: One-piececast brass type.
      b. Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.
      c. Insulated Piping: One-piece, stamped-steel type with spring clips.
      d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-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 in Unfinished Service Spaces: One-piece, cast-brass type with polished chrome-plated finish.
      g. Bare Piping in Equipment Rooms: One-piece, cast-brass type.
      h. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.

M. Sleeves are not required for core-drilled holes.

N. Permanent sleeves are not required for holes formed by removable PE sleeves.

O. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.

P. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
   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 (50 mm) above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
   2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
   3. Install sleeves that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
      a. SteelPipe Sleeves: For pipes smaller than NPS 6 (DN 150).
      b. Steel Sheet Sleeves: For pipes NPS 6 (DN 150) and larger, penetrating gypsum-board partitions.
      c. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install

section of cast-iron soil pipe to extend sleeve to 2 inches (50 mm) above finished floor level. Refer to Division 07 Section "Sheet Metal Flashing and Trim" for flashing.

1) Seal space outside of sleeve fittings with grout.

4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.

Q. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.

1. Install steel pipe for sleeves smaller than 6 inches (150 mm) in diameter.
2. Install cast-iron "wall pipes" for sleeves 6 inches (150 mm) and larger in diameter.
3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

R. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.

1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

S. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section "Penetration Firestopping" for materials.

T. Verify final equipment locations for roughing-in.

U. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.2 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 22 Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. 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.

E. 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.

F. 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.

G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

I. Plastic Pressure Piping Gasketed Joints: Join according to ASTM D 3139.

J. Plastic Nonpressure Piping Gasketed Joints: Join according to ASTM D 3212.

K. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.
   1. Plain-End Pipe and Fittings: Use butt fusion.
   2. Plain-End Pipe and Socket Fittings: Use socket fusion.

3.3 PIPING CONNECTIONS

A. Make connections according to the following, unless otherwise indicated:
   1. Install unions, in piping NPS 2 (DN 50) and smaller, adjacent to each valve and at final connection to each piece of equipment.
   2. Install flanges, in piping NPS 2-1/2 (DN 65) and larger, adjacent to flanged valves and at final connection to each piece of equipment.
   ~~3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.~~
   ~~4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.~~

3.4 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.

B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

C. Install plumbing equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

D. Install equipment to allow right of way for piping installed at required slope.

3.5 PAINTING

A. Painting of plumbing systems, equipment, and components is specified in Division 09 Sections "Interior Painting" and "Exterior Painting."

B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.6 CONCRETE BASES

A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.
   1. Construct concrete bases of dimensions indicated, but not less than 4 inches (100 mm) larger in both directions than supported unit.
   2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of the base.
   3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
   4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   5. Install anchor bolts to elevations required for proper attachment to supported equipment.
   6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
   7. Use 3000-psi 28-day compressive-strength concrete and reinforcement as specified in Division 03 Section "

3.7 ERECTION OF METAL SUPPORTS AND ANCHORAGES

A. Refer to Division 05 Section "Metal Fabrications" for structural steel.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor plumbing materials and equipment.

C. Field Welding: Comply with AWS D1.1.

3.8 ERECTION OF WOOD SUPPORTS AND ANCHORAGES

A. Cut, fit, and place wood grounds, nailers, blocking, and anchorages to support, and anchor plumbing materials and equipment.

B. Select fastener sizes that will not penetrate members if opposite side will be exposed to view or will receive finish materials. Tighten connections between members. Install fasteners without splitting wood members.

C. Attach to substrates as required to support applied loads.

3.9 GROUTING

A. Mix and install grout for plumbing equipment base bearing surfaces, pump and other equipment base plates, and anchors.

B. Clean surfaces that will come into contact with grout.

C. Provide forms as required for placement of grout.
D. Avoid air entrapment during placement of grout.
E. Place grout, completely filling equipment bases.
F. Place grout on concrete bases and provide smooth bearing surface for equipment.
G. Place grout around anchors.
H. Cure placed grout.

END OF SECTION

This page is intentionally left blank.

SECTION 22 05 13

COMMON MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.3 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 requirements in this Section except when stricter requirements are specified in plumbing equipment schedules or Sections.

B. Comply with NEMA MG 1 unless otherwise indicated.

C. Comply with IEEE 841 for severe-duty motors.

2.2 MOTOR CHARACTERISTICS

A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet (1000 m) 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: Energy 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. Multispeed Motors: Separate winding for each speed.

F. Rotor: Random-wound, squirrel cage.

G. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.

H. Temperature Rise: Match insulation rating.

I. Insulation: Class F.

J. 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.

K. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

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: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.

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. Energy- and 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.

C. Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor.

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

This page is intentionally left blank.

SECTION 22 05 16

EXPANSION FITTINGS AND LOOPS FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Rubber expansion joints.
   2. Flexible-hose expansion joints.
   3. Pipe bends and loops.
   4. Alignment guides and anchors.

1.3 DEFINITIONS

A. BR: Butyl rubber.

B. Buna-N: Nitrile rubber.

C. CR: Chlorosulfonated polyethylene synthetic rubber.

D. CSM: Chlorosulfonyl-polyethylene rubber.

E. EPDM: Ethylene-propylene-diene terpolymer rubber.

F. NR: Natural rubber.

1.4 PERFORMANCE REQUIREMENTS

A. Compatibility: Products shall be suitable for piping system fluids, materials, working pressures, and temperatures.

B. Capability: Products shall absorb 200 percent of maximum axial movement between anchors.

1.5 SUBMITTALS

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

B. Delegated-Design Submittal: For each anchor and alignment guide 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. Design Calculations: Calculate requirements for thermal expansion of piping systems and for selecting and designing expansion joints, loops, and bends.
   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.

C. Welding certificates.

D. Product Certificates: For each type of pipe expansion joint, signed by product manufacturer.

E. Maintenance Data: For pipe expansion joints to include in maintenance manuals.

1.6 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to the following:
1. Steel Shapes and Plates: AWS D1.1, "Structural Welding Code - Steel."
2. Welding to Piping: ASME Boiler and Pressure Vessel Code: Section IX.

PART 2 - PRODUCTS

2.1 EXPANSION JOINTS

A. Rubber Expansion Joints: ASTM F 1123, fabric-reinforced rubber with external control rods and complying with FSA's "Technical Handbook: Non-Metallic Expansion Joints and Flexible Pipe Connectors."
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Mason Industries, Inc.; Mercer Rubber Co.
   b. Metraflex, Inc.
   c. MG Piping Products Co.
   d. Tozen America Corp.
2. Spherical Type: Single or multiple spheres.
   a. Minimum Pressure and Temperature Ratings for NPS 1-1/2 to NPS 4 (DN 40 to DN 100): 150 psig (1035 kPa) at 220 deg F (104 deg C).
   b. Minimum Pressure and Temperature Ratings for NPS 5 and NPS 6 (DN 125 and DN 150): 140 psig (966 kPa) at 200 deg F (93 deg C).
   c. Minimum Pressure and Temperature Ratings for NPS 8 to NPS 12 (DN 200 to DN 300): 140 psig (966 kPa) at 180 deg F (82 deg C).
3. Material:Buna-N.
4. End Connections: Full-faced, integral, steel flanges with steel retaining rings.

B. Flexible-Hose Expansion Joints: Manufactured assembly with two flexible-metal-hose legs joined by long-radius, 180-degree return bend or center section of flexible hose; with inlet and outlet elbow fittings, corrugated-metal inner hoses, and braided outer sheaths.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Flexicraft Industries.
   b. Metraflex, Inc.
2. Flexible-Hose Expansion Joints for Copper Piping: Copper-alloy fittings with solder- joint end connections.

a. NPS 2 (DN 50) and Smaller: Bronze hoses and double-braid bronze sheaths with 700 psig at 70 deg F (4830 kPa at 21 deg C) and 500 psig at 450 deg F (3450 kPa at 232 deg C) ratings.
b. NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Stainless-steel hoses and double-braid, stainless-steel sheaths with 420 psig at 70 deg F (2890 kPa at 21 deg C) and 315 psig at 450 deg F (2170 kPa at 232 deg C) ratings.

2.2 ALIGNMENT GUIDES

A. Description: Steel, factory fabricated, with bolted two-section outer cylinder and base for alignment of piping and two-section guiding spider for bolting to pipe.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Adsco Manufacturing, LLC.
b. Advanced Thermal Systems, Inc.
c. Flexicraft Industries.
d. Metraflex, Inc.

2.3 MATERIALS FOR ANCHORS

A. Steel Shapes and Plates: ASTM A 36/A 36M.

B. Bolts and Nuts: ASME B18.10 or ASTM A 183, steel, hex head.

C. Washers: ASTM F 844, steel, plain, flat washers.

D. Mechanical Fasteners: Insert-wedge-type stud with expansion plug anchor for use in hardened portland cement concrete, and tension and shear capacities appropriate for application.
1. Stud: Threaded, zinc-coated carbon steel.
2. Expansion Plug: Zinc-coated steel.
3. Washer and Nut: Zinc-coated steel.

E. Chemical Fasteners: Insert-type-stud bonding system anchor for use with hardened portland cement concrete, and tension and shear capacities appropriate for application.
1. Bonding Material: ASTM C 881, Type IV, Grade 3, 2-component epoxy resin suitable for surface temperature of hardened concrete where fastener is to be installed.
2. Stud: ASTM A 307, zinc-coated carbon steel with continuous thread on stud, unless otherwise indicated.
3. Washer and Nut: Zinc-coated steel.

F. Concrete: Portland cement mix, 3000 psi (20.7 MPa) minimum. Comply with requirements in Division 03 Section "Cast-in-Place Concrete" for formwork, reinforcement, and concrete.

G. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink, nonmetallic grout; suitable for interior and exterior applications.
1. Properties: Nonstaining, noncorrosive, and nongaseous.
2. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

PART 3 - EXECUTION

3.1 EXPANSION-JOINT INSTALLATION

A. Install manufactured, nonmetallic expansion joints according to FSA's "Technical Handbook: Non-Metallic Expansion Joints and Flexible Pipe Connectors."

B. Install expansion joints of sizes matching size of piping in which they are installed.

C. Install alignment guides to allow expansion and to avoid end-loading and torsional stress.

3.2 PIPE BEND AND LOOP INSTALLATION

A. Install pipe bends and loops cold-sprung in tension or compression as required to partly absorb tension or compression produced during anticipated change in temperature.

B. Attach pipe bends and loops to anchors.
   1. Steel Anchors: Attach by welding. Comply with ASME B31.9 and ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
   2. Concrete Anchors: Attach by fasteners. Follow fastener manufacturer's written instructions.

3.3 SWING CONNECTIONS

A. Connect risers and branch connections to mains with at least three pipe fittings, including tee in main.

3.4 ALIGNMENT-GUIDE INSTALLATION

A. Install guides on piping adjoining pipe expansion fittings and loops.

B. Attach guides to pipe and secure to building structure.

3.5 ANCHOR INSTALLATION

A. 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.

B. Fabricate and install steel anchors by welding steel shapes, plates, and bars to piping and to structure. Comply with ASME B31.9 and AWS D1.1.

C. Construct concrete anchors of poured-in-place concrete of dimensions indicated and include embedded fasteners.

D. Install pipe anchors according to expansion-joint manufacturer's written instructions if expansion joints are indicated.

E. Use grout to form flat bearing surfaces for expansion fittings, guides, and anchors installed on or in concrete.

END OF SECTION

SECTION 22 05 19

METERS AND GAGES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
1. Thermometers.
2. Gages.
3. Test plugs.
4. Water Meters

~~B. Related Sections:~~
~~1. Division 22 Section "Facility Water Distribution Piping" for domestic and fire-protection water service meters outside the building.~~
~~2. Division 22 Section "Domestic Water Piping" for domestic and fire-protection water service meters inside the building.~~
~~3. Division 23 Section "Facility Natural-Gas Piping" for gas meters.~~

1.3 DEFINITIONS

A. CR: Chlorosulfonated polyethylene synthetic rubber.

B. EPDM: Ethylene-propylene-diene terpolymer rubber.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated; include performance curves.

B. Shop Drawings: Schedule for thermometers and gages indicating manufacturer's number, scale range, and location for each.

C. Product Certificates: For each type of thermometer and gage, signed by product manufacturer.

PART 2 - PRODUCTS

2.1 METAL-CASE, LIQUID-IN-GLASS THERMOMETERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Trerice, H. O. Co.
   2. Weiss Instruments, Inc.
   3. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.

B. Case: Die-cast aluminum ,9 inches (229 mm) long.

C. Tube: Red or blue reading, organic-liquid filled, with magnifying lens.

D. Tube Background: Satin-faced, nonreflective aluminum with permanently etched scale markings.

E. Window: Glass.

F. Connector: Adjustable type, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device .

G. Stem: Copper-plated steel, aluminum, or brass for thermowell installation and of length to suit installation.

H. Accuracy: Plus or minus 1 percent of range or plus or minus 1 scale division to maximum of 1.5 percent of range.

2.2 THERMOWELLS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. AMETEK, Inc.; U.S. Gauge Div.
   2. Ashcroft Commercial Instrument Operations; Dresser Industries; Instrument Div.
   3. Ernst Gage Co.
   4. Trerice, H. O. Co.
   5. Weiss Instruments, Inc.
   6. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.
   7. WIKA Instrument Corporation.

B. Manufacturers: Same as manufacturer of thermometer being used.

C. Description: Pressure-tight, socket-type metal fitting made for insertion into piping and of type, diameter, and length required to hold thermometer.

2.3 PRESSURE GAGES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. AMETEK, Inc.; U.S. Gauge Div.
   2. Ashcroft Commercial Instrument Operations; Dresser Industries; Instrument Div.
   3. Ernst Gage Co.
   4. Trerice, H. O. Co.
   5. Weiss Instruments, Inc.

6. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.
7. WIKA Instrument Corporation.

B. Direct-Mounting, Dial-Type Pressure Gages: Indicating-dial type complying with ASME B40.100.
1. Case: Dry or Liquid-filled type, drawn steel or cast aluminum ,6-inch (152-mm) diameter.
2. Pressure-Element Assembly: Bourdon tube, unless otherwise indicated.
3. Pressure Connection: Brass, NPS 1/4 (DN 8), bottom-outlet type unless back-outlet type is indicated.
4. Movement: Mechanical, with link to pressure element and connection to pointer.
5. Dial: Satin-faced, nonreflective aluminum with permanently etched scale markings.
6. Pointer: Red metal.
7. Window: Glass.
8. Ring: Stainless steel .
9. Accuracy: Grade A, plus or minus 1 percent of middle half scale.
10. Vacuum-Pressure Range: 30-in. Hg of vacuum to 15 psig of pressure (100 kPa of vacuum to 103 kPa of pressure).
11. Range for Fluids under Pressure: Two times operating pressure.

C. Pressure-Gage Fittings:
1. Valves: NPS 1/4 (DN 8) brass or stainless-steel needle type.
2. Snubbers: ASME B40.5, NPS 1/4 (DN 8) brass bushing with corrosion-resistant, porous-metal disc of material suitable for system fluid and working pressure.

2.4 WATER METERS

A. Turbine-Type Water Meters (2 ½’ and smaller):
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. ABB.
   b. Badger Meter, Inc.
   c. Mueller Company; Water Products Division.
   d. Schlumberger Limited; Water Division.
   e. Sensus Metering Systems.
2. Description:
   a. Standard: AWWA C701.
   b. Pressure Rating: 150-psig working pressure.
   c. Body Design: Turbine; totalization meter.
   d. Registration: In gallons or cubic feet as required by utility company .
   e. Case: Bronze.
   f. End Connections for Meters NPS 2 and Smaller: Threaded.
   g. End Connections for Meters NPS 2-1/2 and Larger: Flanged.

B. Compound-Type Water Meters (3” and Larger):
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. ABB.
   b. Badger Meter, Inc.
   c. Sensus Metering Systems.

2. Description:
   a. Standard: AWWA C702.
   b. Pressure Rating: 150-psig working pressure.
   c. Body Design: With integral mainline and bypass meters; totalization meter.
   d. Registration: In gallons or cubic feet as required by utility company.
   e. Case: Bronze.
   f. Pipe Connections: Flanged.

C. Remote Registration System: Direct-reading type complying with AWWA C706; modified with signal transmitting assembly, low-voltage connecting wiring, and remote register assembly as required by utility company.

D. Electronic Digital Pulse Output for connection to BAS: Electronic pulse output proportional to meter flow rate. 4-20 mA analog output and high frequency forward/reverse pulse output. Stainless Steel construction with tamper-proof seal pin. AWG, 22 twisted pair cable. Similar to Neptune "Tricon/E3 Transmitter. Refer to specification section 23-09-00 for BAS coordination

PART 3 - EXECUTION

3.1 THERMOMETER APPLICATIONS

A. Install liquid-in-glass thermometers in the outlet of each domestic, hot-water storage tank at each hot water circulating branch, adjacent to hot water circulating pumps and at the most remote hot water outlet..

B. Provide the following temperature ranges for thermometers:
   1. Domestic Hot Water: 30 to 180 deg F, with 2-degree scale divisions (Minus 1 to plus 82 deg C, with 1-degree scale divisions) .
   2. Domestic Cold Water: 0 to 100 deg F, with 2-degree scale divisions (Minus 18 to plus 38 deg C, with 1-degree scale divisions) .

3.2 GAGE APPLICATIONS

A. Install dry-case-type pressure gages for discharge of each pressure-reducing valve.

B. Install liquid-filled-case-type pressure gages at suction and discharge of each pump.

3.3 INSTALLATIONS

A. Install direct-mounting thermometers and adjust vertical and tilted positions to be visible from the floor.

B. Install remote-mounting dial thermometers on panel, with tubing connecting panel and thermometer bulb supported to prevent kinks. Use minimum tubing length.

C. Install thermowells with socket extending to center of pipe and in vertical position in piping tees where thermometers are indicated.

D. Install direct-mounting pressure gages in piping tees with pressure gage located on pipe at most readable position.

E. Install remote-mounting pressure gages on panel.

F. Install needle-valve and snubber fitting in piping for each pressure gage.

G. Install test plugs in tees in piping.

H. Install permanent indicators on walls or brackets in accessible and readable positions.

I. Install connection fittings for attachment to portable indicators in accessible locations.

J. Install thermometers and gages adjacent to machines and equipment to allow service and maintenance for thermometers, gages, machines, and equipment.

K. Adjust faces of thermometers and gages to proper angle for best visibility.

3.4 WATER METER INSTALLATION

A. Rough-in domestic water piping for service water meter installation according to utility company's requirements.

B. Install water meters according to AWWA M6, utility company's requirements, and the following:
   1. Install turbine-type water meters with shutoff valve on water-meter inlet. Install valve on water-meter outlet and valved bypass around meter unless prohibited by authorities having jurisdiction.
   2. Install compound-type water meters with shutoff valves on water-meter inlet and outlet and on valved bypass around meter. Support meters, valves, and piping on brick or concrete piers.

C. Install remote registration system according to standards of utility company and of authorities having jurisdiction.

END OF SECTION

This page is intentionally left blank.

SECTION 22 05 23

GENERAL-DUTY VALVES FOR PLUMBING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
1. Bronze lift check valves.
2. Bronze swing check valves.
3. Iron swing check valves.
4. Bronze gate valves.
5. Iron gate valves.
6. Bronze globe valves.

B. Related Sections:
1. Division 22 plumbing piping Sections for specialty valves applicable to those Sections only.
2. Division 22 Section "Identification for Plumbing Piping and Equipment" for valve tags and schedules.
3. Division 33 water distribution piping Sections for general-duty and specialty valves for site construction piping.

1.3 DEFINITIONS

A. CWP: Cold working pressure.

B. EPDM: Ethylene propylene copolymer rubber.

C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.

D. NRS: Nonrising stem.

E. OS&Y: Outside screw and yoke.

F. RS: Rising stem.

G. SWP: Steam working pressure.

1.4 SUBMITTALS

A. Product Data: For each type of valve indicated.

1.5 QUALITY ASSURANCE

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:
   1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
   2. ASME B31.1 for power piping valves.
   3. ASME B31.9 for building services piping valves.

C. NSF Compliance: NSF 61 for valve materials for potable-water service.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:
   1. Protect internal parts against rust and corrosion.
   2. Protect threads, flange faces, grooves, and weld ends.
   3. Set angle, gate, and globe valves closed to prevent rattling.
   4. Set ball and plug valves open to minimize exposure of functional surfaces.
   5. Set butterfly valves closed or slightly open.
   6. 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.

D. PEX Valves
   1. General: Comply with product requirement section.
   2. Delivery: Deliver materials in manufacturers original, unopened, undamaged containers

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

A. Refer to valve schedule articles for applications of valves.

B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

C. Valve Sizes: Same as upstream piping unless otherwise indicated.

D. Valve Actuator Types:
   1. Handwheel: For valves other than quarter-turn types.
   2. Handlever: For quarter-turn valves NPS 6 (DN 150) and smaller.

E. Valves in Insulated Piping: With 2-inch (50-mm) stem extensions and the following features:
   1. Gate Valves: With rising stem.
   2. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.

F. Valve-End Connections:
   1. Flanged: With flanges according to ASME B16.1 for iron valves.

2. Grooved: With grooves according to AWWA C606.
3. Solder Joint: With sockets according to ASME B16.18.
4. Threaded: With threads according to ASME B1.20.1.

G. Valve Bypass and Drain Connections: MSS SP-45.

2.2 BRONZE BALL VALVES

A. Two-Piece, Full-Port, Bronze Ball Valves with Stainless-Steel Trim:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Conbraco Industries, Inc.; Apollo Valves.
   b. NIBCO INC.
   c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
   a. Standard: MSS SP-110.
   b. SWP Rating: 150 psig (1035 kPa).
   c. CWP Rating: 600 psig (4140 kPa).
   d. Body Design: Two piece.
   e. Body Material: Bronze.
   f. Ends: Threaded.
   g. Seats: PTFE or TFE.
   h. Stem: Stainless steel.
   i. Ball: Stainless steel, vented.
   j. Port: Full.

2.3 BRONZE LIFT CHECK VALVES

A. Class 125, Lift Check Valves with Nonmetallic Disc:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Milwaukee Valve Company.
   b. NIBCO INC.
   c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
   a. Standard: MSS SP-80, Type 2.
   b. CWP Rating: 200 psig (1380 kPa).
   c. Body Design: Vertical flow.
   d. Body Material: ASTM B 61 or ASTM B 62, bronze.
   e. Ends: Threaded.
   f. Disc: NBR, PTFE, or TFE.

2.4 BRONZE SWING CHECK VALVES

A. Class 125, Bronze Swing Check Valves with Nonmetallic Disc:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Milwaukee Valve Company.
   b. NIBCO INC.
   c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
   a. Standard: MSS SP-80, Type 4.
   b. CWP Rating: 200 psig (1380 kPa).

c. Body Design: Horizontal flow.
d. Body Material: ASTM B 62, bronze.
e. Ends: Threaded.
f. Disc: PTFE or TFE.

B. Class 150, Bronze Swing Check Valves with Nonmetallic Disc:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Milwaukee Valve Company.
b. NIBCO INC.
c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
a. Standard: MSS SP-80, Type 4.
b. CWP Rating: 300 psig (2070 kPa).
c. Body Design: Horizontal flow.
d. Body Material: ASTM B 62, bronze.
e. Ends: Threaded.
f. Disc: PTFE or TFE.

2.5 BRONZE GATE VALVES

A. Class 125, RS Bronze Gate Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Milwaukee Valve Company.
b. NIBCO INC.
c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
a. Standard: MSS SP-80, Type 2.
b. CWP Rating: 200 psig (1380 kPa).
c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
d. Ends: Threaded or solder joint.
e. Stem: Bronze.
f. Disc: Solid wedge; bronze.
g. Packing: Asbestos free.
h. Handwheel: Malleable iron, bronze, or aluminum.

B. Class 150, RS Bronze Gate Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Milwaukee Valve Company.
b. NIBCO INC.
c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
a. Standard: MSS SP-80, Type 2.
b. CWP Rating: 300 psig (2070 kPa).
c. Body Material: ASTM B 62, bronze with integral seat and union-ring bonnet.
d. Ends: Threaded.
e. Stem: Bronze.
f. Disc: Solid wedge; bronze.
g. Packing: Asbestos free.

h. Handwheel: Malleable iron.

2.6 IRON GATE VALVES

A. Class 125, OS&Y, Iron Gate Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Milwaukee Valve Company.
   b. NIBCO INC.
   c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
   a. Standard: MSS SP-70, Type I.
   b. CWP Rating: 200 psig (1380 kPa).
   c. Body Material: ASTM A 126, gray iron with bolted bonnet.
   d. Ends: Flanged.
   e. Trim: Bronze.
   f. Disc: Solid wedge.
   g. Packing and Gasket: Asbestos free.

B. Class 250, OS&Y, Iron Gate Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Milwaukee Valve Company.
   b. NIBCO INC.
   c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
2. Description:
   a. Standard: MSS SP-70, Type I.
   b. CWP Rating: 500 psig (3450 kPa).
   c. Body Material: ASTM A 126, gray iron with bolted bonnet.
   d. Ends: Flanged.
   e. Trim: Bronze.
   f. Disc: Solid wedge.
   g. Packing and Gasket: Asbestos free.

2.7 BRONZE GLOBE VALVES

A. Class 125, Bronze Globe Valves with Nonmetallic Disc:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Milwaukee Valve Company.
   b. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
   c. NIBCO INC.
2. Description:
   a. Standard: MSS SP-80, Type 2.
   b. CWP Rating: 200 psig (1380 kPa).
   c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
   d. Ends: Threaded.
   e. Stem: Bronze.
   f. Disc: PTFE or TFE.
   g. Packing: Asbestos free.
   h. Handwheel: Malleable iron.

B. Class 150, Bronze Globe Valves with Nonmetallic Disc:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. NIBCO INC.
      b. Milwaukee Valve Company.
      c. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
   2. Description:
      a. Standard: MSS SP-80, Type 2.
      b. CWP Rating: 300 psig (2070 kPa).
      c. Body Material: ASTM B 62, bronze with integral seat and union-ring bonnet.
      d. Ends: Threaded.
      e. Stem: Bronze.
      f. Disc: PTFE or TFE.
      g. Packing: Asbestos free.
      h. Handwheel: Malleable iron.

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 chainwheels on operators for gate valves NPS 4 (DN 100) and larger and more than 84 inches (2400 mm) above floor. Extend chains to 60 inches (1520 mm) above finished floor.

F. Install check valves for proper direction of flow and as follows:
   1. Swing Check Valves: In horizontal position with hinge pin level.

3.3 ADJUSTING

A. Adjust or replace valve packing after piping systems have been tested and put into service but before final adjusting and balancing. Replace valves if persistent leaking occurs.

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. If valve applications are not indicated, use the following:
   1. Shutoff Service: Ball, butterfly, or gate valves.
   2. Throttling Service: Globe valves.
   3. Pump-Discharge Check Valves:
      a. NPS 2 (DN 50) and Smaller: Bronze swing check valves with disc.
      b. NPS 2-1/2 (DN 65) and Larger for Domestic Water: Iron swing check valves with lever and weight or with spring or iron, center-guided, resilient-seat check valves.
      c. NPS 2-1/2 (DN 65) and Larger for Sanitary Waste and Storm Drainage: Iron swing check valves with lever and weight or spring.

B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.

C. Select valves, except wafer types, with the following end connections:
   1. For Copper Tubing, NPS 2 (DN 50) and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.
   2. For Copper Tubing, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Flanged ends except where threaded valve-end option is indicated in valve schedules below.
   3. For Copper Tubing, NPS 5 (DN 125) and Larger: Flanged ends.
   4. For Steel Piping, NPS 2 (DN 50) and Smaller: Threaded ends.
   5. For Steel Piping, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Flanged ends except where threaded valve-end option is indicated in valve schedules below.
   6. For Steel Piping, NPS 5 (DN 125) and Larger: Flanged ends.
   7. For Grooved-End Copper Tubing and Steel Piping: Valve ends may be grooved.

3.5 LOW-PRESSURE, COMPRESSED-AIR VALVE SCHEDULE (150 PSIG (1035 kPa) OR LESS)

A. Pipe NPS 2 (DN 50) and Smaller:
   1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
   2. Ball Valves: Two piece, full port, bronze with bronze trim.
   3. Bronze Lift Check Valves: Class 125, nonmetallicdisc.
   4. Bronze Swing Check Valves: Class 150, nonmetallicdisc.
   5. Bronze Gate Valves: Class 150, RS.

3.6 DOMESTIC, HOT- AND COLD-WATER VALVE SCHEDULE

A. Pipe NPS 2 (DN 50) and Smaller:
   1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
   2. Bronze Angle Valves: Class 150, nonmetallic disc.
   3. Ball Valves: Two piece, full port, bronze with stainless-steel trim.
   4. Bronze Swing Check Valves: Class 150, nonmetallic disc.

5. Bronze Gate Valves: Class 150, RS.
6. Bronze Globe Valves: Class 150, nonmetallic disc.

B. Pipe NPS 2-1/2 (DN 65) and Larger:
1. Iron Valves, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): May be provided with threaded ends instead of flanged ends.
2. Iron Swing Check Valves: Class 250, metal seats.
3. Iron, Grooved-End Swing Check Valves: 300 CWP.
4. Iron, Center-Guided Check Valves: Class 125 Class 150 Class 250 Class 300, globe, resilientseat.
5. Iron Gate Valves: Class 125 Class 250, .

3.7 SANITARY-WASTE AND STORM-DRAINAGE VALVE SCHEDULE

A. Pipe NPS 2 (DN 50) and Smaller:
1. Bronze Valves: May be provided with solder-joint ends instead of threaded ends.
2. Ball Valves: Two piece, full port, bronze with stainless-steel trim.
3. Bronze Swing Check Valves: Class 125, nonmetallic disc.
4. Bronze Gate Valves: Class 125, RS.

B. Pipe NPS 2-1/2 (DN 65) and Larger:
1. Iron Valves, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): May be provided with threaded ends instead of flanged ends.
2. Iron Swing Check Valves: Class 125, metal seats.
3. Iron Swing Check Valves with Closure Control: Class 125, lever and spring.
4. Iron, Grooved-End Swing Check Valves: 300 CWP.
5. Iron Gate Valves: Class 125, OS&Y.

END OF SECTION

SECTION 22 05 29

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 and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following hangers and supports for plumbing system piping and equipment:
   1. Steel pipe hangers and supports.
   2. Trapeze pipe hangers.
   3. Metal framing systems.
   4. Thermal-hanger shield inserts.
   5. Fastener systems.
   6. Pipe stands.
   7. Pipe positioning systems.
   8. Equipment supports.

B. Related Sections include the following:
   1. Division 05 Section "Metal Fabrications" for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
   2. Division 21 Section "Water-Based Fire-Suppression Systems" for pipe hangers for fire-suppression piping.
   3. Division 22 Section "Expansion Fittings and Loops for Plumbing Piping" for pipe guides and anchors.
   4. Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment" for vibration isolation devices.

1.3 DEFINITIONS

A. MSS: Manufacturers Standardization Society for The Valve and Fittings Industry Inc.

B. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.4 PERFORMANCE REQUIREMENTS

A. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.

B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

C. Design seismic-restraint hangers and supports for piping and equipment.

1.5 SUBMITTALS

A. Product Data: For the following:
   1. Steel pipe hangers and supports.
   2. Fiberglass pipe hangers.
   3. Thermal-hanger shield inserts.
   4. Powder-actuated fastener systems.
   5. Pipe positioning systems.

B. Shop Drawings: Show fabrication and installation details and include calculations for the following:
   1. Trapeze pipe hangers. Include Product Data for components.
   2. Metal framing systems. Include Product Data for components.
   3. Pipe stands. Include Product Data for components.
   4. Equipment supports.

C. Welding certificates.

1.6 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to the following:
   1. AWS D1.1, "Structural Welding Code--Steel."
   2. AWS D1.2, "Structural Welding Code--Aluminum."
   3. AWS D1.4, "Structural Welding Code--Reinforcing Steel."
   4. ASME Boiler and Pressure Vessel Code: Section IX.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
   1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
   2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 STEEL PIPE HANGERS AND SUPPORTS

A. Description: MSS SP-58, Types 1 through 58, factory-fabricated components. Refer to Part 3 "Hanger and Support Applications" Article for where to use specific hanger and support types.

B. Manufacturers:
   1. B-Line Systems, Inc.; a division of Cooper Industries.
   2. Carpenter & Paterson, Inc.
   3. Grinnell Corp.

C. Galvanized, Metallic Coatings: Pregalvanized or hot dipped.

D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

E. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion for support of bearing surface of piping.

2.3 TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural-steel shapes with MSS SP-58 hanger rods, nuts, saddles, and U-bolts.

2.4 METAL FRAMING SYSTEMS

A. Description: MFMA-3, shop- or field-fabricated pipe-support assembly made of steel channels and other components.

B. Manufacturers:
   1. B-Line Systems, Inc.; a division of Cooper Industries.
   2. Power-Strut Div.; Tyco International, Ltd.
   3. Unistrut Corp.; Tyco International, Ltd.

C. Coatings: Manufacturer's standard finish unless bare metal surfaces are indicated.

D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

2.5 THERMAL-HANGER SHIELD INSERTS

A. Description: 100-psig- (690-kPa-) minimum, compressive-strength insulation insert encased in sheet metal shield.

B. Manufacturers:
   1. Carpenter & Paterson, Inc.
   2. ERICO/Michigan Hanger Co.
   3. Pipe Shields, Inc.

C. Insulation-Insert Material for Cold Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate or ASTM C 552, Type II cellular glass with vapor barrier.

D. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate or ASTM C 552, Type II cellular glass.

E. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

F. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

G. Insert Length: Extend 2 inches (50 mm) beyond sheet metal shield for piping operating below ambient air temperature.

2.6 FASTENER SYSTEMS

A. 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.
   1. Manufacturers:
      a. Hilti, Inc.
      b. ITW Ramset/Red Head.
      c. Powers Fasteners.

B. Mechanical-Expansion Anchors: Insert-wedge-type stainless steel, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

1. Manufacturers:
   a. B-Line Systems, Inc.; a division of Cooper Industries.
   b. Hilti, Inc.
   c. ITW Ramset/Red Head.

2.7 PIPE STAND FABRICATION

A. Pipe Stands, General: Shop or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.

B. Compact Pipe Stand: One-piece plastic unit with integral-rod-roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.
   1. Manufacturers:
      a. ERICO/Michigan Hanger Co.
      b. MIRO Industries.

C. Low-Type, Single-Pipe Stand: One-stainless-steel base unit with plastic roller, for roof installation without membrane penetration.
   1. Manufacturers:
      a. MIRO Industries.
      b. ERICO/Michigan Hanger Co.

D. High-Type, Single-Pipe Stand: Assembly of base, vertical and horizontal members, and pipe support, for roof installation without membrane penetration.
   1. Manufacturers:
      a. ERICO/Michigan Hanger Co.
      b. MIRO Industries.
      c. Portable Pipe Hangers.
   2. Base: Stainless steel.
   3. Vertical Members: Two or more cadmium-plated-steel or stainless-steel, continuous-thread rods.
   4. Horizontal Member: Cadmium-plated-steel or stainless-steel rod with plastic or stainless-steel, roller-type pipe support.

E. High-Type, Multiple-Pipe Stand: Assembly of bases, vertical and horizontal members, and pipe supports, for roof installation without membrane penetration.
   1. Manufacturers:
      a. Portable Pipe Hangers.
      b. MIRO Industries.
      c. ERICO/Michigan Hanger Co.
   2. Bases: One or more plastic.
   3. Vertical Members: Two or more protective-coated-steel channels.
   4. Horizontal Member: Protective-coated-steel channel.
   5. Pipe Supports: Galvanized-steel, clevis-type pipe hangers.

F. Curb-Mounting-Type Pipe Stands: Shop- or field-fabricated pipe support made from structural-steel shape, continuous-thread rods, and rollers for mounting on permanent stationary roof curb.

2.8 PIPE POSITIONING SYSTEMS

A. Description: IAPMO PS 42, system of metal brackets, clips, and straps for positioning piping in pipe spaces for plumbing fixtures for commercial applications.

B. Manufacturers:
   1. C & S Mfg. Corp.
   2. HOLDRITE Corp.; Hubbard Enterprises.
   3. Samco Stamping, Inc.

2.9 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural-steel shapes.

2.10 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, 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 (34.5-MPa), 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS

A. Specific hanger and support requirements are specified in Sections specifying piping systems and equipment.

B. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized, metallic coatings for piping and equipment that will not have field-applied finish.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use padded hangers for piping that is subject to scratching.

F. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated stationary pipes, NPS 1/2 to NPS 30 (DN 15 to DN 750).
   2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of 120 to 450 deg F (49 to 232 deg C) pipes, NPS 4 to NPS 16 (DN 100 to DN 400), requiring up to 4 inches (100 mm) of insulation.
   3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes, NPS 3/4 to NPS 24 (DN 20 to DN 600), requiring clamp flexibility and up to 4 inches (100 mm) of insulation.
   4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes, NPS 1/2 to NPS 24 (DN 15 to DN 600), if little or no insulation is required.
   5. Pipe Hangers (MSS Type 5): For suspension of pipes, NPS 1/2 to NPS 4 (DN 15 to DN 100), to allow off-center closure for hanger installation before pipe erection.

6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated stationary pipes, NPS 3/4 to NPS 8 (DN 20 to DN 200).
7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8 (DN 15 to DN 200).
8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8 (DN 15 to DN 200).
9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 2 (DN 15 to DN 50).
10. Split Pipe-Ring with or without Turnbuckle-Adjustment Hangers (MSS Type 11): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 8 (DN 10 to DN 200).
11. Extension Hinged or 2-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 3 (DN 10 to DN 80).
12. U-Bolts (MSS Type 24): For support of heavy pipes, NPS 1/2 to NPS 30 (DN 15 to DN 750).
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 (DN 100 to DN 900), with steel pipe base stanchion support and cast-iron floor flange.
15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes, NPS 4 to NPS 36 (DN 100 to DN 900), with steel pipe base stanchion support and cast-iron floor flange 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 (DN 65 to DN 900), 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 (DN 25 to DN 750), from 2 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 20 (DN 65 to DN 500), from single rod if horizontal movement caused by expansion and contraction might occur.
19. Complete Pipe Rolls (MSS Type 44): For support of pipes, NPS 2 to NPS 42 (DN 50 to DN 1050), if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes, NPS 2 to NPS 24 (DN 50 to DN 600), if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes, NPS 2 to NPS 30 (DN 50 to DN 750), if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

G. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20 (DN 20 to DN 500).
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20 (DN 20 to DN 500), if longer ends are required for riser clamps.

H. 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 (150 mm) for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F (49 to 232 deg C) 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 (49 to 232 deg C) piping installations.

I. 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 (340 kg).
    b. Medium (MSS Type 32): 1500 lb (680 kg).
    c. Heavy (MSS Type 33): 3000 lb (1360 kg).
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.

J. 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.

K. 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 (32 mm).
   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 absorb 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 absorb 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 absorb 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.

L. Comply with MSS SP-69 for trapeze pipe hanger selections and applications that are not specified in piping system Sections.

M. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.

N. Use powder-actuated fasteners or 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.

3.2 HANGER AND SUPPORT INSTALLATION

A. Steel Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.

B. Trapeze Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated trapeze pipe hangers.
   1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.
   2. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D1.1.

C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled metal framing systems.

D. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

E. Fastener System Installation:
   1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches (100 mm) 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. Pipe Stand Installation:
   1. Pipe Stand Types except Curb-Mounting Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
   2. Curb-Mounting-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. Refer to Division 07 Section "Roof Accessories" for curbs.

G. Pipe Positioning System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture. Refer to Division 22 Section "Plumbing Fixtures" for plumbing fixtures.

H. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers, and other accessories.

I. Equipment Support Installation: Fabricate from welded-structural-steel shapes.

J. 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.

K. Install lateral bracing with pipe hangers and supports to prevent swaying.

L. 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 (DN 65) 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.

M. Load Distribution: Install hangers and supports so piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

N. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes and so maximum pipe deflections allowed by ASME B31.9 (for building services piping) are not exceeded.

O. Insulated Piping: Comply with the following:
   1. Attach clamps and spacers to piping.
      a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
      b. 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 according to 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 (DN 100) 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 (DN 100) 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 (DN 8 to DN 90): 12 inches (305 mm) long and 0.048 inch (1.22 mm) thick.
   b. NPS 4 (DN 100): 12 inches (305 mm) long and 0.06 inch (1.52 mm) thick.
   c. NPS 5 and NPS 6 (DN 125 and DN 150): 18 inches (457 mm) long and 0.06 inch (1.52 mm) thick.
   d. NPS 8 to NPS 14 (DN 200 to DN 350): 24 inches (610 mm) long and 0.075 inch (1.91 mm) thick.
   e. NPS 16 to NPS 24 (DN 400 to DN 600): 24 inches (610 mm) long and 0.105 inch (2.67 mm) thick.
5. Pipes NPS 8 (DN 200) and Larger: Include wood inserts.
6. Insert Material: Length at least as long as protective shield.
7. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.3 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 smooth bearing surface.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.4 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 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 contours of welded surfaces match adjacent contours.

3.5 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 (40 mm).

3.6 PAINTING

A. Touch Up: 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 2.0 mils (0.05 mm).

B. Touch Up: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09 painting Sections.

C. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION

This page is intentionally left blank.

SECTION 22 05 48

VIBRATION AND SEISMIC CONTROLS 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 and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following:
1. Isolation pads.
2. Isolation mounts.
3. Restrained elastomeric isolation mounts.
4. [Freestanding] [Restrained] [Freestanding and restrained] spring isolators.
5. Housed spring mounts.
6. Elastomeric hangers.
7. Spring hangers.
8. Spring hangers with vertical-limit stops.
9. Pipe riser resilient supports.
10. Resilient pipe guides.
11. Seismic snubbers.
12. Restraining braces and cables.
13. [Steel] [Inertia] [Steel and inertia], vibration isolation equipment bases.

1.3 DEFINITIONS

A. IBC: International Building Code.

B. ICC-ES: ICC-Evaluation Service.

C. OSHPD: Office of Statewide Health Planning and Development for the State of California.

1.4 PERFORMANCE REQUIREMENTS

A. Seismic-Restraint Loading:
1. Site Class as Defined in the IBC: [A] [B] [C] [D] [E] [F].
2. Assigned Seismic Use Group or Building Category as Defined in the IBC: [I] [II] [III].
   a. Component Importance Factor: [1.0] [1.5] <Insert value>.
   b. Component Response Modification Factor: [1.5] [2.5] [3.5] [5.0] <Insert value>.
   c. Component Amplification Factor: [1.0] [2.5] <Insert value>.
3. Design Spectral Response Acceleration at Short Periods (0.2 Second): <Insert percent>.

4. Design Spectral Response Acceleration at 1-Second Period: <Insert percent>.

1.5 SUBMITTALS

A. Product Data: For the following:
   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 seismic-restraint component used.
      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. Delegated-Design Submittal: For vibration isolation and seismic-restraint details 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. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation, seismic forces required to select vibration isolators, seismic restraints, and for designing vibration isolation bases.
   2. 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 has been examined for excessive stress and that none will exist.
   3. Vibration Isolation Base Details: Detail overall dimensions, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, base weights, equipment static loads, power transmission, component misalignment, and cantilever loads.
   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. 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).

C. Coordination Drawings: Show coordination of seismic bracing for plumbing piping and equipment with other systems and equipment in the vicinity, including other supports and seismic restraints.

D. Welding certificates.

E. Qualification Data: For [professional engineer] [and] [testing agency].

F. Field quality-control test reports.

G. Operation and Maintenance Data: For air-mounting systems to include in operation and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (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: 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, preapproved by ICC-ES, or preapproved 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 not available, 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 VIBRATION ISOLATORS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

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

C. Basis-of-Design Product: Subject to compliance with requirements, provide [the product indicated on Drawings] <Insert manufacturer's name; product name or designation> or a comparable product by one of the following:
1. Ace Mountings Co., Inc.
2. Amber/Booth Company, Inc.
3. California Dynamics Corporation.
4. Isolation Technology, Inc.
5. Kinetics Noise Control.
6. Mason Industries.
7. Vibration Eliminator Co., Inc.
8. Vibration Isolation.
9. Vibration Mountings & Controls, Inc.
10. <Insert manufacturer's name>.

D. Pads <Insert drawing designation>: Arranged in single or multiple layers of sufficient stiffness for uniform loading over pad area, molded with a nonslip pattern and galvanized-steel baseplates, and factory cut to sizes that match requirements of supported equipment.
   1. Resilient Material: Oil- and water-resistant [neoprene] [rubber] [hermetically sealed compressed fiberglass].

E. Mounts <Insert drawing designation>: Double-deflection type, with molded, oil-resistant rubber, hermetically sealed compressed fiberglass, or neoprene isolator elements with factory-drilled, encapsulated top plate for bolting to equipment and with baseplate for bolting to structure. Color-code or otherwise identify to indicate capacity range.
   1. Materials: Cast-ductile-iron or welded steel housing containing two separate and opposing, oil-resistant rubber or neoprene elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.
   2. Neoprene: Shock-absorbing materials compounded according to the standard for bridge-bearing neoprene as defined by AASHTO.

F. Restrained Mounts <Insert drawing designation>: All-directional mountings with seismic restraint.
   1. Materials: Cast-ductile-iron or welded steel housing containing two separate and opposing, oil-resistant rubber or neoprene elements that prevent central threaded element and attachment hardware from contacting the housing during normal operation.
   2. Neoprene: Shock-absorbing materials compounded according to the standard for bridge-bearing neoprene as defined by AASHTO.

G. Spring Isolators <Insert drawing designation>: Freestanding, laterally stable, open-spring isolators.
   1. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
   2. Minimum Additional Travel: 50 percent of the required deflection at rated load.
   3. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
   4. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
   5. Baseplates: Factory drilled for bolting to structure and bonded to 1/4-inch-thick, rubber isolator pad attached to baseplate underside. Baseplates shall limit floor load to 500 psig.
   6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

H. Restrained Spring Isolators <Insert drawing designation>: Freestanding, steel, open-spring isolators with seismic or limit-stop restraint.
   1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to weight being removed; factory-drilled baseplate bonded to 1/4-inch-thick, neoprene or rubber isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
   2. Restraint: Seismic or limit-stop as required for equipment and authorities having jurisdiction.

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.

I. Housed Spring Mounts <Insert drawing designation>: Housed spring isolator with integral seismic snubbers.
1. Housing: Ductile-iron or steel housing to provide all-directional seismic restraint.
2. Base: Factory drilled for bolting to structure.
3. Snubbers: Vertically adjustable to allow a maximum of 1/4-inch travel up or down before contacting a resilient collar.

J. Elastomeric Hangers <Insert drawing designation>: Single or double-deflection type, fitted with molded, oil-resistant elastomeric isolator elements bonded to steel housings with threaded connections for hanger rods. Color-code or otherwise identify to indicate capacity range.

K. Spring Hangers <Insert drawing designation>: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression.
1. 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.
2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the 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. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
7. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

L. Spring Hangers with Vertical-Limit Stop <Insert drawing designation>: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression and with a vertical-limit stop.
1. 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.
2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the 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. Elastomeric Element: Molded, oil-resistant rubber or neoprene.

7. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.
8. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

M. Pipe Riser Resilient Support <Insert drawing designation>: All-directional, acoustical pipe anchor consisting of 2 steel tubes separated by a minimum of 1/2-inch-thick neoprene. Include steel and neoprene vertical-limit stops arranged to prevent vertical travel in both directions. Design support for a maximum load on the isolation material of 500 psig and for equal resistance in all directions.

N. Resilient Pipe Guides: Telescopic arrangement of 2 steel tubes or post and sleeve arrangement separated by a minimum of 1/2-inch-thick neoprene. Where clearances are not readily visible, a factory-set guide height with a shear pin to allow vertical motion due to pipe expansion and contraction shall be fitted. Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.

2.2 VIBRATION ISOLATION EQUIPMENT BASES

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

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

C. Basis-of-Design Product: Subject to compliance with requirements, provide [the product indicated on Drawings] <Insert manufacturer's name; product name or designation> or a comparable product by one of the following:
1. Amber/Booth Company, Inc.
2. California Dynamics Corporation.
3. Isolation Technology, Inc.
4. Kinetics Noise Control.
5. Mason Industries.
6. Vibration Eliminator Co., Inc.
7. Vibration Isolation.
8. Vibration Mountings & Controls, Inc.
9. <Insert manufacturer's name>.

D. Steel Base <Insert drawing designation>: 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.

E. Inertia Base <Insert drawing designation>: Factory-fabricated, welded, structural-steel bases and rails ready for placement of cast-in-place concrete.

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.
4. Fabrication: Fabricate steel templates to hold equipment anchor-bolt sleeves and anchors in place during placement of concrete. Obtain anchor-bolt templates from supported equipment manufacturer.

2.3 SEISMIC-RESTRAINT DEVICES

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

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

C. Basis-of-Design Product: Subject to compliance with requirements, provide [the product indicated on Drawings] <Insert manufacturer's name; product name or designation> or a comparable product by one of the following:
   1. Amber/Booth Company, Inc.
   2. California Dynamics Corporation.
   3. Cooper B-Line, Inc.; a division of Cooper Industries.
   4. Hilti, Inc.
   5. Kinetics Noise Control.
   6. Loos & Co.; Cableware Division.
   7. Mason Industries.
   8. TOLCO Incorporated; a brand of NIBCO INC.
   9. Unistrut; Tyco International, Ltd.
   10. <Insert manufacturer's name>.

D. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by [an evaluation service member of ICC-ES] [OSHPD] [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] <Insert number> times the maximum seismic forces to which they will be subjected.

E. Snubbers: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.
   1. Anchor bolts for attaching to concrete shall be seismic-rated, drill-in, and stud-wedge or female-wedge type.
   2. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.
   3. Maximum 1/4-inch air gap, and minimum 1/4-inch-thick resilient cushion.

F. Channel Support System: MFMA-3, shop- or field-fabricated support assembly made of slotted steel channels with accessories for attachment to braced component at one end and to building structure at the other end and other

matching components and with corrosion-resistant coating; and rated in tension, compression, and torsion forces.

G. Restraint Cables: [ASTM A 603 galvanized] [ASTM A 492 stainless]-steel cables with end connections made of steel assemblies with thimbles, brackets, swivel, and bolts designed for restraining cable service; and with a minimum of two clamping bolts for cable engagement.

H. Hanger Rod Stiffener: [Steel tube or steel slotted-support-system sleeve with internally bolted connections] [Reinforcing steel angle clamped] to hanger rod.

I. 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.

J. 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.

K. Resilient Isolation Washers and Bushings: One-piece, molded, oil- and water-resistant neoprene, with a flat washer face.

L. 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. Minimum length of eight times diameter.

M. Adhesive Anchor Bolts: Drilled-in and capsule anchor system containing polyvinyl 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.

2.4 FACTORY FINISHES

A. Finish: Manufacturer's standard prime-coat finish ready for field painting.

B. Finish: Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.
   1. Powder coating on springs and housings.
   2. All hardware shall be galvanized. Hot-dip galvanize metal components for exterior use.
   3. Baked enamel or powder coat for metal components on isolators for interior use.
   4. Color-code or otherwise mark vibration isolation and seismic-control devices to indicate capacity range.

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.

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 evaluation service member of ICC-ES] [OSHPD] [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 will be adequate to carry present and future static and seismic loads within specified loading limits.

3.3 VIBRATION-CONTROL AND SEISMIC-RESTRAINT DEVICE INSTALLATION

A. Equipment Restraints:
   1. Install seismic snubbers on plumbing 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 inches.
   3. Install seismic-restraint devices using methods approved by [an evaluation service member of ICC-ES] [OSHPD] [an agency acceptable to authorities having jurisdiction] providing required submittals for component.

B. Piping Restraints:
   1. Comply with requirements in MSS SP-127.
   2. Space lateral supports a maximum of [40 feet] <Insert dimension> o.c., and longitudinal supports a maximum of [80 feet] <Insert dimension> o.c.
   3. Brace a change of direction longer than 12 feet.

C. Install cables so they do not bend across edges of adjacent equipment or building structure.

D. Install seismic-restraint devices using methods approved by [an evaluation service member of ICC-ES] [OSHPD] [an agency acceptable to authorities having jurisdiction] providing required submittals for component.

E. Install bushing assemblies for anchor bolts for floor-mounted equipment, arranged to provide resilient media between anchor bolt and mounting hole in concrete base.

F. 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.

G. 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.

H. 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 Division 22 Section "Domestic Water Piping" for piping flexible connections.

3.5 FIELD QUALITY CONTROL

A. Testing Agency: [Owner will engage] [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] <Insert number> 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. Air-Mounting System Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

10. Air-Mounting System Operational Test: Test the compressed-air leveling system.
11. Test and adjust air-mounting system controls and safeties.
12. If a device fails test, modify all installations of same type and retest until satisfactory results are achieved.

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.

C. Adjust active height of sprint isolators.

D. Adjust restraints to permit free movement of equipment within normal mode of operation.

3.7 PLUMBING VIBRATION-CONTROL AND SEISMIC-RESTRAINT DEVICE SCHEDULE

A. Supported or Suspended Equipment: <Insert name and drawing designation>.
1. Equipment Location: <Insert room number>.
2. Pads:
   a. Material: [Neoprene] [Rubber] [Hermetically sealed compressed fiberglass].
   b. Thickness: <Insert inches>.
   c. Number of Pads: <Insert number> thick.
3. Isolator Type: <Insert generic name or designation used in Part 2>.
4. Base Type: <Insert generic name or designation used in Part 2>.
5. Minimum Deflection: <Insert inches>.
6. Component Importance Factor: [1.0] [1.5].
7. Component Response Modification Factor: [1.5] [2.5] [3.5] [5.0].
8. Component Amplification Factor: [1.0] [2.5].

END OF SECTION

This page is intentionally left blank

SECTION 22 05 53

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 and Division 01 Specification Sections, 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 SUBMITTALS

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

B. Samples: For color, letter style, and graphic representation required for each identification material and device.

C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

D. Valve numbering scheme.

E. Valve Schedules: For each piping system to include in maintenance manuals.

1.4 COORDINATION

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Plastic Labels for Equipment:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch (3.2 mm) thick, and having predrilled holes for attachment hardware.
2. Letter Color: White.
3. Background Color: Black.
4. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).
5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
6. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.
7. Fasteners: Stainless-steel 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), plus 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 (A4) bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus 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. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch (3.2 mm) thick, and having predrilled holes for attachment hardware.

B. Letter Color: White.

C. Background Color: Red.

D. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).

E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).

F. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

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.

B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full 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, pipe size, and an arrow indicating flow direction.
   1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.
   2. Lettering Size: At least 1-1/2 inches (38 mm) high.

2.4 STENCILS

A. Stencils: Prepared with letter sizes according to ASME A13.1 for piping; and minimum letter height of 3/4 inch (19 mm) for access panel and door labels, equipment labels, and similar operational instructions.
   1. Stencil Material: Fiberboard or metal.
   2. Stencil Paint: Exterior, gloss, alkyd enamel black unless otherwise indicated. Paint may be in pressurized spray-can form.
   3. Identification Paint: Exterior, alkyd enamel in colors according to ASME A13.1 unless otherwise indicated.

2.5 VALVE TAGS

A. Valve Tags: Stamped or engraved with 1/4-inch (6.4-mm) letters for piping system abbreviation and 1/2-inch (13-mm) numbers.
   1. Tag Material: Brass, 0.032-inch (0.8-mm) minimum thickness, and having predrilled or stamped holes for attachment hardware.
   2. Fasteners: Brass wire-link or beaded chain; or S-hook .

B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch (A4) bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.
   1. Valve-tag schedule shall be included in operation and maintenance data.
   2. Valve-tag schedule(s) shall be mounted in locations to be directed by Owner. Mountings shall be in a metal frame with plexi-glass (clear) cover.

PART 3 - EXECUTION

3.1 PREPARATION

A. Clean piping and equipment surfaces of substances that could impair bond of identification devices, including dirt, oil, grease, release agents, and incompatible primers, paints, and encapsulants.

3.2 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

3.3 PIPE LABEL INSTALLATION

A. Piping Color-Coding: Painting of piping is specified in Division 09 Section "Interior Painting."

B. Stenciled Pipe Label Option: Stenciled labels may be provided instead of manufactured pipe labels, at Installer's option. Install stenciled pipe labels with painted, color-coded bands or rectangles, complying with ASME A13.1, on each piping system.
   1. Identification Paint: Use for contrasting background.
   2. Stencil Paint: Use for pipe marking.

C. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
   1. Near each valve and control device.
   2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
   3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
   4. At access doors, manholes, and similar access points that permit view of concealed piping.
   5. Near major equipment items and other points of origination and termination.
   6. Spaced at maximum intervals of 50 feet (15 m) along each run. Reduce intervals to 25 feet (7.6 m) in areas of congested piping and equipment.
   7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

D. Pipe Label Color Schedule:
   1. Low-Pressure, Compressed-Air Piping:
      a. Background Color: Green
      b. Letter Color: White
   2. Domestic Water Piping:
      a. Background Color: Green
      b. Letter Color: White
   3. Sanitary Waste Piping:
      a. Background Color: Green
      b. Letter Color: White
   4. Non-Domestic Water Piping:
      a. Background Color: Green
      b. Letter Color: White
   5. Natural Gas Piping:
      a. Background Color: Green
      b. Letter Color: White
   6. Medical Gas and Vacuum:
      a. Background Color: Green
      b. Letter Color: White

3.4 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; faucets; convenience and lawn-watering hose connections; and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

B. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:
   1. Valve-Tag Size and Shape:
      a. Domestic and Non-Domestic Cold Water: 2 inches (50 mm), round.
      b. Domestic and Non-Domestic Hot Water: 2 inches (50 mm), round.
      c. Low-Pressure Compressed Air: 2 inches (50 mm), square.
      d. Natural Gas: 2 inches (50mm), square.
   2. Valve-Tag Color:
      a. Domestic and Non-Domestic Cold Water: Natural.
      b. Domestic and Non-Domestic Hot Water: Natural.
      c. Low-Pressure Compressed Air: Natural.
      d. Natural Gas: Natural.
   3. Letter Color:
      a. Domestic and Non-Domestic Cold Water: Black.
      b. Domestic and Non-Domestic Hot Water: Black.
      c. Low-Pressure Compressed Air: Black.
      d. Natural Gas: Black.

END OF SECTION

This page is intentionally left blank.

SECTION 22 07 00

PLUMBING INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Insulation Materials:
      a. Flexible elastomeric.
      b. Mineral fiber.
   2. Insulating cements.
   3. Adhesives.
   4. Sealants.
   5. Factory-applied jackets.
   6. Field-applied jackets.
   7. Tapes.
   8. Securements.
   9. Corner angles.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, thickness, and jackets (both factory and field applied, if any).

B. Shop Drawings:
   1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
   2. Detail attachment and covering of heat tracing inside insulation.
   3. Detail insulation application at pipe expansion joints for each type of insulation.
   4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
   5. Detail removable insulation at piping specialties, equipment connections, and access panels.
   6. Detail application of field-applied jackets.
   7. Detail field application for each equipment type.

C. Samples: For each type of insulation and jacket indicated. Identify each Sample, describing product and intended use. Sample sizes are as follows:
   1. Sample Sizes:
      a. Preformed Pipe Insulation Materials: 12 inches (300 mm) long by NPS 2 (DN 50).

b. Manufacturer's Color Charts: For products where color is specified, show the full range of colors available for each type of finish material.

D. Qualification Data: For qualified Installer.

E. 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.

F. Field quality-control reports.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.
1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.6 COORDINATION

A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."

B. Coordinate clearance requirements with piping Installer for piping insulation application and equipment Installer for equipment insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

C. Coordinate installation and testing of heat tracing.

1.7 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in Part 3 schedule articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Aeroflex USA Inc.; Aerocel.
      b. Armacell LLC; AP Armaflex.
      c. RBX Corporation; Insul-Sheet 1800 and Insul-Tube 180.

G. Mineral-Fiber, Preformed Pipe Insulation:
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Johns Manville; Micro-Lok.
      b. Knauf Insulation; 1000(Pipe Insulation.
      c. Owens Corning; Fiberglas Pipe Insulation.
   2. Type I, 850 deg F (454 deg C) Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

H. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied ASJcomplying 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. (40 kg/cu. m) or more. Thermal conductivity (k-value) at 100 deg F (55 deg C) is 0.29 Btu x in./h x sq. ft. x deg F (0.042 W/m x K) or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. CertainTeed Corp.; CrimpWrap.
      b. Johns Manville; MicroFlex.
      c. Knauf Insulation; Pipe and Tank Insulation.
      d. Owens Corning; Fiberglas Pipe and Tank Insulation.

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. Products: Subject to compliance with requirements, provide one of the following:
      a. Aeroflex USA Inc.; Aeroseal.
      b. Armacell LCC; 520 Adhesive.
      c. RBX Corporation; Rubatex Contact Adhesive.

C. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Childers Products, Division of ITW; CP-82.
      b. Foster Products Corporation, H. B. Fuller Company; 85-20.
      c. ITW TACC, Division of Illinois Tool Works; S-90/80.
      d. Marathon Industries, Inc.; 225.
      e. Mon-Eco Industries, Inc.; 22-25.

D. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Childers Products, Division of ITW; CP-82.
      b. Foster Products Corporation, H. B. Fuller Company; 85-20.
      c. ITW TACC, Division of Illinois Tool Works; S-90/80.
      d. Marathon Industries, Inc.; 225.
      e. Mon-Eco Industries, Inc.; 22-25.

E. PVC Jacket Adhesive: Compatible with PVC jacket.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Dow Chemical Company (The); 739, Dow Silicone.
      b. Johns-Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
      c. P.I.C. Plastics, Inc.; Welding Adhesive.
      d. Red Devil, Inc.; Celulon Ultra Clear.
      e. Speedline Corporation; Speedline Vinyl Adhesive.

2.3 SEALANTS

A. FSK and Metal Jacket Flashing Sealants:
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Childers Products, Division of ITW; CP-76-8.
      b. Foster Products Corporation, H. B. Fuller Company; 95-44.
      c. Marathon Industries, Inc.; 405.
      d. Mon-Eco Industries, Inc.; 44-05.
      e. Vimasco Corporation; 750.

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 (Minus 40 to plus 121 deg C).
5. Color: Aluminum.

B. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Childers Products, Division of ITW; CP-76.
   b. Insert manufacturer's name; product name or designation.
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 (Minus 40 to plus 121 deg C).
5. Color: White.

2.4 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. PVDC Jacket for Indoor Applications: 4-mil- (0.10-mm-) thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perms (0.013 metric perms) when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.

2.5 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. Products: Subject to compliance with requirements, provide one of the following:
   a. Johns Manville; Zeston.
   b. P.I.C. Plastics, Inc.; FG Series.
   c. Proto PVC Corporation; LoSmoke.
   d. Speedline Corporation; SmokeSafe.
2. Adhesive: As recommended by jacket material manufacturer.
3. Color: White.

4. 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.
5. Factory-fabricated tank heads and tank side panels.

C. Metal Jacket:
1. Products: Subject to compliance with requirements, provide one of the following:
   a. Childers Products, Division of ITW; Metal Jacketing Systems.
   b. PABCO Metals Corporation; Surefit.
   c. RPR Products, Inc.; Insul-Mate.
2. Aluminum Jacket: Comply with ASTM B 209 (ASTM B 209M), 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: 1-mil- (0.025-mm-) thick, heat-bonded polyethylene and kraft paper .
   d. Moisture Barrier for Outdoor Applications: 3-mil- (0.075-mm-) 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.
3. 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: 1-mil- (0.025-mm-) thick, heat-bonded polyethylene and kraft paper .
   d. Moisture Barrier for Outdoor Applications: 3-mil- (0.075-mm-) 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.

2.6 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0835.
      b. Compac Corp.; 104 and 105.
      c. Ideal Tape Co., Inc., an American Biltrite Company; 428 AWF ASJ.
      d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
   2. Width: 3 inches (75 mm).
   3. Thickness: 11.5 mils (0.29 mm).
   4. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
   5. Elongation: 2 percent.
   6. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
   7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
      b. Compac Corp.; 110 and 111.
      c. Ideal Tape Co., Inc., an American Biltrite Company; 491 AWF FSK.
      d. Venture Tape; 1525 CW, 1528 CW, and 1528 CW/SQ.
   2. Width: 3 inches (75 mm).
   3. Thickness: 6.5 mils (0.16 mm).
   4. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
   5. Elongation: 2 percent.
   6. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
   7. 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. Products: Subject to compliance with requirements, provide one of the following:
      a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0555.
      b. Compac Corp.; 130.
      c. Ideal Tape Co., Inc., an American Biltrite Company; 370 White PVC tape.
      d. Venture Tape; 1506 CW NS.
   2. Width: 2 inches (50 mm).
   3. Thickness: 6 mils (0.15 mm).
   4. Adhesion: 64 ounces force/inch (0.7 N/mm) in width.
   5. Elongation: 500 percent.
   6. Tensile Strength: 18 lbf/inch (3.3 N/mm) in width.

2.7 SECUREMENTS

A. Bands:
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Childers Products; Bands.

b. PABCO Metals Corporation; Bands.
c. RPR Products, Inc.; Bands.

2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304; 0.015 inch (0.38 mm) thick, 1/2 inch (13 mm) wide with wing or closed seal.

B. Insulation Pins and Hangers:

1. 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. Products: Subject to compliance with requirements, provide one of the following:
      1) AGM Industries, Inc.; Tactoo Insul-Hangers, Series T.
      2) GEMCO; Perforated Base.
      3) Midwest Fasteners, Inc.; Spindle.
   b. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch (0.76 mm) thick by 2 inches (50 mm) square.
   c. Spindle: Aluminum, fully annealed, 0.106-inch- (2.6-mm-) 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.
2. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- (0.41-mm-) thick, aluminumsheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches (38 mm) in diameter.
   a. Products: Subject to compliance with requirements, provide one of the following:
      1) AGM Industries, Inc.; RC-150.
      2) GEMCO; R-150.
      3) Midwest Fasteners, Inc.; WA-150.
      4) Nelson Stud Welding; Speed Clips.
   b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

C. Staples: Outward-clinching insulation staples, nominal 3/4-inch- (19-mm-) wide, stainless steel or Monel.

D. Wire: 0.062-inch (1.6-mm) soft-annealed, stainless steel.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. C & F Wire.
   b. Childers Products.
   c. PABCO Metals Corporation.
   d. RPR Products, Inc.

2.8 FIRE WRAP

A. Provide 3μ fire wrap for all piping required to meet fire resistences rating.

2.9 PLENUM WRAP

A. Provide 3µ Plenum wrap for all piping required to meet fire smoke density requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.
   1. Verify that systems and equipment to be insulated have been tested and are free of defects.
   2. Verify that surfaces to be insulated are clean and dry.
   3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. 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 (0.127 mm) thick and an epoxy finish 5 mils (0.127 mm) thick if operating in a temperature range between 140 and 300 deg F (60 and 149 deg C). 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 (0 and 149 deg C) 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 equipment and piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment and pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. 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- (75-mm-) wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches (100 mm) o.c.
   3. Overlap jacket longitudinal seams at least 1-1/2 inches (38 mm). 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 (50 mm) o.c.
      a. For below ambient services, apply vapor-barrier mastic over staples.
   4. Cover joints and seams with tape as recommended by insulation material manufacturer 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 (100 mm) 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 (50 mm) 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 (50 mm).
   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: Install insulation continuously through penetrations of fire-rated walls and partitions.
   1. Comply with requirements in Division 07 Section "Penetration Firestopping"firestopping and fire-resistive joint sealers.

E. Insulation Installation at Floor Penetrations:
   1. Pipe: Install insulation continuously through floor penetrations.
   2. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 07 Section "Penetration Firestopping."

3.5 EQUIPMENT, TANK, AND VESSEL INSULATION INSTALLATION

A. Mineral Fiber, Pipe and Tank Insulation Installation for Tanks and Vessels: Secure insulation with adhesive and anchor pins and speed washers.
   1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100percent coverage of tank and vessel surfaces.

2. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.
3. Protect exposed corners with secured corner angles.
4. Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels as follows:
   a. Do not weld anchor pins to ASME-labeled pressure vessels.
   b. Select insulation hangers and adhesive that are compatible with service temperature and with substrate.
   c. On tanks and vessels, maximum anchor-pin spacing is 3 inches (75 mm) from insulation end joints, and 16 inches (400 mm) o.c. in both directions.
   d. Do not overcompress insulation during installation.
   e. Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.
   f. Impale insulation over anchor pins and attach speed washers.
   g. 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.
5. Secure each layer of insulation with stainless-steel or aluminum bands. Select band material compatible with insulation materials.
6. Where insulation hangers on equipment and vessels are not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch prestressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs. Place one circumferential girdle around equipment approximately 6 inches (150 mm) from each end. Install wire or cable between two circumferential girdles 12 inches (300 mm) o.c. Install a wire ring around each end and around outer periphery of center openings, and stretch prestressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of 48 inches (1200 mm) o.c. Use this network for securing insulation with tie wire or bands.
7. Stagger joints between insulation layers at least 3 inches (75 mm).
8. Install insulation in removable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.
9. Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.
10. For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.

B. Flexible Elastomeric Thermal Insulation Installation for Tanks and Vessels: Install insulation over entire surface of tanks and vessels.
   1. Apply 100 percent coverage of adhesive to surface with manufacturer's recommended adhesive.
   2. Seal longitudinal seams and end joints.

3.6 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, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:
   1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
   2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
   3. Construct removable valve insulation covers in same manner as for flanges except divide the two-part section on the vertical center line of valve body.
   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 (50 mm) 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.

3.7 FLEXIBLE ELASTOMERIC INSULATION INSTALLATION

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 MINERAL-FIBER INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:
   1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
   2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
   3. For insulation with factory-applied jackets on above ambient surfaces, secure laps with outward clinched staples at 6 inches (150 mm) o.c.
   4. For insulation with factory-applied jackets on below ambient surfaces, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe 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 (25 mm), 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 FIELD-APPLIED JACKET INSTALLATION

A. Where PVC jackets are indicated, install with 1-inch (25-mm) overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. 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.

B. Where metal jackets are indicated, install with 2-inch (50-mm) 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 (300 mm) o.c. and at end joints.

3.10 FINISHES

A. Equipment and Pipe Insulation with ASJ, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Division 09 painting Sections.
   1. Flat Acrylic Finish: Twofinish 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.

3.11 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 field-insulated equipment, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location(s) for each type of equipment defined in the "Equipment Insulation Schedule" Article. For large equipment, remove only a portion adequate to determine compliance.
   2. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, locations of threaded strainers, 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.

3.12 EQUIPMENT INSULATION SCHEDULE

A. Insulation materials and thicknesses are identified below. If more than one material is listed for a type of equipment, selection from materials listed is Contractor's option.

B. Insulate indoor and outdoor equipment in paragraphs below that is not factory insulated.

C. Domestic hot-water hydropneumatic tank insulation shall be the following:
   1. Mineral-Fiber Pipe and Tank: 1 inch (25 mm) thick.

D. Domestic hot-water storage tank insulation shall be the following:
   1. Mineral-Fiber Pipe and Tank: 4 inches (100 mm) thick.

E. Domestic water storage tank insulation shall be the following:
   1. Flexible Elastomeric: 1 inch (25 mm) thick.
   2. Mineral-Fiber Board: 1 inch (25 mm) thick and 3-lb/cu. ft. (48-kg/cu. m) nominal density.
   3. Mineral-Fiber Pipe and Tank: 1 inch (25 mm) thick.

F. Piping system filter-housing insulation shall be the following:
   1. Mineral-Fiber Board: 2 inches (50 mm) thick and 3-lb/cu. ft. (48-kg/cu. m) nominal density.
   2. Mineral-Fiber Pipe and Tank: 2 inches (50 mm) thick.

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. Domestic Cold Water:
   1. NPS 1 (DN 25) and Smaller: Insulation shall be the following:
      a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch (13 mm) thick.
   2. NPS 1-1/4 (DN 32) and Larger: Insulation shall be the following:
      a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch (25 mm) thick.

B. Domestic Hot and Recirculated Hot Water:
   1. NPS 1-1/4 (DN 32) and Smaller: Insulation shall be the following:
      a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch (25 mm) thick.
   2. NPS 1-1/2 (DN 40) and Larger: Insulation shall be the following:
      a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch (25 mm) thick.

C. Domestic Chilled Water (Potable):
   1. All Pipe Sizes: Insulation shall be the following:
      a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch (25 mm) thick.

D. Stormwater and Overflow:
   1. All Pipe Sizes: Insulation shall be the following:
      a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch (25 mm) thick.

E. Roof Drain and Overflow Drain Bodies and Horizontal Offsets:
   1. All Pipe Sizes: Insulation shall be the following:
      a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1 inch (25 mm) thick.

F. 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. Flexible Elastomeric: 1/2 inch (13 mm) thick.

G. Sanitary Waste Piping Where Heat Tracing Is Installed:
   1. All Pipe Sizes: Insulation shall be the following:
      a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1-1/2 inches (38 mm) thick.

H. Condensate and Equipment Drain Water below 60 Deg F (16 Deg C):
   1. All Pipe Sizes: Insulation shall be the following:
      a. Flexible Elastomeric: 1 inch (25 mm) thick.

I. Floor Drains, Traps, and Sanitary Drain Piping within 10 Feet (3 m) of Drain Receiving Condensate and Equipment Drain Water below 60 Deg F (16 Deg C):
   1. All Pipe Sizes: Insulation shall be the following:
      a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1/2 inch (13 mm) thick.

3.15 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

A. Domestic Water Piping:
   1. All Pipe Sizes: Insulation shall be the following:
      a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inches (50 mm) thick.

B. Domestic Hot and Recirculated Hot Water:
   1. All Pipe Sizes: Insulation shall be the following:
      a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inches (50 mm) thick.

C. Sanitary Waste Piping Where Heat Tracing Is Installed:
   1. All Pipe Sizes: Insulation shall be the following:
      a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 2 inches (50 mm) thick.

3.16 OUTDOOR, UNDERGROUND PIPING INSULATION SCHEDULE

A. Loose-fill insulation, for belowground piping, is specified in Division 33 piping distribution Sections.

3.17 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, Exposed:
   ~~1. None.~~

2. PVC: 20 mils (0.5 mm) thick.

D. PVC Jacket shall be applied to all exposed piping.

3.18 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, Exposed:
1. Aluminum, Corrugated with Z-Shaped Locking Seam: 0.020 inch (0.51 mm) thick.

3.19 UNDERGROUND, FIELD-INSTALLED INSULATION JACKET

A. For underground direct-buried piping applications, install underground direct-buried jacket over insulation material.

END OF SECTION

This page is intentionally left blank.

SECTION 22 11 16

DOMESTIC WATER PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
1. Under-building slab and aboveground domestic water pipes, tubes, fittings, and specialties inside the building.
2. Encasement for piping.
3. Specialty valves.
4. Flexible connectors.
5. Water meters furnished by utility company for installation by Contractor.
6. Water meters.
7. Escutcheons.
8. Sleeves and sleeve seals.
9. Wall penetration systems.

B. Related Section:
1. Division 22 Section "Facility Water Distribution Piping" for water-service piping outside the building from source to the point where water-service piping enters the building.

1.3 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Domestic water piping and support and installation shall withstand effects of earthquake motions determined according to SEI/ASCE 7.

1.4 SUBMITTALS

A. Product Data: For the following products:
1. Specialty valves.
2. Transition fittings.
3. Flexible connectors.
4. Water meters.
5. Backflow preventers and vacuum breakers.
6. Escutcheons.
7. Sleeves and sleeve seals.
8. Water penetration systems.

B. Water Samples: Specified in "Cleaning" Article.

C. Coordination Drawings: For piping in equipment rooms and other congested areas, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:
   1. Fire-suppression-water piping.
   2. Domestic water piping.
   3. Natural gas piping.
   4. Medical gas and vacuum piping.
   5. Compressed air piping.
   6. HVAC hydronic piping.

D. Field quality-control reports.

1.5 QUALITY ASSURANCE

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

B. Comply with NSF 61 for potable domestic water piping and components.

1.6 PROJECT CONDITIONS

A. Interruption of Existing Water Service: Do not interrupt water service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water service according to requirements indicated:
   1. Notify Owner no fewer than five days in advance of proposed interruption of water service.
   2. Do not proceed with interruption of water service without Owner's written permission.

1.7 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Comply with requirements in "Piping Schedule" Article for applications of pipe, tube, fitting materials, and joining methods for specific services, service locations, and pipe sizes.

2.2 COPPER TUBE AND FITTINGS

A. Hard Copper Tube: ASTM B 88, Type L (ASTM B 88M, Type B) water tube, drawn temper.
   1. Cast-Copper Solder-Joint Fittings: ASME B16.18, pressure fittings.
   2. Wrought-Copper Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.
   3. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.

4. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.
5. Grooved-Joint Copper-Tube Appurtenances:
   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1) Victaulic Company.
   b. Copper Grooved-End Fittings: ASTM B 75 (ASTM B 75M) copper tube or ASTM B 584 bronze castings.
   c. Grooved-End-Tube Couplings: Copper-tube dimensions and design similar to AWWA C606. Include ferrous housing sections, EPDM-rubber gaskets suitable for hot and cold water, and bolts and nuts.

B. Soft Copper Tube: ASTM B 88, Type L (ASTM B 88M, Type B) water tube, annealed temper.
   1. Copper Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.

2.3 DUCTILE-IRON PIPE AND FITTINGS

A. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.
   1. Standard-Pattern, Mechanical-Joint Fittings: AWWA C110, ductile or gray iron.
   2. Compact-Pattern, Mechanical-Joint Fittings: AWWA C153, ductile iron.
      a. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

B. Push-on-Joint, Ductile-Iron Pipe: AWWA C151, with push-on-joint bell and plain spigot end unless grooved or flanged ends are indicated.
   1. Standard-Pattern, Push-on-Joint Fittings: AWWA C110, ductile or gray iron.
      a. Gaskets: AWWA C111, rubber.
   2. Compact-Pattern, Push-on-Joint Fittings: AWWA C153, ductile iron.
      a. Gaskets: AWWA C111, rubber.

2.4 GALVANIZED-STEEL PIPE AND FITTINGS

A. Galvanized-Steel Pipe: ASTM A 53/A 53M, Type E, Grade B, Standard Weight. Include ends matching joining method.
   1. Galvanized-Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106/A 106M, Standard Weight, seamless steel pipe with threaded ends.
   2. Galvanized, Gray-Iron Threaded Fittings: ASME B16.4, Class 125, standard pattern.
   3. Malleable-Iron Unions: ASME B16.39, Class 150, hexagonal-stock body with ball-and-socket, metal-to-metal, bronze seating surface, and female threaded ends.
   4. Flanges: ASME B16.1, Class 125, cast iron.
   5. Grooved-Joint, Galvanized-Steel-Pipe Appurtenances:
      a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
         1) Victaulic Company.

b. Galvanized, Grooved-End Fittings for Galvanized-Steel Piping: ASTM A 47/A 47M, malleable-iron casting; ASTM A 106/A 106M, steel pipe; or ASTM A 536, ductile-iron casting; with dimensions matching steel pipe.

c. Grooved-End-Pipe Couplings for Galvanized-Steel Piping: AWWA C606 for steel-pipe dimensions. Include ferrous housing sections, EPDM-rubber gaskets suitable for hot and cold water, and bolts and nuts.

2.5 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch (3.2 mm) thick or ASME B16.21, nonmetallic and asbestos free, unless otherwise indicated; 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. Include water-flushable flux according to ASTM B 813.

D. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

2.6 ENCASEMENT FOR PIPING

A. Standard: ASTM A 674 or AWWA C105.

B. Form: Sheet or Tube.

C. Material: High-density, cross-laminated PE film of 0.004-inch (0.10-mm) minimum thickness.

D. Color: Black.

2.7 SPECIALTY VALVES

A. Comply with requirements in Division 22 Section "General-Duty Valves for Plumbing Piping" for general-duty metal valves.

B. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for balancing valves, drain valves, backflow preventers, and vacuum breakers.

2.8 TRANSITION FITTINGS

A. General Requirements:
1. Same size as pipes to be joined.
2. Pressure rating at least equal to pipes to be joined.
3. End connections compatible with pipes to be joined.

B. Fitting-Type Transition Couplings: Manufactured piping coupling or specified piping system fitting.

C. Sleeve-Type Transition Coupling: AWWA C219.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Dresser, Inc.; Dresser Piping Specialties.
b. Ford Meter Box Company, Inc. (The).
c. Romac Industries, Inc.
d. Smith-Blair, Inc; a Sensus company.
e. Viking Johnson; c/o Mueller Co.

2.9 FLEXIBLE CONNECTORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Mercer Rubber Co.
2. Metraflex, Inc.
3. Tozen Corporation.
4. Universal Metal Hose; a Hyspan company

B. Bronze-Hose Flexible Connectors: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.
1. Working-Pressure Rating: Minimum 200 psig (1380 kPa).
2. End Connections NPS 2 (DN 50) and Smaller: Threaded copper pipe or plain-end copper tube.
3. End Connections NPS 2-1/2 (DN 65) and Larger: Flanged copper alloy.

C. Stainless-Steel-Hose Flexible Connectors: Corrugated-stainless-steel tubing with stainless-steel wire-braid covering and ends welded to inner tubing.
1. Working-Pressure Rating: Minimum 200 psig (1380 kPa).
2. End Connections NPS 2 (DN 50) and Smaller: Threaded steel-pipe nipple.
3. End Connections NPS 2-1/2 (DN 65) and Larger: Flanged steel nipple.

2.10 WATER METERS

A. Compound-Type Water Meters:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. ABB.
b. Badger Meter, Inc.
c. Mueller Company; Water Products Division.
d. Schlumberger Limited; Water Division.
e. Sensus Metering Systems.
2. Description:
a. Standard: AWWA C702.
b. Pressure Rating: 150-psig (1035-kPa) working pressure.
c. Body Design: With integral mainline and bypass meters; totalization meter.
d. Registration: In gallons (liters) or cubic feet (cubic meters) as required by utility company.
e. Case: Bronze.
f. Pipe Connections: Flanged.

B. Remote Registration System: Direct-reading type complying with AWWA C706; modified with signal transmitting assembly, low-voltage connecting wiring, and remote register assembly as required by utility company.

2.11 ESCUTCHEONS

A. General: Manufactured ceiling, floor, and wall escutcheons and floor plates.

B. One Piece, Cast Brass: Polished, chrome-plated finish with setscrews.

C. One Piece, Deep Pattern: Deep-drawn, box-shaped brass with chrome-plated finish.

D. Split Casting, Cast Brass: Polished, chrome-plated finish with concealed hinge and setscrew.

E. One-Piece Floor Plates: Cast-iron flange with holes for fasteners.

F. Split-Casting Floor Plates: Cast brass with concealed hinge.

2.12 SLEEVES

A. Cast-Iron Wall Pipes: Fabricated of cast iron, and equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

B. Galvanized-Steel-Sheet Sleeves: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.

C. Molded-PE Sleeves: Reusable, PE, tapered-cup shaped, and smooth outer surface with nailing flange for attaching to wooden forms.

D. Galvanized-Steel-Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc-coated, with plain ends.

E. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
   1. Underdeck Clamp: Clamping ring with setscrews.

2.13 SLEEVE SEALS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Calpico, Inc.
   2. Metraflex, Inc.
   3. Thunderline.

B. Description: Modular sealing element unit, designed for field assembly, used to fill annular space between pipe 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: Plastic.
   3. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

2.14 GROUT

A. Standard: ASTM C 1107, 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 (34.5-MPa), 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Comply with requirements in Division 31 Section "Earth Moving" 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 copper tubing under building slab according to CDA's "Copper Tube Handbook."

C. Install ductile-iron piping under building slab with restrained joints according to AWWA C600 and AWWA M41.

D. Install underground copper tube and ductile-iron pipe in PE encasement according to ASTM A 674 or AWWA C105.

E. 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 in Division 22 Section "Meters and Gages for Plumbing Piping" for pressure gages and Division 22 Section "Domestic Water Piping Specialties" for drain valves and strainers.

F. Install shutoff valve immediately upstream of each brass fitting.

G. Install water-pressure-reducing valves downstream from shutoff valves. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for pressure-reducing valves.

H. Install domestic water piping level and plumb.

I. Rough-in domestic water piping for water-meter installation according to utility company's requirements.

J. Install seismic restraints on piping. Comply with requirements in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment" for seismic-restraint devices.

K. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

L. 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.

M. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal, and coordinate with other services occupying that space.

N. Install piping adjacent to equipment and specialties to allow service and maintenance.

O. Install piping to permit valve servicing.

P. Install nipples, unions, special fittings, and valves with pressure ratings the same as or higher than system pressure rating used in applications below unless otherwise indicated.

Q. Install piping free of sags and bends.

R. Install fittings for changes in direction and branch connections.

S. Install unions in copper tubing at final connection to each piece of equipment, machine, and specialty.

T. Install pressure gages on suction and discharge piping from each plumbing pump and packaged booster pump. Comply with requirements in Division 22 Section "Meters and Gages for Plumbing Piping" for pressure gages.

U. Install thermostats in hot-water circulation piping. Comply with requirements in Division 22 Section "Domestic Water Pumps" for thermostats.

V. Install thermometers on inlet and outlet piping from each water heater. Comply with requirements in Division 22 Section "Meters and Gages for Plumbing Piping" for thermometers.

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. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" Chapter.

E. Soldered Joints: 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."

F. Copper-Tubing Grooved Joints: Roll groove end of tube. Assemble coupling with housing, gasket, lubricant, and bolts. Join copper tube and grooved-end fittings according to AWWA C606 for roll-grooved joints.

G. Steel-Piping Grooved Joints: Rollgroove end of pipe. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.

H. 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.

I. Dissimilar-Material Piping Joints: Make joints using adapters compatible with materials of both piping systems.

3.4 VALVE INSTALLATION

A. General-Duty Valves: Comply with requirements in Division 22 Section "General-Duty Valves for Plumbing Piping" for valve installations.

B. Install shutoff valve close to water main on each branch and riser serving plumbing fixtures or equipment, on each water supply to equipment, and on each water supply to plumbing fixtures that do not have supply stops. Use ball or gate valves for piping NPS 2 (DN 50) and smaller. Use gate valves for piping NPS 2-1/2 (DN 65) and larger.

C. Install drain valves for equipment at base of each water riser, at low points in horizontal piping, and where required to drain water piping. Drain valves are specified in Division 22 Section "Domestic Water Piping Specialties."
   1. Hose-End Drain Valves: At low points in water mains, risers, and branches.
   2. Stop-and-Waste Drain Valves: Instead of hose-end drain valves where indicated.

D. Install calibrated balancing valves in each hot-water circulation return branch and discharge side of each pump and circulator. Set calibrated balancing valves partly open to restrict but not stop flow. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for calibrated balancing valves.

3.5 TRANSITION FITTING INSTALLATION

A. Install transition couplings at joints of dissimilar piping.

B. Transition Fittings in Underground Domestic Water Piping:
   1. NPS 1-1/2 (DN 40) and Smaller: Fitting-type coupling.
   2. NPS 2 (DN 50) and Larger: Sleeve-type coupling.

3.6 FLEXIBLE CONNECTOR INSTALLATION

A. Install flexible connectors in suction and discharge piping connections to each domestic water pump and in suction and discharge manifold connections to each domestic water booster pump.

B. Install bronze-hose flexible connectors in copper domestic water tubing.

C. Install stainless-steel-hose flexible connectors in steel domestic water piping.

3.7 WATER METER INSTALLATION

A. Rough-in domestic water piping for service water meter installation according to utility company's requirements.

B. Water meters will be furnished and installed by utility company.

C. Install water meters according to AWWA M6, utility company's requirements, and the following:

D. Install displacement-type water meters with shutoff valve on water-meter inlet. Install valve on water-meter outlet and valved bypass around meter unless prohibited by authorities having jurisdiction.

E. Install turbine-type water meters with shutoff valve on water-meter inlet. Install valve on water-meter outlet and valved bypass around meter unless prohibited by authorities having jurisdiction.

F. Install compound-type water meters with shutoff valves on water-meter inlet and outlet and on valved bypass around meter. Support meters, valves, and piping on brick or concrete piers.

G. Install fire-service water meters with shutoff valves on water-meter inlet and outlet and on full-size valved bypass around meter. Support meter, valves, and piping on brick or concrete piers.

H. Install remote registration system according to standards of utility company and of authorities having jurisdiction.

3.8 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment" for seismic-restraint devices.

B. Comply with requirements in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support products and installation.
   1. Vertical Piping: MSS Type 8 or 42, clamps.
   2. Individual, Straight, Horizontal Piping Runs:
      a. 100 Feet (30 m) and Less: MSS Type 1, adjustable, steel clevis hangers.
      b. Longer Than 100 Feet (30 m): MSS Type 43, adjustable roller hangers.
   3. Multiple, Straight, Horizontal Piping Runs 100 Feet (30 m) 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. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 3/4 (DN 20) and Smaller: 60 inches (1500 mm) with 3/8-inch (10-mm) rod.
   2. NPS 1 and NPS 1-1/4 (DN 25 and DN 32): 72 inches (1800 mm) with 3/8-inch (10-mm) rod.
   3. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 96 inches (2400 mm) with 3/8-inch (10-mm) rod.
   4. NPS 2-1/2 (DN 65): 108 inches (2700 mm) with 1/2-inch (13-mm) rod.
   5. NPS 3 to NPS 5 (DN 80 to DN 125): 10 feet (3 m) with 1/2-inch (13-mm) rod.
   6. NPS 6 (DN 150): 10 feet (3 m) with 5/8-inch (16-mm) rod.
   7. NPS 8 (DN 200): 10 feet (3 m) with 3/4-inch (19-mm) rod.

E. Install supports for vertical copper tubing every 10 feet (3 m).

F. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/4 (DN 32) and Smaller: 84 inches (2100 mm) with 3/8-inch (10-mm) rod.
2. NPS 1-1/2 (DN 40): 108 inches (2700 mm) with 3/8-inch (10-mm) rod.
3. NPS 2 (DN 50): 10 feet (3 m) with 3/8-inch (10-mm) rod.
4. NPS 2-1/2 (DN 65): 11 feet (3.4 m) with 1/2-inch (13-mm) rod.
5. NPS 3 and NPS 3-1/2 (DN 80 and DN 90): 12 feet (3.7 m) with 1/2-inch (13-mm) rod.
6. NPS 4 and NPS 5 (DN 100 and DN 125): 12 feet (3.7 m) with 5/8-inch (16-mm) rod.
7. NPS 6 (DN 150): 12 feet (3.7 m) with 3/4-inch (19-mm) rod.
8. NPS 8 to NPS 12 (DN 200 to DN 300): 12 feet (3.7 m) with 7/8-inch (22-mm) rod.

G. Install supports for vertical steel piping every 15 feet (4.5 m).

H. Support piping and tubing not listed in this article according to MSS SP-69 and manufacturer's written instructions.

3.9 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment and machines to allow service and maintenance.

C. Connect domestic water piping to exterior water-service piping. Use transition fitting to join dissimilar piping materials.

D. Connect domestic water piping to water-service piping with shutoff valve; extend and connect to the following:

1. Domestic Water Booster Pumps: Cold-water suction and discharge piping.
2. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.
3. Plumbing Fixtures: Cold- and hot-water supply piping in sizes indicated, but not smaller than required by plumbing code. Comply with requirements in Division 22 plumbing fixture Sections for connection sizes.
4. Equipment: Cold- and hot-water supply piping as indicated, but not smaller than equipment connections. Provide shutoff valve and union for each connection. Use flanges instead of unions for NPS 2-1/2 (DN 65) and larger.

3.10 ESCUTCHEON INSTALLATION

A. Install escutcheons for penetrations of walls, ceilings, and floors.

B. Escutcheons for New Piping:
1. Piping with Fitting or Sleeve Protruding from Wall: One piece, deep pattern.
2. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish .
3. Bare Piping at Ceiling Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish.
4. Bare Piping in Unfinished Service Spaces: One piece, cast brass with polished chrome-plated finish .
5. Bare Piping in Equipment Rooms: One piece, cast brass .
6. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece floor plate.

C. Escutcheons for Existing Piping:
   1. Chrome-Plated Piping: Split casting, cast brass with chrome-plated finish.
   2. Insulated Piping: Split plate, stamped steel with concealed hinge and spring clips.
   3. Bare Piping at Wall and Floor Penetrations in Finished Spaces: Split casting, cast brass with chrome-plated finish.
   4. Bare Piping at Ceiling Penetrations in Finished Spaces: Split casting, cast brass with chrome-plated finish.
   5. Bare Piping in Unfinished Service Spaces: Split casting, cast brass with polished chrome-plated finish.
   6. Bare Piping in Equipment Rooms: Split casting, cast brass.
   7. Bare Piping at Floor Penetrations in Equipment Rooms: Split-casting floor plate.

3.11 SLEEVE INSTALLATION

A. General Requirements: Install sleeves for pipes and tubes passing through penetrations in floors, partitions, roofs, and walls.

B. Sleeves are not required for core-drilled holes.

C. Permanent sleeves are not required for holes formed by removable PE sleeves.

D. Cut sleeves to length for mounting flush with both surfaces unless otherwise indicated.

E. Install sleeves in new partitions, slabs, and walls as they are built.

F. For interior wall penetrations, seal annular space between sleeve and pipe or pipe insulation using joint sealants appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants" for joint sealants.

G. For exterior wall penetrations above grade, seal annular space between sleeve and pipe using joint sealants appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants" for joint sealants.

H. For exterior wall penetrations below grade, seal annular space between sleeve and pipe using sleeve seals specified in this Section.

I. Seal space outside of sleeves in concrete slabs and walls with grout.

J. Install sleeves that are large enough to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pipe or pipe insulation unless otherwise indicated.

K. Install sleeve materials according to the following applications:
   1. Sleeves for Piping Passing through Concrete Floor Slabs: Steel pipe.
   2. Sleeves for Piping Passing through Concrete Floor Slabs of Mechanical Equipment Areas or Other Wet Areas: Steel pipe Stack sleeve fittings.
      a. Extend sleeves 2 inches (50 mm) above finished floor level.
      b. For pipes penetrating floors with membrane waterproofing, extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches (50 mm) above finished floor level. Comply with requirements in Division 07 Section "Sheet Metal Flashing and Trim" for flashing.
   3. Sleeves for Piping Passing through Gypsum-Board Partitions:

a. Steel pipe sleeves for pipes smaller than NPS 6 (DN 150).
b. Galvanized-steel sheet sleeves for pipes NPS 6 (DN 150) and larger.
c. Exception: Sleeves are not required for water supply tubes and waste pipes for individual plumbing fixtures if escutcheons will cover openings.

4. Sleeves for Piping Passing through Concrete Roof Slabs: Steel pipe.
5. Sleeves for Piping Passing through Exterior Concrete Walls:
   a. Steel pipe sleeves for pipes smaller than NPS 6 (DN 150).
   b. Cast-iron wall pipe sleeves for pipes NPS 6 (DN 150) and larger.
   c. Install sleeves that are large enough to provide 1-inch (25-mm) annular clear space between sleeve and pipe or pipe insulation when sleeve seals are used.
   d. Do not use sleeves when wall penetration systems are used.
6. Sleeves for Piping Passing through Interior Concrete Walls:
   a. Steel pipe sleeves for pipes smaller than NPS 6 (DN 150).
   b. Galvanized-steel sheet sleeves for pipes NPS 6 (DN 150) and larger.

L. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements in Division 07 Section "Penetration Firestopping" for firestop materials and installations.

3.12 SLEEVE SEAL INSTALLATION

A. Install sleeve seals in sleeves in exterior concrete walls at water-service piping entries into building.

B. Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble sleeve seal components and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.13 WALL PENETRATION SYSTEM INSTALLATION

A. Install wall penetration systems in new, exterior concrete walls.

B. Assemble wall penetration system components with sleeve pipe. Install so that end of sleeve pipe and face of housing are flush with wall. Adjust locking devices to secure sleeve pipe in housing.

3.14 IDENTIFICATION

A. Identify system components. Comply with requirements in Division 22 Section "Identification for Plumbing Piping and Equipment" for identification materials and installation.

B. Label pressure piping with system operating pressure.

3.15 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Piping Inspections:
   1. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.
   2. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:
      a. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.
      b. Final Inspection: Arrange final inspection for authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.
   3. Reinspection: If authorities having jurisdiction find that piping will not pass tests or inspections, make required corrections and arrange for reinspection.
   4. Reports: Prepare inspection reports and have them signed by authorities having jurisdiction.

C. Piping Tests:
   1. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.
   2. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.
   3. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.
   4. Cap and subject piping to static water pressure of 50 psig (345 kPa) above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.
   5. Repair leaks and defects with new materials and retest piping or portion thereof until satisfactory results are obtained.
   6. Prepare reports for tests and for corrective action required.

D. Domestic water piping will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.16 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. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.
      a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide flow of hot water in each branch.
      b. Adjust calibrated balancing valves to flows indicated.
   5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.

6. Remove and clean strainer screens. Close drain valves and replace drain plugs.
7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.
8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.17 CLEANING

A. Clean and disinfect potable and non-potable domestic water piping as follows:
   1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
   2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:
      a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
      b. Fill and isolate system according to either of the following:
         1) Fill system or part thereof with water/chlorine solution with at least 50 ppm (50 mg/L) of chlorine. Isolate with valves and allow to stand for 24 hours.
         2) Fill system or part thereof with water/chlorine solution with at least 200 ppm (200 mg/L) of chlorine. Isolate and allow to stand for three hours.
      c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
      d. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.

B. Clean non-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 procedures prescribed by authorities having jurisdiction or; if methods are not prescribed, follow procedures described below:
      a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
      b. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.

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

D. Clean interior of domestic water piping system. Remove dirt and debris as work progresses.

3.18 PIPING SCHEDULE

A. Transition and 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. Under-building-slab, domestic water, building service piping, NPS 2 and smaller, shall be the following:
   1. Soft copper tube, ASTM B 88, Type L (ASTM B 88M, Type B); wrought-copper solder-joint fittings; and brazed joints.

E. Under-building-slab, domestic water, building-service piping, NPS 4 to NPS 8 (DN 100 to DN 200) and larger, shall be one of the following:
   1. Mechanical-joint, ductile-iron pipe; standard- pattern mechanical-joint fittings; and mechanical joints.
   2. Push-on-joint, ductile-iron pipe; standard- pattern push-on-joint fittings; and gasketed joints.

F. Under-building slab, combined domestic water, building-service, and fire-service-main piping, NPS 6 to NPS 12 (DN 150 to DN 300), shall be the following:
   1. Mechanical-joint, ductile-iron pipe; standard pattern mechanical-joint fittings; and mechanical joints.
   2. Push-on-joint, ductile-iron pipe; standard pattern push-on-joint fittings; and gasketed joints.

G. Under-building-slab, domestic water piping, NPS 2 (DN 50) and smaller, shall be the following:
   1. Hard or soft copper tube, ASTM B 88, Type L (ASTM B 88M, Type B); wrought-copper solder-joint fittings; and brazed joints.

H. Aboveground domestic water piping, NPS 2 (DN 50) and smaller, shall be the following:
   1. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B); cast-copper solder-joint fittings; and solderedjoints.

I. Aboveground domestic water piping, NPS 2-1/2 to NPS 4 (DN 65 to DN 100), shall be the following:
   1. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B); cast- or wrought- copper solder-joint fittings; and brazedjoints.
   2. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B) grooved-joint copper-tube appurtenances; and grooved joints.

J. Aboveground domestic water piping, NPS 5 to NPS 8 (DN 125 to DN 200), shall be the following:
   1. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B); cast- or wrought- copper solder-joint fittings; and brazed joints.
   2. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B) ; grooved-joint copper-tube appurtenances; and grooved joints.
   3. Galvanized-steel pipe and nipples; galvanized, gray-iron threaded fittings; and threaded joints.
   4. Galvanized-steel pipe; grooved-joint, galvanized-steel-pipe appurtenances; and grooved joints.

K. Aboveground, combined domestic-water-service and fire-service-main piping, NPS 6 to NPS 12 (DN 150 to (DN300), shall be the following:
   1. Galvanized-steel pipe and nipples; galvanized, gray-iron threaded fittings; and threaded joints.
   2. Galvanized-steel pipe; grooved-joint, galvanized-steel-pipe appurtenances; and grooved joints.

3.19 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 or gate valves for piping NPS 2 (DN 50) and smaller. Use butterfly, ball, or gate valves with flanged ends for piping NPS 2-1/2 (DN 65) and larger.
   2. Throttling Duty: Use ball or globe valves for piping NPS 2 (DN 50) and smaller. Use butterfly or ball valves with flanged ends for piping NPS 2-1/2 (DN 65) and larger.
   3. Hot-Water Circulation Piping, Balancing Duty: Memory-stop balancing valves.
   4. Drain Duty: Hose-end drain valves.

B. Use check valves to maintain correct direction of domestic water flow to and from equipment.

C. Iron grooved-end valves may be used with grooved-end piping.

END OF SECTION

Conformed Set, 02 Oct 2020

SECTION 22 11 19

DOMESTIC WATER PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following domestic water piping specialties:
1. Vacuum breakers.
2. Backflow preventers.
3. Water pressure-reducing valves.
4. Balancing valves.
5. ~~Temperature-actuated~~ Electronic water mixing valves.
6. Strainers.
7. Hose bibbs.
8. Wall hydrants.
9. Drain valves.
10. Water hammer arresters.
11. Air vents.
12. Trap-seal primer valves.

B. Related Sections include the following:
1. Division 22 Section "Meters and Gages for Plumbing Piping" for thermometers, pressure gages, and flow meters in domestic water piping.
2. Division 22 Section "Domestic Water Piping" for water meters.
3. Division 22 Section "Domestic Water Filtration Equipment" for water filters in domestic water piping.
4. Division 22 Section "Healthcare Plumbing Fixtures" for thermostatic mixing valves for sitz baths, thermostatic mixing-valve assemblies for hydrotherapy equipment, and outlet boxes for dialysis equipment.
5. Division 22 Section "Emergency Plumbing Fixtures" for water tempering equipment.
6. Division 22 Section "Drinking Fountains and Water Coolers" for water filters for water coolers.

1.3 PERFORMANCE REQUIREMENTS

A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig (860 kPa), unless otherwise indicated.

1.4 SUBMITTALS

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

B. Shop Drawings: Diagram power, signal, and control wiring.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For domestic water piping specialties to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. NSF Compliance:
1. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic domestic water piping components.
2. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9."

PART 2 - PRODUCTS

2.1 VACUUM BREAKERS

A. Pipe-Applied, Atmospheric-Type Vacuum Breakers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Ames Co.
   b. Conbraco Industries, Inc.
   c. FEBCO; SPX Valves & Controls.
   d. Watts Industries, Inc.; Water Products Div.
   e. Zurn Plumbing Products Group; Wilkins Div.
2. Standard: ASSE 1001.
3. Size: NPS 1/4 to NPS 3 (DN 8 to DN 80), as required to match connected piping.
4. Body: Bronze.
5. Inlet and Outlet Connections: Threaded.
6. Finish: Chrome plated.

B. Hose-Connection Vacuum Breakers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Conbraco Industries, Inc.
   b. MIFAB, Inc.
   c. Watts Industries, Inc.; Water Products Div.
   d. Woodford Manufacturing Company.
   e. Zurn Plumbing Products Group; Wilkins Div.
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.

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

a. Ames Co.
b. Conbraco Industries, Inc.
c. FEBCO; SPX Valves & Controls.
d. Watts Industries, Inc.; Water Products Div.
e. Zurn Plumbing Products Group; Wilkins Div.

2. Standard: ASSE 1020.
3. Operation: Continuous-pressure applications.
4. Pressure Loss: 5 psig (35 kPa) maximum, through middle 1/3 of flow range.
5. Accessories:
   a. Valves: Ball type, on inlet and outlet.

D. Laboratory-Faucet Vacuum Breakers:
1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Conbraco Industries, Inc.
   b. Watts Industries, Inc.; Water Products Div.
   c. Woodford Manufacturing Company.
   d. Zurn Plumbing Products Group; Wilkins Div.
3. Standard: ASSE 1035.
4. Size: NPS 1/4 or NPS 3/8 (DN 8 or DN 10) matching faucet size.
5. Body: Bronze.
6. End Connections: Threaded.
7. Finish: Chrome plated.

2.2 BACKFLOW PREVENTERS

A. Intermediate Atmospheric-Vent Backflow Preventers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Conbraco Industries, Inc.
   b. FEBCO; SPX Valves & Controls.
   c. Watts Industries, Inc.; Water Products Div.
   d. Zurn Plumbing Products Group; Wilkins Div.
2. Standard: ASSE 1012.
3. Operation: Continuous-pressure applications.
4. Size: NPS 3/4 (DN 20).
5. Body: Bronze.
6. End Connections: Union, solder joint.
7. Finish: Rough bronze.

B. Reduced-Pressure-Principle Backflow Preventers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Watts Industries, Inc.; Water Products Div. LF909 Small and LF909 Large.
   b. Substitutions are not allowed.
2. Standard: ASSE 1013.
3. Operation: Continuous-pressure applications.
4. Pressure Loss: 12 psig (83 kPa) maximum, through middle 1/3 of flow range.
5. Size: As shown on the drawings.

6. Body: Bronze for NPS 2 (DN 50) and smaller; cast iron with interior lining complying with AWWA C550 or that is FDA approved for NPS 2-1/2 (DN 65) and larger.
7. End Connections: Threaded for NPS 2 (DN 50) and smaller; flanged for NPS 2-1/2 (DN 65) and larger.
8. Configuration: Designed for horizontal, straight through flow.
9. Accessories:
   a. Valves: Ball type with threaded ends on inlet and outlet of NPS 2 (DN 50) and smaller; outside screw and yoke gate-type with flanged ends on inlet and outlet of NPS 2-1/2 (DN 65) and larger.
   b. Air-Gap Fitting: ASME A112.1.2, matching backflow-preventer connection.

C. Double-Check Backflow-Prevention Assemblies:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Ames Co.
   b. Conbraco Industries, Inc.
   c. FEBCO; SPX Valves & Controls.
   d. Watts Industries, Inc.; Water Products Div.
   e. Zurn Plumbing Products Group; Wilkins Div.
2. Standard: ASSE 1015.
3. Operation: Continuous-pressure applications, unless otherwise indicated.
4. Pressure Loss: 5 psig (35 kPa) maximum, through middle 1/3 of flow range.
5. Body: Bronze for NPS 2 (DN 50) and smaller; cast iron with interior lining complying with AWWA C550 or that is FDA approved for NPS 2-1/2 (DN 65) and larger.
6. End Connections: Threaded for NPS 2 (DN 50) and smaller; for NPS 2-1/2 (DN 65) and larger.
7. Configuration: Designed for horizontal, straight through flow.
8. Accessories:
   a. Valves: Ball type with threaded ends on inlet and outlet ofNPS 2 (DN 50) and smaller; outside screw and yoke gate-type with flanged ends on inlet and outlet of NPS 2-1/2 (DN 65) and larger.

D. Hose-Connection Backflow Preventers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Conbraco Industries, Inc.
   b. Watts Industries, Inc.; Water Products Div.
   c. Woodford Manufacturing Company.
2. Standard: ASSE 1052.
3. Operation: Up to 10-foot head of water (30-kPa) back pressure.
4. Inlet Size: NPS 1/2 or NPS 3/4 (DN 15 or DN 20).
5. Outlet Size: Garden-hose thread complying with ASME B1.20.7.
6. Capacity: At least 3-gpm (0.19-L/s) flow.

E. Backflow-Preventer Test Kits:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Conbraco Industries, Inc.
   b. FEBCO; SPX Valves & Controls.
   c. Watts Industries, Inc.; Water Products Div.
   d. Zurn Plumbing Products Group; Wilkins Div.

2. Description: Factory calibrated, with gages, fittings, hoses, and carrying case with test-procedure instructions.

2.3 WATER PRESSURE-REDUCING VALVES

A. Water Regulators:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Conbraco Industries, Inc.
   b. Watts Industries, Inc.; Water Products Div.
   c. Zurn Plumbing Products Group; Wilkins Div.
2. Standard: ASSE 1003.
3. Pressure Rating: Initial working pressure of 150 psig (1035 kPa).
4. Body: Bronze for NPS 2 (DN 50) and smaller; cast iron with interior lining complying with AWWA C550 or that is FDA approved for NPS 2-1/2 and NPS 3 (DN 65 and DN 80).
5. Valves for Booster Heater Water Supply: Include integral bypass.
6. End Connections: Threaded for NPS 2 (DN 50) and smaller; flanged for NPS 2-1/2 and NPS 3 (DN 65 and DN 80).

B. Water Control Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. CLA-VAL Automatic Control Valves.
   b. Watts Industries, Inc.; Ames Fluid Control Systems.
   c. Watts Industries, Inc.; Watts ACV.
   d. Zurn Plumbing Products Group; Wilkins Div.
2. Description: Pilot-operation, diaphragm-type, single-seated main water control valve.
3. Pressure Rating: Initial working pressure of 150 psig (1035 kPa) minimum with AWWA C550 or FDA-approved, interior epoxy coating. Include small pilot-control valve, restrictor device, specialty fittings, and sensor piping.
4. Main Valve Body: Cast- or ductile-iron body with AWWA C550 or FDA-approved, interior epoxy coating; or stainless-steel body.
5. End Connections: Threaded for NPS 2 (DN 50) and smaller; flanged for NPS 2-1/2 (DN 65) and larger.

2.4 BALANCING VALVES

A. Copper-Alloy Calibrated Balancing Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. ITT Industries; Bell & Gossett Div.
   b. NIBCO INC.
   c. Taco, Inc.
   d. Watts Industries, Inc.; Water Products Div.
2. Type: Ball or Y-pattern globe valve with two readout ports and memory setting indicator.
3. Body: bronze,
4. Size: Same as connected piping, but not larger than NPS 2 (DN 50).
5. Accessories: Meter hoses, fittings, valves, differential pressure meter, and carrying case.

B. Accessories: Meter hoses, fittings, valves, differential pressure meter, and carrying case.

C. Memory-Stop Balancing Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Conbraco Industries, Inc.
   b. Milwaukee Valve Company.
   c. NIBCO INC.
2. Standard: MSS SP-110 for two-piece, copper-alloy ball valves.
3. Pressure Rating: 400-psig (2760-kPa) minimum CWP.
4. Size: NPS 2 (DN 50) or smaller.
5. Body: Copper alloy.
6. Port: Standard or full port.
7. Ball: Chrome-plated brass.
8. Seats and Seals: Replaceable.
9. End Connections: Solder joint or threaded.
10. Handle: Vinyl-covered steel with memory-setting device.

2.5 ELECTRONIC WATER MIXING VALVES

A. Manifold, Electronic, Water-Mixing-Valve Assemblies:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Powers; a Watts Industries Co.
2. Description: Factory-fabricated, exposed-mounting electronic controlled, water-mixing-valve assembly in multi -valve parallel arrangement. (Refer to Schedule on Drawings for configuration.
3. Large-Flow Parallel: Electronic water mixing valve and downstream pressure regulator with pressure gages on inlet and outlet.
4. Electronic Mixing Valves: Comply with ASSE 1017. Include check stops on hot- and cold-water inlets and shutoff valve on outlet.
5. Water Regulator(s): Comply with ASSE 1003. Include pressure gage on inlet and outlet.
6. Component Pressure Ratings: 125 psig minimum, unless otherwise indicated.
7. Tempered-Water Setting: 125 deg F
8. Unit Pressure Drop at Design Flow Rate: 5 psig
9. Mixing Valve and Water Regulator Finish: Rough bronze.
10. Piping Finish: Copper.
11. Standard: ASSE 1017, thermostatically controlled water mixing valve made for precise, process-water temperature control.
12. Pressure Rating: 125 psig (860 kPa) minimum, unless otherwise indicated.
13. Body: Bronze with corrosion-resistant interior components.
14. Connections: Threaded inlets and outlet.
15. Accessories: Manual temperature control, check stops on hot- and cold-water supplies, thermometer, shutoff valve, and adjustable, temperature-control handle.

B. Lead Free digital water temperature control and monitoring system shall feature full-color touchless screen interface which is configurable on location and does not require factory pre-programming. System shall control water temperature to +/- 2

deg F in accordance with ASSE 1017 and during periods of low/zero demand and feature a user-programmable high temperature alarm. Unit shall feature Feed Forward or Predictable Control which anticipates changes in system demands and adjusts valve pre-emptively to maintain fixed set point. Controller shall be password protected and feature a user-adjustable outlet temperature range of 80-180 deg F and an approach temperature of 2 deg F.

C. System shall digitally monitor inlet pressure and temperature, mixed outlet temperature, mixed outlet set point, pressure and flow/BTU's, as well as return temperature without the use of an external module. System shall control an engineer specified recirculation pump based on user-set return temperature limits. Controller shall integrate with building automation systems through Bacnet and Modbus protocols and feature local and remote temperature alarms. System shall also feature a user-set and controlled, high temperature sanitization mode for use as part of users safe and properly designed thermal bacteria eradication protocol. In the event of a power failure or loss of cold water, system shall close the hot water supply. System shall be listed/approved to ASSE 1017,cUPC, NSF, CSA 24/UL873 and BTL (Bacnet Testing Laboratories) and should be mounted on a heavy duty welded strut with corrosion resistance coating and factory tested as a complete unit.

D. Systems shall be Powers Intellistation:
   1. Main Master Mixing Valve: #LFIS200 DV FFSLP
   2. Tempered Water Mixing Valve: #LFIS150 FFSLP

~~2.5 TEMPERATURE-ACTUATED WATER MIXING VALVES~~

~~E. Primary, Thermostatic, Water Mixing Valves:~~
   ~~1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:~~
      ~~a. Lawler Manufacturing Company, Inc.~~
      ~~b. Leonard Valve Company.~~
      ~~c. Powers; a Watts Industries Co.~~
   ~~2. Standard: ASSE 1017.~~
   ~~3. Pressure Rating: 125 psig (860 kPa).~~
   ~~4. Type: Exposed-mounting, thermostatically controlled water mixing valve.~~
   ~~5. Material: Bronze body with corrosion-resistant interior components.~~
   ~~6. Connections: Threaded inlets and outlet.~~
   ~~7. Accessories: Manual temperature control, check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.~~
   ~~8. Valve Pressure Rating: 125 psig (860 kPa) minimum, unless otherwise indicated.~~
   ~~9. Tempered-Water Setting: 125 deg F (deg C).~~
   ~~10. Tempered-Water Design Flow Rate: 69.44~~
   ~~11. Valve Finish: Rough bronze.~~
   ~~12. Piping Finish: Copper.~~

2.6 STRAINERS FOR DOMESTIC WATER PIPING

A. Y-Pattern Strainers:
   1. Pressure Rating: 125 psig (860 kPa) minimum, unless otherwise indicated.

2. Body: Bronze for NPS 2 (DN 50) and smaller; cast iron with interior lining complying with AWWA C550 or FDA-approved, epoxy coating and for NPS 2-1/2 (DN 65) and larger.
3. End Connections: Threaded for NPS 2 (DN 50) and smaller;flanged for NPS 2-1/2 (DN 65) and larger.
4. Screen: Stainless steel with round perforations, unless otherwise indicated.
5. Perforation Size:
   a. StrainersNPS 2 (DN 50) and Smaller: 0.033 inch (0.84 mm) .
   b. Strainers NPS 2-1/2 to NPS 4 (DN 65 to DN 100): 0.062 inch (1.57 mm).
   c. Strainers NPS 5 (DN 125) and Larger: 0.125 inch (3.18 mm) .
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 (DN 15 or DN 20) threaded or solder-joint inlet.
5. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.
6. Pressure Rating: 125 psig (860 kPa).
7. Vacuum Breaker: Integral or field-installation, 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: 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 Operating key.
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. Josam Company.
   b. MIFAB, Inc.
   c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
   d. Tyler Pipe; Wade Div.
   e. Watts Drainage Products Inc.
   f. Woodford Manufacturing Company.
   g. Zurn Plumbing Products Group; Light Commercial Operation.
   h. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASME A112.21.3M for concealed-outlet, self-draining wall hydrants.
3. Pressure Rating: 125 psig (860 kPa).
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 (DN 20 or DN 25).
7. Outlet: Concealed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.
8. Box: Deep, flush mounting 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: Rough bronze.
12. Operating Keys(s): Two with each wall hydrant.

B. Vacuum Breaker Wall Hydrants:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Smith, Jay. R. Mfg. Co.; Division of Smith Industries, Inc.
   b. Watts Industries, Inc.; Water Products Div.
   c. Woodford Manufacturing Company.
   d. Zurn Plumbing Products Group; Light Commercial Operation.
2. Standard: ASSE 1019, Type A or Type B.
3. Type: Freeze-resistant, automatic draining with integral air-inlet valve.
4. Classification: Type B, for automatic draining with hose removed or with hose attached and nozzle closed.
5. Pressure Rating: 125 psig (860 kPa).
6. Operation: Loose key .
7. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.
8. Inlet: NPS 1/2 or NPS 3/4 (DN 15 or DN 20).
9. 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 (2760-kPa) minimum CWP.
3. Size: NPS 3/4 (DN 20).
4. Body: Copper alloy.
5. Ball: Chrome-plated brass.
6. Seats and Seals: Replaceable.
7. Handle: Vinyl-covered steel.
8. Inlet: Threaded or solder joint.
9. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

2.10 WATER HAMMER ARRESTERS

A. Water Hammer Arresters:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. AMTROL, Inc.
   b. Josam Company.
   c. MIFAB, Inc.
   d. PPP Inc.

e. Sioux Chief Manufacturing Company, Inc.
f. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
g. Tyler Pipe; Wade Div.
h. Watts Drainage Products Inc.
i. Zurn Plumbing Products Group; Specification Drainage Operation.

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.

2.11 AIR VENTS

A. Bolted-Construction Automatic Air Vents:
1. Body: Bronze.
2. Pressure Rating: 125-psig (860-kPa) minimum pressure rating at 140 deg F (60 deg C).
3. Float: Replaceable, corrosion-resistant metal.
4. Mechanism and Seat: Stainless steel.
5. Size: NPS 1/2 (DN 15) minimum inlet.
6. Inlet and Vent Outlet End Connections: Threaded.

B. Welded-Construction Automatic Air Vents:
1. Body: Stainless steel.
2. Pressure Rating: 150-psig (1035-kPa) minimum pressure rating.
3. Float: Replaceable, corrosion-resistant metal.
4. Mechanism and Seat: Stainless steel.
5. Size: NPS 3/8 (DN 10) minimum inlet.
6. Inlet and Vent Outlet End Connections: Threaded.

2.12 TRAP-SEAL PRIMER VALVES

A. Supply-Type, Trap-Seal Primer Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. MIFAB, Inc.
b. PPP Inc.
c. Sioux Chief Manufacturing Company, Inc.
d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
e. Watts Industries, Inc.; Water Products Div.
2. Standard: ASSE 1018.
3. Pressure Rating: 125 psig (860 kPa) minimum.
4. Body: Bronze.
5. Inlet and Outlet Connections: NPS 1/2 (DN 15) threaded, union, or solder joint.
6. Gravity Drain Outlet Connection: NPS 1/2 (DN 15) threaded or solder joint.
7. Finish: Chrome plated, or rough bronze for units used with pipe or tube that is not chrome finished.

B. Drainage-Type, Trap-Seal Primer Valves:
1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
3. Standard: ASSE 1044, lavatory P-trap with NPS 3/8 (DN 10) minimum, trap makeup connection.
4. Size: NPS 1-1/4 (DN 32) minimum.
5. Material: Chrome-plated, cast brass.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Refer to Division 22 Section "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.

B. Install backflow preventers in each water supply to mechanical equipment and systems and to other equipment and water systems that may be sources of contamination. Comply with authorities having jurisdiction.
   1. Locate backflow preventers in same room as connected equipment or system.
   2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe to floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are not acceptable for this application.
   3. Do not install bypass piping around backflow preventers.

C. Install water regulators with inlet and outlet shutoff valves. Install pressure gages on inlet and outlet.

D. Install water control valves with inlet and outlet shutoff valves and bypass with globe valve. Install pressure gages on inlet and outlet.

E. Install balancing valves in locations where they can easily be adjusted.

F. Install temperature-actuated water mixing valves with check stops or shutoff valves on inlets and with shutoff valve on outlet.
   1. Install thermometers and water regulators if specified.
   2. Install cabinet-type units recessed in or surface mounted on wall as specified.

G. Install Y-pattern strainers for water on supply side of each control valve, solenoid valve, and pump.

H. Install hose stations with check stops or shutoff valves on inlets and with thermometer on outlet.
   1. Install shutoff valve on outlet if specified.
   2. Install cabinet-type units recessed in or surface mounted on wall as specified. Install 2-by-4-inch (38-by-89-mm) fire-retardant-treated-wood blocking wall reinforcement between studs. Fire-retardant-treated-wood blocking is specified in Division 06 Section "Rough Carpentry."

I. Install nonfreeze, nondraining-type post hydrants set in concrete or pavement.

J. Install water hammer arresters in water piping according to PDI-WH 201.

K. Install air vents at high points of water piping. Install drain piping and discharge onto floor drain.

L. Install supply-type, trap-seal primer valves with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust valve for proper flow.

M. Install drainage-type, trap-seal primer valves as lavatory trap with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting.

N. Install trap-seal primer systems with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust system for proper flow.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping and specialties.

B. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

C. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

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. Water pressure-reducing valves.
   4. Calibrated balancing valves.
   5. Primary, thermostatic, water mixing valves.
   6. Manifold, thermostatic, water-mixing-valve assemblies.
   7. Supply-type, trap-seal primer 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 Division 22 Section "Identification for Plumbing Piping and Equipment."

3.4 FIELD QUALITY CONTROL

A. Perform the following tests and prepare test reports:
   1. Test each pressure vacuum breaker, reduced-pressure-principle backflow preventer and double-check backflow-prevention assembly according to authorities having jurisdiction and the device's reference standard.

B. Remove and replace malfunctioning domestic water piping specialties and retest as specified above.

3.5 ADJUSTING

A. Set field-adjustable pressure set points of water pressure-reducing valves.

B. Set field-adjustable flow set points of balancing valves.

C. Set field-adjustable temperature set points of temperature-actuated water mixing valves.

END OF SECTION

This page is intentionally left blank.

SECTION 22 11 23

DOMESTIC WATER PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following all-bronze and bronze-fitted centrifugal pumps for domestic cold- and hot-water circulation:
   1. Close-coupled, horizontally mounted, in-line centrifugal pumps.
   2. Close-coupled, vertically mounted, in-line centrifugal pumps.

B. Related Sections include the following:
   1. Division 33 Section "Water Supply Wells" for well pumps.

1.3 SUBMITTALS

A. Product Data: For each type and size of domestic water pump specified. Include certified performance curves with operating points plotted on curves; and rated capacities of selected models, furnished specialties, and accessories.

B. Shop Drawings: Diagram power, signal, and control wiring.

C. Operation and Maintenance Data: For domestic water pumps to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of domestic water pumps and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. UL Compliance: Comply with UL 778 for motor-operated water pumps.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Retain shipping flange protective covers and protective coatings during storage.

B. Protect bearings and couplings against damage.

C. Comply with pump manufacturer's written rigging instructions for handling.

1.6 COORDINATION

A. Coordinate size and location of concrete bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

2.2 CLOSE-COUPLED, HORIZONTALLY MOUNTED, IN-LINE CENTRIFUGAL PUMPS

A. Manufacturers:
   1. Armstrong Pumps Inc.
   2. Bell & Gossett Domestic Pump; ITT Industries.
   3. Taco, Inc.

B. Description: Factory-assembled and -tested, overhung impeller, single-stage, close-coupled, horizontally mounted, in-line centrifugal pumps as defined in HI 1.1-1.2 and HI 1.3; and designed for installation with pump and motor shafts mounted horizontally.
   1. Pump Construction: All bronze.
      a. Casing: Radially split, cast iron, with threaded companion-flange connections for pumps with NPS 2 (DN 50) pipe connections and flanged connections for pumps with NPS 2-1/2 (DN 65) pipe connections.
      b. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, closed, and keyed to shaft.
      c. Shaft and Shaft Sleeve: Steel shaft, with copper-alloy shaft sleeve.
      d. Seal: Mechanical, with carbon-steel rotating ring, stainless-steel spring, ceramic seat, and rubber bellows and gasket. Include water slinger on shaft between motor and seal.
      e. Bearings: Oil-lubricated; bronze-journal or ball type.
   2. Shaft Coupling: Rigid type if pump is provided with coupling.
   3. Motor: Single speed, with grease-lubricated ball bearings. Comply with requirements in Division 22 Section "Common Motor Requirements for Plumbing Equipment."

C. Capacities and Characteristics:
   1. As scheduled on the plans

2.3 CLOSE-COUPLED, VERTICALLY MOUNTED, IN-LINE CENTRIFUGAL PUMPS

A. Manufacturers:
   1. Armstrong Pumps Inc.
   2. Bell & Gossett Domestic Pump; ITT Industries.
   3. Grundfos Pumps Corp.
   4. Taco, Inc.

B. Description: Factory-assembled and -tested, overhung impeller, single-stage, close-coupled, vertically mounted, in-line centrifugal pumps as defined in HI 1.1-1.2 and HI 1.3; and designed for installation with pump and motor shafts mounted vertically.
   1. Pump Construction: Bronze fitted.
      a. Casing: Radially split, cast iron, with wear rings and threaded companion-flange connections for pumps with NPS 2 (DN 50) pipe connections and flanged connections for pumps with NPS 2-1/2 (DN 65) pipe connections. Include pump manufacturer's base attachment for mounting pump on concrete base.
      b. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, closed, and keyed to shaft.
      c. Shaft and Shaft Sleeve: Stainless-steel shaft, with copper-alloy shaft sleeve.
      d. Seal: Mechanical, with carbon-steel rotating ring, stainless-steel spring, ceramic seat, and rubber bellows and gasket. Include water slinger on shaft between motor and seal.
      e. Bearings: Oil-lubricated; bronze-journal or ball type.
   2. Shaft Coupling: Rigid type if pump is provided with coupling.
   3. Motor: Single speed, with grease-lubricated ball bearings; and directly mounted to pump casing. Comply with requirements in Division 22 Section "Common Motor Requirements for Plumbing Equipment."
      a. Lifting and Supporting Lug: Factory mounted in top of motor enclosure.

C. Capacities and Characteristics As Shown on the Drawings:

2.4 CONTROLS

A. Thermostats: Electric; adjustable for control of hot-water circulation pump.
   1. Manufacturers:
      a. Honeywell International, Inc.
      b. Square D.
   2. Type: Water-immersion sensor, for installation in hot-water circulation piping.
   3. Range: 65 to 200 deg F (18 to 93 deg C) .
   4. Operation of Pump: On or off.
   5. Transformer: Provide if required.
   6. Power Requirement: 120 V, ac.
   7. Settings: Start pump at 115 deg F (46 deg C) and stop pump 125 deg F (52 deg C).

2.5 FLEXIBLE CONNECTORS

A. Manufacturers:
   1. Mercer Rubber.
   2. Metraflex, Inc.
   3. Unaflex Inc.

B. Description: Corrugated, bronze inner tubing covered with bronze wire braid. Include copper-tube ends or bronze flanged ends, braze-welded to tubing. Include 125-psig (860-kPa) minimum working-pressure rating and ends matching pump connections.

2.6 BUILDING-AUTOMATION-SYSTEM INTERFACE

A. Provide auxiliary contacts in pump controllers for interface to building automation system. Include the following:
   1. On-off status of each pump.
   2. Alarm status.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in of domestic-water-piping system to verify actual locations of connections before pump installation.

3.2 CONCRETE BASES

A. Install concrete bases of dimensions indicated for pumps and controllers. Refer to Division 22 Section "Common Work Results for Plumbing."
   1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around full perimeter of base.
   2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
   3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   4. Install anchor bolts to elevations required for proper attachment to supported equipment.

B. Cast-in-place concrete materials and placement requirements are specified in Division 03.

3.3 PUMP INSTALLATION

A. Comply with HI 1.4.

B. Install pumps with access for periodic maintenance including removal of motors, impellers, couplings, and accessories.

C. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.

D. Install close-coupled, horizontally mounted, in-line centrifugal pumps with motor and pump shafts horizontal.

E. Install continuous-thread hanger rods and spring hangers with vertical-limit stop of sufficient size to support pump weight. Vibration isolation devices are specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment." Fabricate brackets or supports as required. Hanger and support materials are specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."

F. Suspend vertically mounted, in-line centrifugal pumps independent of piping. Install pumps with motor and pump shafts vertical. Use continuous-thread hanger rods and spring hangers with vertical-limit stop of sufficient size to support pump

weight. Vibration isolation devices are specified in Division 21 Section "Vibration and Seismic Controls for Fire-Suppression Piping and Equipment." Hanger and support materials are specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."

G. Install vertical in-line pumps on concrete bases. Install pumps with motor and pump shafts vertical.

3.4 CONTROL INSTALLATION

A. Install immersion-type thermostats in hot-water return piping.

3.5 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to pumps to allow service and maintenance.

C. Connect domestic water piping to pumps. Install suction and discharge piping equal to or greater than size of pump nozzles. Refer to Division 22 Section "Domestic Water Piping."
   1. Install flexible connectors adjacent to pumps in suction and discharge piping of the following pumps:
      a. Close-coupled, horizontally mounted, in-line centrifugal pumps.
      b. Close-coupled, vertically mounted, in-line centrifugal pumps.
   2. Install shutoff valve and strainer on suction side of pumps, and check valve and throttling valve on discharge side of pumps. Install valves same size as connected piping. Refer to Division 22 Section "General-Duty Valves for Plumbing Piping" for general-duty valves for domestic water piping and Division 22 Section "Domestic Water Piping Specialties" for strainers.
   3. Install pressure gages at suction and discharge of pumps. Install at integral pressure-gage tappings where provided or install pressure-gage connectors in suction and discharge piping around pumps. Refer to Division 22 Section "Meters and Gages for Plumbing Piping" for pressure gages and gage connectors.

D. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

E. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

F. Connect thermostats and timers to pumps that they control.

G. Interlock pump with water heater burner and time delay relay.

3.6 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.
   1. Complete installation and startup checks according to manufacturer's written instructions.
   2. Check piping connections for tightness.
   3. Clean strainers on suction piping.

4. Set thermostats and timers for automatic starting and stopping operation of pumps.
5. 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.
6. Prime pump by opening suction valves and closing drains, and prepare pump for operation.
7. Start motor.
8. Open discharge valve slowly.
9. Adjust temperature settings on thermostats.
10. Adjust timer settings.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain controls and pumps. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION

SECTION 22 11 23.13

DOMESTIC-WATER PACKAGED BOOSTER PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes constant-speed, triplex, packaged booster pumps for domestic water piping systems.

1.3 SUBMITTALS

A. Product Data: For each packaged booster pump specified. Include certified performance curves with operating points plotted on curves; and rated capacities of selected models, furnished specialties, and accessories.

B. Shop Drawings: For packaged booster pumps and accessories. Include plans, elevations, sections, details, and attachments to other work:
   1. For installed products indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
   2. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
   3. 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.
   4. Wiring Diagrams: Detail power, signal, and control wiring.

C. Manufacturer Seismic Qualification Certification: Submit certification that packaged booster pumps, accessories, and components will withstand seismic forces defined in Division 22 Section "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.
      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 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.

D. Operation and Maintenance Data: For each packaged booster pump to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of packaged booster pumps and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. ASME Compliance: Comply with ASME B31.9 for piping.

D. Packaged booster pumps shall be listed and labeled as pumping systems by testing agency acceptable to authorities having jurisdiction.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Retain shipping flange protective covers and protective coatings during storage.

B. Protect bearings and couplings against damage.

C. Comply with pump manufacturer's written rigging instructions for handling.

1.6 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.7 GENERAL

A. Furnish and install a prefabricated quadraplex variable speed water pressure booster system model 65QH256VFD as manufactured by SyncroFlo, Inc., Norcross, GA, distributed by Gustavo Preston Company of Chelmsford, MA 978-250-3333. The system shall be capable of providing a constant system pressure of 148 psig with flow rates from 0 to 600 GPM when suction pressure is 35 psig minimum using 460 Volt, 3 phase, 60 hertz power.

B. Each pump shall deliver 150 gpm at 273 ft. TDH using a 25 HP, 3500 rpm motor.

1.8 FACTORY TEST AND CERTIFICATION

A. The factory shall certify in writing that the water pressure booster system and its component parts have undergone a complete operational electric and hydraulic flow test prior to shipment. The test shall include a SYSTEM operating test from zero to 100% design flow and suction and system pressure conditions. The certification shall include copies of the flow and pressure test data as recorded on 11" x 17" X-Y

plot. The system test may be witnessed by the owner, architect, consulting engineer, or contractor by reporting intent to do so to the factory no later than 2 weeks before expected system shipment. After flow test, manufacturer shall conduct hi-pot voltage test of system.

1.9 WARRANTY

A. The complete pumping system shall be guaranteed in writing by the manufacturer for a period of one year from date of startup or eighteen months from shipment, whichever comes first, against defects in design, materials, or construction. The motors shall also be guaranteed for one year from date of shipment against burnout from any cause when equipped with the pumping system manufacturer's over-temperature protection, standard minimum run timers and maintained according to instructions. Warranties and guarantees by the suppliers of various components in lieu of single-source responsibility by the manufacturer will not be accepted. The PLC, Touchscreen HMI, and VFDs shall be warranted for 5 years by a single third party. Mechanical seals are not covered during the warranty period.

1.10 STARTUP SERVICE

A. The service of a factory-trained representative shall be made available on the jobsite to check installation, supervise startup, and instruct the operator.

1.11 BOOSTER PUMP PACKAGE MAINTENANCE

A. One (1) preventative service maintenance visit shall be provided on site by the authorized service center for the manufacturer’s equipment. Manufacturer shall have a contracted factory authorized service center with a minimum of 10 years’ experience within a 250-mile radius of the jobsite installation to respond to repairs and service requirements.

1.12 BIDDING PROCESS

A. Alternate manufacturers, manufactures other than those listed above, shall be allowed to bid if pre-bid submittal information is submitted SEVEN (7) working days before the bid data and approved by the Engineer and owner via addendum THREE (3) working days before the bid date.

B. All bidders must submit the following data with their pre-bid submittal:
   1. A statement of full conformance to the specification and plans signed by an officer of the manufacturer or it’s representative.
   2. Pump curves for the proposed pumps.
   3. Installation list of similar pumping systems, which have been installed in the last five (5) years.
   4. Location of the closest owned or trained service centers.
   5. Manufacturer’s system UL category file number.

6. A copy of manufacturer's certificate of insurance showing minimum general liability coverage and excess liability coverage.
7. A complete list of all field service offices, complete with phone numbers and contact information, having the field closest to the site clearly indicated.

C. Pre-bid submittals shall be delivered to the Engineer in triplicate (3 Copies) and shall be bound into a single all-inclusive document with a detailed table of contents. The pre-bid submittals shall have a title or cover page clearly identifying the project name, project number, Owner, Engineer, submitting party, date of submittal, and bid date. All copies of pre-bid submittals shall become property of the reviewing Engineer.

D. Approval of a pre-bid submittal in no way does not waive a manufacturer or supplier of the responsibility of providing full equipment submittals post bid, nor are any requirements of these specifications mitigated in any way.

E. Any bids submitted by a supplier or manufacturer not completing the pre-bid submittal process will, at the Owner's option, be considered non-responsive and will not be opened.

1.13 SUBSTITUTIONS

A. The contractor must provide with substitution approval request certification of the following:
1. The proposed substitution does not affect dimensions shown on drawings.
2. The contractor will pay for changes to the building design, including engineering design, detailing, and construction costs caused by the requested substitution.
3. The proposed substitution will have no adverse effect on other trades, the construction schedule, or specified warranty requirements.
4. Maintenance, warranty repair and service parts will be locally available for the proposed substitution.

B. After execution of the contract it will be assumed that the cost to the contractor of the equipment proposed to be substituted is less than that of the equipment specified in the contract and if substitution is approved, an amount equal to the savings shall reduce the contract price.

1.14 References

A. American National Standards Institute (ANSI)

B. American Standard for Testing Materials (ASTM)

C. National Electric Code (NEC)

D. Underwriters Laboratory (UL) - Electrical Assemblies - UL 508

E. Occupational Safety and Health Administration (OSHA)

F. Food and Drug Administration (FDA)

G. National Fire Protection Association (NFPA) 70

H. American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) 90.1-2010

I. International Organization for Standardization (ISO)

J. National Institute of Standards and Technology (NIST)

K. National Sanitation Foundation (NSF) International

1.15 SUBMITTALS

A. Prior to Fabrication
   1. Submit 1 set of electronic submittal to the Engineer for approval, including the following:
      a. Certification that the manufacturer is a UL listed control panel manufacturer.
      b. Manufacturer's NRTL approval as a manufacturer of factory assembled pumping systems meeting OSHA safety standards.
      c. Easily readable functional description of the proposed equipment.
      d. Detail description of the Sequence of operation.
      e. Electrical schematic showing internal and external wiring connections.
      f. Test facility location, flow capacity, and all standard measurements taken.
      g. Pump performance curves plotting flow, head, efficiency, and NPSH required.
      h. Panel face diagram showing location of components.
      i. List of job name, city, state, system type, model number, consulting engineer, and contractor of the past 30 projects that used similar components.
      j. System data sheet listing all mechanical components and overall size.
      k. Control panel data sheeting listing major components and pressure switch settings.
      l. System warranty.
      m. Detailed system drawings in Revit format and descriptions of all components.
      n. Certification that testing instrumentation is traceable to NIST standards.
      o. Certification that manufacturer is ISO 9001.
      p. Controls meet ANSI/ASHRAE/IESNA Standard 90.1-2010 para 10.4.2.
      q. Certification that equipment is NSF372 compliant and NSF61 Annex G certified.

B. Prior to Final Acceptance
   1. As-built drawings for all components and software listed above.
   2. Flow test results (X-Y plot).

1.16 CODE COMPLIANCE

A. All packaged equipment shall be Nationally Recognized Testing Laboratory (NRTL) certified as a packaged pumping system suitable for the intended use in accordance with OSHA Federal Regulations and National Electric Code (NEC) Article 90-7. Safety certification label shall be permanently attached to pump system.

B. The packaged pumping system shall meet the EPA lead free requirement. Instrumentation will be traceable to NIST standards. The equipment shall be certified by NSF 61 Annex G and be NSF 372 compliant.

1.17 MANUFACTURER'S QUALIFICATIONS

A. A single supplier shall furnish equipment under this section.

B. The supplier shall have the sole responsibility for proper functioning of the system and equipment supplied.

C. Equipment shall be a product that the manufacturer regularly produces.

D. Manufacturer shall have in place a quality assurance program under ISO 9001.

E. Manufacturer shall have thirty years manufacturing and pump system application experience.

F. Manufacturer shall have a facility capable of testing the specified system at design flow and system pressure. Facility shall be capable of providing suction pressure throughout the specified range.

G. Manufacturer shall have a contracted factory authorized service center with a minimum of 30 years.

H. The system supplier shall assist customer with submittal of all completed documentation and applications to electric service provider for an energy saving rebate evaluation, if applicable.

1.18 SPARE PARTS

A. Ship the following spare parts with the system: 1 pint of touchup paint.

PART 2 - PRODUCTS

2.1 FACTORY PREFABRICATION

1. The entire booster system shall be factory prefabricated on fabricated carbon steel system skid with a removable panel stand with all interconnecting piping and wiring completed and operationally tested prior to shipment. The assembled package shall also include NSF certified lug type nylon coated

butterfly valves for isolating pumps. Suction and discharge headers shall be 6" Carbon Steel Pipe, FBE Coating. The header piping will be field reversible and piping connections shall be flanged. All discharge-side piping shall be rated for the specified maximum suction pressure plus pump shutoff pressure. Tubing for pressure switches and gauges shall be NSF certified plastic tubing with brass isolation valves. The only field connections required will be to the suction and discharge headers, the power connections at the control panel and any remote control devices.

B. Pumps & Motors
   1. Pumps shall be NSF certified, single stage, end suction design with BULGED FORMED PROCESS stainless steel construction (Stamped pump component parts are not considered equal), stainless steel impeller, equipped with sleeve mounted mechanical shaft seals and close-coupled to a premium efficiency motor, which will meet or exceed NEMA MG-1 Table 12-11 for epact motor efficiencies. Motor shall have a service factor of 1.15, ODP, and class F insulation. Incoming electrical service shall be designed for 460 volt, 3 phase, 60 Hz. Motors shall be non-overloading at all points on the curve at rated speed. Motors when coupled to a VFD shall have a 1.0 service factor per NEMA MG-1.

C. Valves
   1. A NSF certified stainless steel non-slam, wafer style, lead free, check valve shall be installed on each pump discharge line. The valve body shall be suitable for operation at maximum pump pressure plus maximum suction pressure. Provide isolation valves on the suction and discharge of each pump.

D. Pressure Transmitter
   1. Digital pressure transmitters shall be connected to the system suction and discharge headers. The transmitter shall have 1.0% accuracy, stainless steel wetted parts and a waterproof enclosure. Transmitter shall be capable of withstanding over pressurization of double its range. The transmitter shall use a digital 1-6 kHz pulse output that can be directly sent to a programmable logic controller (PLC) without requiring an additional analog module for measuring current. The transmitter zero set point must be capable of field calibration.

E. Variable Frequency Drives
   1. Each pump shall have its own Mitsubishi variable frequency drive with the following features:
      a. Voltage source, GTR or IBGT power transistor based inverter - PWM Type
      b. Use a high carrier frequency to reduce drive and motor noise
      c. Shall be capable of operating in an ambient temperature between 15 degrees F and 100 degrees F and a line voltage variation of less than 10 percent.
      d. Self protection features shall include: under voltage and over voltage protection, current overload protection, short circuit protection, power failure protection, ground fault protection, and over-temperature protection.

e. Include a four-digit LED readout to indicate the following: drive enabled, output frequency, and all VFD fault conditions.
f. The drive shall automatically restart after any of the following: overload over-voltage, converter over-current, inverter over-current, or power failure.
g. The following drive parameters shall be user adjustable: acceleration speed (1 to 300 seconds), deceleration speed (1 to 300 seconds), minimum speed, and maximum speed.
h. The drive shall have a front mounted "HAND-OFF-AUTO" selector switch and a potentiometer for adjusting drive speed in the "HAND" position.
i. Minimum 100,000 SCCR
j. The VFD shall use the following energy saving techniques
   1) Slows down the motor
   2) Reduce current
   3) Reduces voltage
   4) Evaluates 6 motor characteristics to further increase efficiency
k. The VFD shall communicate with the PLC with a DIGITAL connection, with the following capabilities:
   1) Able to modify 300 different VFD parameters through the PLC and HMI
   2) Read all VFD data and communicate it to the PLC, HMI, and write to the compact flash drive.
l. Each drive will record its energy usage (kWh). The HMI will display the energy usage as measured from each drive, including totalized energy usage of all drives. A 30 day history is displayed on the HMI of the totalized energy usage of all drives, including daily usage, average daily usage, and total energy usage over the last 30 days. Daily average and total energy used the last seven days is also provided. A resettable totalized energy usage counter is also provided which records the date to the last reset point.

F. VFD Dust Protection
1. Install ALL variable frequency drives inside a NEMA 12 control panel, or provide dust protection to an externally-mounted drive. Provide fans to cool control panels with internally-mounted VFD's. Fans shall produce positive cabinet pressure to prevent dust infiltration. Filter all incoming air.

G. Instrumentation and Emergency Controls
1. A temperature relief valve shall be mounted in the discharge head or seal bypass line for fast, accurate response.
2. Individual NSF certified 2½" ASA grade A, glycerin-filled pressure gauges shall be provided for each pump, system, and suction pressures. Gauges shall have an accuracy of 1%.
3. All pressure sensors shall be control panel mounted. Provide pressure sensors for high system pressure, low system pressure, and low suction pressure conditions.

2.2 POWER AND CONTROL PANEL

A. Furnish a power and control panel in NEMA 12 enclosure complete with programmable controller, backpan, operator interface, individual through-the-door pump disconnects, and 120V control circuit transformer. The complete assembly shall have the UL listing mark for industrial control panels. Provide one main non-fused disconnect for disconnecting all control power to the panel. The primary and secondary control power circuit breaker shall comply with UL file code 489. Provide fuse blocks touch safe with rated fuses for each VFD. All components must conform to the IP10 finger safe design to protect against accidental contact. All internal power wiring must be 90° C rated per UL508A. Size power wire in accordance with UL508A Table 28.1. Control panel must meet 10,000 SCCR Rating.

B. Control panel shall have additional dry contacts to allow output to BAS system.

C. Controls must meet ANSI/ASHRAE/IESNA Standard 90.1-2010 para 10.4.2.

D. Color Touchscreen Interface
   1. The touchscreen interface shall be flush mounted in the door of the control panel.
   2. The touchscreen shall have the following features:
      a. 320 x 240 resolution, 256 color, 3 MB memory, 5.7” screen size, 520 characters/screen, 300 touchpoints/screen
      b. Serial port (for PLC communication), USB port (for programming), and Compact Flash port (for troubleshooting and field-loading program changes)
   3. The following data shall be accessible through the operator interface:
      a. System status including current system pressure and setpoint, pump run status, the current speed of the pumps (in %), and the method of speed control. Display system status on all user screens.
      b. Usage history shall record, along with the date and time, overall and current day totalized flow, pump starts, and pump run hours are also recorded. Usage history may be reset.
      c. A Set Points Menu system for adjusting setpoints. Display and adjust pressure, differential pressure, VFD speed, power, minimum speed, lead pump shutdown mode, and tank pressurizer set points and time delays. Restore to either factory defaults or the last saved field defaults. Protect adjustable settings with a password.
      d. Alarm History of the past 200 alarms. Each log shall include individual pump run status, system pressure and run setpoint, alarm type and the date and time. Alarm Type shall be in plain English, not codes requiring a reference list.
      e. Alarm List of all possible alarms and their current status. Display any current alarms on all user screens.
      f. Startup instructions and checklist.
   4. The HMI shall include a method for transferring data:
      a. System information shall automatically copy to an installed compact flash drive every minute, plus an additional entry for each alarm condition.
      b. Include fault codes from the PLC and the VFD.
      c. Copy usage data to the drive daily.

d. Data shall be stored in a text file, readable by non-proprietary software.
e. HMI Software shall allow for program changes to the HMI and PLC to be transferred via the compact flash drive.

E. Programmable Logic Controller
1. A Mitsubishi PLC shall be installed on the control panel base pan, not the door, to protect it from damage. The PLC manufacturer shall be clearly marked on the controller, and non-proprietary. The PLC shall continue to function even if the touchscreen is broken, damaged, or removed. The PLC shall have the following features: 32,000 steps of built-in program memory, 7680 auxiliary relays, 320 timers, 235 counters, 8000 data registers, 24,000 extension registers, and 24,000 extension file registers
2. The PLC will control all pump starts and stops and indicate alarm conditions. The controller shall have the following features:
   a. Nonvolatile EEPROM memory to prevent program loss due to power failure.
   b. Program cartridge or loader which allows program changes to be made by the factory and sent to the field for simple loading by the operator.
   c. Input and output "on" status lights for ease of monitoring.
   d. Controller shall be designed for use in locations where electromagnetic noise, voltage spikes, 32 - 130o temperature, 35 - 85% humidity, and mechanical shock within the range certified by JIS 0912 exist.
3. The controller features both non adjustable and adjustable timers. The adjustable timers can be changed using the HMI. Status LEDs: The status of the PC can be determined by observing the LEDs on the face of the PC. Key LED displays are as follows; a.) POWER, b.) RUN, c.) PROG E / CPU E, d.) IN / OUT.
4. Program Changes: The system manufacturer will do all programming for the PLC. Every phase of the program will have been tested with the entire machine at the factory. Factory-trained personnel make final adjustments at start up. If a program change is required, it will be made by the system manufacturer and transmitted to the field via a program loader or chip. The system manufacturer shall keep a copy of the program at the factory so that any changes can be made and transmitted immediately.
5. Maintenance: The PLC shall require no routine maintenance. The program is stored on an EEPROM chip so that it will not be lost due to loss of power no matter how long the power is off.
6. Operator Controls
   a. Pump Selector Switch shall be provided on the HMI. The touchscreen switch shall have following positions
      1) HAND: Use for manual operation only to start up, restart and reset or test each pump. No pump should run in this position without supervision.
      2) OFF: Pump will not run at all. Use during start up, restart and reset, or when a pump is down for service.
      3) AUTO: Automatic position for each pump, which allows the controller to have full control over the pumps operation.
7. Alarms
   a. Several of the alarms described below feature adjustable set points. These can be adjusted using the HMI. Each of the alarms described

below, except as noted, will activate the alarm horn, illuminate the alarm condition light and post an alarm message on the HMI.

b. Low Suction Pressure \ Level Alarm: The low suction device (pressure switch, pressure transmitter, or level switch) signals a loss of supply water pressure for 5 seconds (default), all pumps will be locked off. This alarm is disabled in the event of a suction pressure transmitter failure. This alarm requires manual resetting.

c. Low System Pressure Alarm: If system pressure drops to or below the low system pressure set point for 30 seconds (default), this alarm will activate. System performance will not be affected by this alarm. It is used to alert the operator that a problem occurred. This alarm will be disabled in the event of a system pressure transmitter failure. The alarm requires manual resetting.

d. Pressure Transmitter Out of Range Alarms: The correct output range of the pressure transmitter(s) is 1 6 kHz. The pressure transmitter failed low alarm will activate if the controller receives an abnormally low signal for 2 seconds. The pressure transmitter failed high alarm will activate if the controller receives an abnormally high signal for 8 seconds. The system will run at the manual speed set point if the system pressure transmitter fails.

e. Individual Drive Fault Alarms: If a fault occurs in the drive when it is being called to run, the VFD failure alarm will be activated. This alarm will stop the pump with the failed drive and start the next available pump if it is not currently running. The alarm requires manual resetting with the alarm silence / reset push button.

f. Irregular Power Alarm (optional): If a power monitor is included with this system, it will protect the system from an abnormal main power condition. If irregular power is sensed, the system will shut down all motors until normal power has been restored for 10 seconds.

g. Alarm Combinations: If multiple alarms occur, the controller will indicate all alarm conditions by continually scrolling them on the HMI. The alarm silence/ reset push button can be pressed to stop the scrolling.

h. Resetting Alarms: Each of the alarms (except Pressure Transmitter Out of Range and Irregular Power) requires manual resetting before returning to normal automatic operation. This ensures proper troubleshooting problem solving, and a smooth return to normal automatic operation by the operator. Before resetting an alarm, the alarm horn must first be silenced by pressing the alarm silence / reset push button. Five seconds after silencing the alarm horn, the system can be reset (provided the original reason for the alarm has been corrected).

i. Event History: This feature displays the last 200 events that have occurred on the system with record 0 being the most recent. An event is when any alarm occurs or the operator attempts to reset an alarm with the alarm reset push button. For each event record, the following information is provided:

1) Event Code (see Appendix 2 for listing)
2) Date
3) Time
4) System Flow Rate (gpm)

5) System Pressure (psig)
6) System Pressure Set Point (psig)
7) Pumps Running Status (0, 1,2,3 if three pump system)

8. Protection Devices
   a. Operator Safety: The enclosure features door interlocking motor disconnecting devices (motor starter protectors, fused disconnect switches, or circuit breakers). These prevent the opening of the panel while the motors are running.
   b. Motor Protection: Each motor will be protected against overload and short circuit current by one of the following devices:
      1) Circuit Breakers/Fuse blocks:
         a) If a circuit breaker should trip due to over current, the handle will turn to the "TRIP" position. Turn the handle to the "OFF" position and then back to "ON".
         b) If a fuse block should trip due to over current, replace the fuse then turn the handle to the "OFF" position and then back to "ON".
      2) Control Circuit Protection: The control power transformer is sized according to the consumption of power of the controls.
      3) Pump Over Temperature Protection: Each pump is fitted with a mechanical temperature purge valve. If the water in a pump becomes too hot (at low flow), the valve will open. The hot water is then dumped to drain, allowing cool water to enter the pump from the suction side. Once the pump is cool again, the temperature purge valve will close.
9. Remote Indication
   a. Discrete Outputs: Indication of the low system pressure alarm, the low suction pressure/ level alarm, and if a pump is disabled is provided.
10. Emergency Alarms and Control
   a. Automatic alarm sequencing shall include the following features:
      1) Sequence shifting that adjusts the pump sequence when any pump is disabled.
      2) Each pump shall have a temperature relief valve.
      3) Sequencing to reduce hydraulic or electric surges after power restoration or alarm reset.
   b. All pumps shall stop and require manual reset in the event of high system pressure, or low suction pressure alarm conditions. Low system pressure alarm requires manual reset.

2.3 PUMP SYSTEM SEQUENCING AND OPERATION

A. The lead pump will start on a low system pressure condition. The lead pump shall run continuously if selected by the operator. The lag pump(s) will sequence based on a combination of system pressure, high lead pump speed, and power usage. This combination of parameters will ensure the starting of the lag pumps as the running pump(s) come to full capacity. System pressure is continuously maintained by adjusting the speed of the pump(s).

B. Pump Sequencing
   1. Automatic sequencing shall include the following features:

a. Power sequencing, programmable in horsepower not Watts
b. Pressure sequencing .
c. End-of-curve protection, based on pump differential, with 2% accuracy
d. VFD speed sequencing
e. Lead pump shutdown feature that can be enabled or disabled by the operator
f. Low-flow test feature testing pressure, power, VFD speed, and flow (if equipped with flow sensor), to reduce pump short-cycling, pressure swings, power surges, and motor wear.
g. Tank pressurization sequence to increase the energy stored in the tank prior to shutdown
h. Time clock to disable lead-pump shutdown during building occupancy.
i. Sequence shifting that adjusts the pump sequence when any pump is disabled
j. Successive and 24 hour alternation of equal capacity pumps
k. Pump overlap during 24-hour alternation
l. Lag pump exerciser function
m. Special sequencing to reduce surges during power restoration
n. Sequential sequencing of lag pumps
o. Minimum run and stop delay timer for each pump
p. Field adjustable time delay for lag pump pressure start signals
q. Field adjustable low suction pressure alarm
r. Field adjustable selection to enable / disable limited auto reset of low suction and high system pressure alarms

2. The controller continuously monitors the system pressure with the system pressure transmitter and power from the VFD. In automatic operation, the controller will signal the appropriate pump(s) to start or stop based upon the sequencing. It should be noted that all pumps follow the same speed control signal produced by the controller. Upon starting, the pumps will slowly ramp up to the appropriate speed. Once this startup sequence is complete, the pumps will always run at whatever speed is required to maintain the set point pressure. All pumps are protected by minimum run timers to prevent unnecessary cycling. The pumps will stop in the reverse order from which they started

C. Automatic PID Speed Control

1. In this mode, the booster system will automatically maintain desired system pressure. The controller compares the system pressure measurement from the system pressure transmitter (process variable PV) and the system pressure set point (SP). A proportional, integral and derivative (PID) algorithm will send the appropriate signal to the VFDs to maintain system pressure. As the pressure in the pipe decreases, the pump speed will increase until the pressure is returned to its set point value. If the pressure begins to rise above the set point, the pump speed will decrease until the set point is reached.
2. All of the PID tuning constants are adjustable through the HMI. Proper settings ensure accurate and timely system response without overshoot or hunting. Minimum and maximum values set through the HMI determine the minimum and maximum speed limits so that the pumps are never operated above or below certain speeds.

D. Manual Speed Control
   1. If the system pressure transmitter fails or the operator chooses, the controller will output a constant speed value to the drive, which can be adjusted by the operator using the HMI.

2.4 SUCTION STRAINER

A. The Installing contractor shall install a 4” CLA-VAL model X43H strainer on the suction side of the pump package. The strainer’s body and cover shall be ductile iron ANSI B16.62 with fusion bonded epoxy coating; the screen shall be 316 stainless steel and include a drain connection with plug. It shall have ANSI class 150 flanges and rated for 250 psi. Two coats of a two part, semi gloss, acrylic, aliphatic, urethane, enamel finish shall be applied to a dry-film thickness of not less than 4 mils.

2.5 PAINT & FINISH

A. The entire station, with the exception of the control panel, base plate and the motors, shall be painted as follows. The station shall be cleaned and painted with a multipart coating system with a total dry-film thickness of not less than 6 mils. One coat of modified alkyd, rust inhibiting, industrial enamel primer shall be applied to a dry film thickness of not less than 2 mils.

PART 3 - EXECUTION

3.1 COMPLETION

A. Installation
   1. The contractor shall install the system in accordance with the manufacturer's recommendations.
      a. Include a floor drain sized according to local code. Drain shall provide emergency drainage to prevent building damage in the event of seal failure, over- temperature, or tank discharge.
      b. Install pump system on a concrete pad at least 4" tall.
      c. Anchor pump system in accordance with system manufacturer's recommendations.
      d. Pipe temperature relief valve discharge to drain
      e. Install isolation valves on each header.
      f. Pipe pumping system bypass line with isolation valve.
      g. All field anchoring, piping, and wiring shall comply with local codes.

END OF SECTION

SECTION 22 13 16

SANITARY WASTE, VENT PIPING AND STORM DRAINAGE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following for soil, waste, and vent piping inside the building:
   1. Pipe, tube, and fittings.
   2. Special pipe fittings.
   3. Encasement for underground metal piping.

B. Related Sections include the following:
   1. Division 22 Section "Chemical Waste Systems for Laboratory and Healthcare Facilities" for chemical-waste and vent piping systems.

1.3 DEFINITIONS

A. ABS: Acrylonitrile-butadiene-styrene plastic.

B. EPDM: Ethylene-propylene-diene terpolymer rubber.

C. LLDPE: Linear, low-density polyethylene plastic.

D. NBR: Acrylonitrile-butadiene rubber.

E. PE: Polyethylene plastic.

F. PVC: Polyvinyl chloride plastic.

G. TPE: Thermoplastic elastomer.

1.4 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.
   2. Sanitary Sewer, Force-Main Piping: 50 psig .

B. Seismic Performance: Soil, waste, and vent piping and support and installation shall be capable of withstanding the effects of seismic events determined according to ASCE 7, "Minimum Design Loads for Buildings and Other Structures."

1.5 SUBMITTALS

A. Product Data: For pipe, tube, fittings, and couplings.

B. Shop Drawings:
   1. Design Calculations: Signed and sealed by a qualified professional engineer for selecting seismic restraints.
   2. Sovent Drainage System: Include plans, elevations, sections, and details.

C. Field quality-control inspection and test reports.

1.6 QUALITY ASSURANCE

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

B. Comply with NSF 14, "Plastics Piping Systems Components and Related Materials," for plastic piping components. Include marking with "NSF-dwv" for plastic drain, waste, and vent piping; "NSF-drain" for plastic drain piping; "NSF-tubular" for plastic continuous waste piping; and "NSF-sewer" for plastic sewer piping.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

2.2 PIPING MATERIALS

A. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.

2.3 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.

C. Calking Materials: ASTM B 29, pure lead and oakum or hemp fiber.

2.4 HUBLESS CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 888 or CISPI 301.

B. Sovent Stack Fittings: ASME B16.45 or ASSE 1043, hubless, cast-iron aerator and deaerator drainage fittings.

C. Shielded Couplings: ASTM C 1277 assembly of metal shield or housing, corrosion-resistant fasteners, and rubber sleeve with integral, center pipe stop.
   1. Heavy-Duty, Shielded, Stainless-Steel Couplings: With stainless-steel shield, stainless-steel bands and tightening devices, and ASTM C 564, rubber sleeve.

a. Manufacturers:
   1) ANACO.
   2) Clamp-All Corp.
   3) Tyler Pipe; Soil Pipe Div.

2.5 STEEL PIPE AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, Type E or S, Grade A or B, Standard Weight or Schedule 40, galvanized. Include ends matching joining method.

B. Drainage Fittings: ASME B16.12, galvanized, threaded, cast-iron drainage pattern.

C. Pressure Fittings:
   1. Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M or ASTM A 106, Schedule 40, galvanized, seamless steel pipe. Include ends matching joining method.
   2. Malleable-Iron Unions: ASME B16.39; Class 150; hexagonal-stock body with ball-and-socket, metal-to-metal, bronze seating surface; and female threaded ends.
   3. Gray-Iron, Threaded Fittings: ASME B16.4, Class 125, galvanized, standard pattern.
   4. Cast-Iron Flanges: ASME B16.1, Class 125.
   5. Cast-Iron, Flanged Fittings: ASME B16.1, Class 125, galvanized.

D. Grooved-Joint Systems:
   1. Manufacturers:
      a. Anvil International.
      b. Star Pipe Products; Star Fittings Div.
      c. Victaulic Company.
      d. Ward Manufacturing, Inc.
   2. Grooved-End, Steel-Piping Fittings: ASTM A 47/A 47M, galvanized, malleable-iron casting; ASTM A 106, galvanized-steel pipe; or ASTM A 536, galvanized, ductile-iron casting; with dimensions matching steel pipe.
   3. Grooved-End, Steel-Piping Couplings: AWWA C606, for steel-pipe dimensions. Include ferrous housing sections, gasket suitable for water, and bolts and nuts.

2.6 COPPER TUBE AND FITTINGS

A. Copper DWV Tube: ASTM B 306, drainage tube, drawn temper.
   1. Copper Drainage Fittings: ASME B16.23, cast copper or ASME B16.29, wrought copper, solder-joint fittings.

B. Hard Copper Tube: ASTM B 88, Types L and M, water tube, drawn temper.
   1. Copper Pressure Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint fittings. Furnish wrought-copper fittings if indicated.
   2. Copper Flanges: ASME B16.24, Class 150, cast copper with solder-joint end.
   3. 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.

2.7 SPECIAL PIPE FITTINGS

A. Flexible, Nonpressure Pipe Couplings: Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition pattern. Include shear ring, ends of same sizes as piping to be joined, and corrosion-resistant-metal tension band and tightening mechanism on each end.
   1. Manufacturers:
      a. Fernco, Inc.
      b. Mission Rubber Co.
      c. Plastic Oddities, Inc.
   2. Sleeve Materials:
      a. For Cast-Iron Soil Pipes: ASTM C 564, rubber.
      b. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
      c. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

B. Shielded Nonpressure Pipe Couplings: ASTM C 1460, elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.
   1. Manufacturers:
      a. Mission Rubber Co.

C. Rigid, Unshielded, Nonpressure Pipe Couplings: ASTM C 1461, sleeve-type reducing- or transition-type mechanical coupling molded from ASTM C 1440, TPE material with corrosion-resistant-metal tension band and tightening mechanism on each end.
   1. Manufacturers:
      a. ANACO.

D. Pressure Pipe Couplings: AWWA C219 metal, sleeve-type same size as, with pressure rating at least equal to, and ends compatible with, pipes to be joined.
   1. Manufacturers:
      a. Dresser, Inc.; DMD Div.
      b. EBAA Iron Sales, Inc.
      c. Romac Industries, Inc.
   2. Center-Sleeve Material: Ductile iron.
   3. Gasket Material: Natural or synthetic rubber.
   4. Metal Component Finish: Corrosion-resistant coating or material.

E. Flexible Ball Joints: Ductile-iron fitting with combination of flanged and mechanical-joint ends complying with AWWA C110 or AWWA C153. Include gasketed ball-joint section and ductile-iron gland, rubber gasket, and steel bolts.
   1. Manufacturers:
      a. EBAA Iron Sales, Inc.

F. Expansion Joints: Two or three-piece, ductile-iron assembly consisting of telescoping sleeve(s) with gaskets and restrained-type, ductile-iron, bell-and-spigot end sections complying with AWWA C110 or AWWA C153. Select and assemble components for expansion indicated. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts.
   1. Manufacturers:
      a. EBAA Iron Sales, Inc.
      b. Romac Industries, Inc.

2.8 ENCASEMENT FOR UNDERGROUND METAL PIPING

A. Description: ASTM A 674 or AWWA C105, high-density, crosslaminated PE film of 0.004-inch minimum thickness.

B. Form: tube.

C. Color: Black.

PART 3 - EXECUTION

3.1 EXCAVATION

A. Refer to Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.

3.2 PIPING APPLICATIONS

A. Flanges and unions may be used on aboveground pressure piping, unless otherwise indicated.

B. Aboveground, soil and waste piping NPS 4 and smaller shall be 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 shielded, stainless-steel couplings; and hubless-coupling joints.
   3. Copper DWV tube, copper drainage fittings, and soldered joints.
   4. Dissimilar Pipe-Material Couplings: Flexible nonpressure pipe couplings for joining dissimilar pipe materials with small difference in OD.

C. Aboveground, soil and waste piping NPS 5 and larger shall be the following:
   1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.
   2. Hubless cast-iron soil pipe and fittings; shielded, stainless-steel couplings; and hubless-coupling joints.
   3. Dissimilar Pipe-Material Couplings: Flexible, nonpressure pipe couplings for joining dissimilar pipe materials with small difference in OD.

D. Aboveground, vent piping NPS 4 and smaller shall be 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 shielded, stainless-steel couplings; and hubless-coupling joints.
   3. Stainless-steel pipe and fittings gaskets, and gasketed joints.
   4. Copper DWV tube, copper drainage fittings, and soldered joints.
      a. Option for Vent Piping, NPS 2-1/2 and NPS 3-1/2: Hard copper tube, Type M; copper pressure fittings; and soldered joints.
   5. Dissimilar Pipe-Material Couplings: Flexible, nonpressure pipe couplings for joining dissimilar pipe materials with small difference in OD.

E. Aboveground, vent piping NPS 5 and larger shall be 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 shielded, stainless-steel couplings; and hubless-coupling joints.
   3. Dissimilar Pipe-Material Couplings: Flexible, nonpressure pipe couplings for joining dissimilar pipe materials with small difference in OD.

F. Underground, soil, waste, and vent piping NPS 4 and smaller shall be the following:
   1. Extra-Heavy Service class, cast-iron soil piping; gaskets; and gasketed joints.
   2. Stainless-steel pipe and fittings, gaskets, and gasketed joints.
   3. Dissimilar Pipe-Material Couplings: Flexible, nonpressure pipe couplings for joining dissimilar pipe materials with small difference in OD.

G. Underground, soil and waste piping NPS 5 and larger shall be the following:
   1. Extra-Heavy Service class, cast-iron soil piping; gaskets; and gasketed joints.
   2. Dissimilar Pipe-Material Couplings: Flexible, nonpressure pipe couplings for joining dissimilar pipe materials with small difference in OD.

3.3 PIPING INSTALLATION

A. Sanitary sewer piping outside the building is specified in Division 22 Section "Facility Sanitary Sewers."

B. Basic piping installation requirements are specified in Division 22 Section "Common Work Results for Plumbing."

C. Install seismic restraints on piping. Seismic-restraint devices are specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."

D. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers.

E. Install cleanout fitting with closure plug inside the building in sanitary force-main piping.

F. Install underground, ductile-iron, force-main piping according to AWWA C600. Install buried piping inside the building between wall and floor penetrations and connection to sanitary sewer piping outside the building with restrained joints. Anchor pipe to wall or floor. Install thrust-block supports at vertical and horizontal offsets.
   1. Install encasement on piping according to ASTM A 674 or AWWA C105.

G. Install underground, ductile-iron, special pipe fittings according to AWWA C600.
   1. Install encasement on piping according to ASTM A 674 or AWWA C105.

H. Install cast-iron sleeve with water stop and mechanical sleeve seal at each service pipe penetration through foundation wall. Select number of interlocking rubber links required to make installation watertight. Sleeves and mechanical sleeve seals are specified in Division 22 Section "Common Work Results for Plumbing."

I. Install wall-penetration fitting at each service pipe penetration through foundation wall. Make installation watertight.

J. 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.

K. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if 2 fixtures are installed back to back or side by side with common drain pipe.

Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

L. 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.

M. 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; 1 percent downward in direction of flow for piping NPS 4 and larger.
   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.

N. Sleeves are not required for cast-iron soil piping passing through concrete slabs-on-grade if slab is without membrane waterproofing.

O. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

3.4 JOINT CONSTRUCTION

A. Basic piping joint construction requirements are specified in Division 22 Section "Common Work Results for Plumbing."

B. 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.

C. Join hubless cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-coupling joints.

D. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated.

E. Grooved Joints: Assemble joint with keyed coupling, gasket, lubricant, and bolts according to coupling and fitting manufacturer's written instructions.

3.5 VALVE INSTALLATION

A. General valve installation requirements are specified in Division 22 Section "General-Duty Valves for Plumbing Piping."

B. Shutoff Valves: Install shutoff valve on each sewage pump discharge.
   1. Install gate or full-port ball valve for piping NPS 2 and smaller.
   2. Install gate valve for piping NPS 2-1/2 and larger.

C. Check Valves: Install swing check valve, between pump and shutoff valve, on each sewage pump discharge.

D. Backwater Valves: Install backwater valves in piping subject to sewage backflow.
   1. Horizontal Piping: Horizontal backwater valves. Use normally closed type, unless otherwise indicated.

2. Floor Drains: Drain outlet backwater valves, unless drain has integral backwater valve.
3. Install backwater valves in accessible locations.
4. Backwater valve are specified in Division 22 Section "Sanitary Waste Piping Specialties."

3.6 HANGER AND SUPPORT INSTALLATION

A. Seismic-restraint devices are specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."

B. Pipe hangers and supports are specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment." Install the following:
   1. Vertical Piping: MSS Type 8 or Type 42, clamps.
   2. Install individual, straight, horizontal piping runs according to the following:
      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. Install supports according to Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."

D. Support vertical piping and tubing at base and at each floor.

E. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.

F. 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: 60 inches with 3/4-inch rod.
   5. NPS 8 to NPS 12: 60 inches with 7/8-inch rod.

G. Install supports for vertical cast-iron soil piping every 15 feet.

H. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 1-1/4: 84 inches with 3/8-inch rod.
   2. NPS 1-1/2: 108 inches with 3/8-inch rod.
   3. NPS 2: 10 feet with 3/8-inch rod.
   4. NPS 2-1/2: 11 feet with 1/2-inch rod.
   5. NPS 3: 12 feet with 1/2-inch rod.
   6. NPS 4 and NPS 5: 12 feet with 5/8-inch rod.
   7. NPS 6: 12 feet with 3/4-inch rod.
   8. NPS 8 to NPS 12: 12 feet with 7/8-inch rod.

I. Install supports for vertical steel piping every 15 feet.

J. 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 to 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.

K. Install supports for vertical copper tubing every 10 feet.

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. 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. Connect force-main piping to the following:
1. Sanitary Sewer: To exterior force main or sanitary manhole.
2. Sewage Pumps: To sewage pump discharge.

3.8 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. Reinspection: 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.

3.9 CLEANING

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

END OF SECTION

SECTION 22 13 19

SANITARY WASTE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following sanitary drainage piping specialties:
   1. Cleanouts.
   2. Floor drains.
   3. Trench drains.
   4. Air-admittance valves.
   5. Roof flashing assemblies.
   6. Through-penetration firestop assemblies.
   7. Miscellaneous sanitary drainage piping specialties.
   8. Flashing materials.
   9. Solids interceptors.

B. Related Sections include the following:
   1. Division 22 Section "Storm Drainage Piping Specialties" for trench drains for storm water, channel drainage systems for storm water, roof drains, and catch basins.
   2. Division 22 Section "Plumbing Fixtures" for hair interceptors.

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 SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and accessories for the following:
   1. Solids Interceptions

B. Shop Drawings: Show fabrication and installation details for frost-resistant vent terminals.
   1. Wiring Diagrams: Power, signal, and control wiring.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For drainage piping specialties to include in emergency, operation, and maintenance manuals.

1.5 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.

1.6 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

B. Coordinate size and location of roof penetrations.

PART 2 - PRODUCTS

2.1 CLEANOUTS

A. Exposed Metal Cleanouts:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Josam Company; Josam Div.
      b. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
      c. Tyler Pipe; Wade Div.
      d. Zurn Plumbing Products Group; Specification Drainage Operation.
   2. Standard: ASME A112.36.2M for cast iron ASME A112.3.1 for stainless steel for cleanout test tee.
   3. Size: Same as connected drainage piping
   4. Body Material: Hub-and-spigot, cast-iron soil pipe T-branch and Hubless, cast-iron soil pipe test tee as required to match connected piping.
   5. Closure: Countersunk, brass cast-iron plastic 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. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Josam Company; Josam Div.
      b. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.

c. Tyler Pipe; Wade Div.
d. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Standard: ASME A112.36.2M for adjustable housing heavy-duty, adjustable housing cleanout.
3. Size: Same as connected branch.
4. Type: Adjustable housing Heavy-duty, adjustable housing.
5. Body or Ferrule: Cast iron .
6. Clamping Device: Required.
7. Outlet Connection: Threaded.
8. Closure: Brass plug with straight threads and gasket.
9. Adjustable Housing Material: Cast iron with threads.
10. Frame and Cover Material and Finish: Nickel-bronze, copper alloy .
11. Frame and Cover Shape: Round Square.
12. Top Loading Classification: Extra Heavy Duty.
13. Riser: ASTM A 74, Service class, cast-iron drainage pipe fitting and riser to cleanout.
14. Standard: ASME A112.3.1.
15. Size: Same as connected branch.
16. Housing: Stainless steel.
17. Closure: Stainless steel with seal.
18. Riser: Stainless-steel drainage pipe fitting to cleanout.

C. Cast-Iron Wall Cleanouts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Josam Company; Josam Div.
   b. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
   c. Tyler Pipe; Wade Div.
   d. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASME A112.36.2M. Include wall access.
3. Size: Same as connected drainage piping.
4. Body: Hub-and-spigot, cast-iron soil pipe T-branch and Hubless, cast-iron soil pipe test tee as required to match connected piping.
5. Closure: Countersunk, brass cast-iron plug.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
7. Wall Access: Round, flat, chrome-plated brass or stainless-steel cover plate with screw.
8. Wall Access: Round wall-installation frame and cover.

2.2 FLOOR DRAINS

A. Cast-Iron Floor Drains:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Josam Company; Josam Div.
   b. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
   c. Tyler Pipe; Wade Div.
   d. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Drains shall be as scheduled on the plans.

2.3 TRENCH DRAINS

A. Trench Drains:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Josam Company; Josam Div.
      b. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
      c. Tyler Pipe; Wade Div.
      d. Zurn Plumbing Products Group; Specification Drainage Operation.
   2. Drains shall be as scheduled on the plans..

2.4 ROOF FLASHING ASSEMBLIES

A. Roof Flashing Assemblies:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Acorn Engineering Company; Elmdor/Stoneman Div.
      b. Thaler Metal Industries Ltd.

B. Description: Manufactured assembly made of 6.0-lb/sq. ft. (30-kg/sq. m), 0.0938-inch- (2.4-mm-) thick, lead flashing collar and skirt extending at least 10 inches (250 mm) from pipe, with galvanized-steel boot reinforcement and counterflashing fitting.
   1. Open-Top Vent Cap: Without cap.
   2. Low-Silhouette Vent Cap: With vandal-proof vent cap.
   3. Extended Vent Cap: With field-installed, vandal-proof vent cap.

2.5 THROUGH-PENETRATION FIRESTOP ASSEMBLIES

A. Through-Penetration Firestop Assemblies:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. ProSet Systems Inc.
   2. Standard: UL 1479 assembly of sleeve and stack fitting with firestopping plug.
   3. Size: Same as connected soil, waste, or vent stack.
   4. 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.
   5. 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.
   6. Special Coating: Corrosion resistant on interior of fittings.

2.6 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

A. Open End Drains:
   1. Description: Shop or field fabricate from ASTM A 74, Service class, hub-and-spigot, cast-iron, soil-pipe fittings. Include P-trap, hub-and-spigot riser section; and where required, increaser fitting joined with ASTM C 564, rubber gaskets.
   2. Size: Same as connected waste piping with increaser fitting of size indicated.

B. 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 (DN 50): 4-inch- (100-mm-) minimum water seal.
   b. NPS 2-1/2 (DN 65) and Larger: 5-inch- (125-mm-) minimum water seal.

C. Floor-Drain, Trap-Seal Primer Fittings:
1. Description: Cast iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
2. Size: Same as floor drain outlet with NPS 1/2 (DN 15) side inlet.

D. Air-Gap Fittings:
1. Standard: ASME A112.1.2, for fitting designed to ensure fixed, positive air gap between installed inlet and outlet piping.
2. Body: Bronze or cast iron.
3. Inlet: Opening in top of body.
4. Outlet: Larger than inlet.
5. Size: Same as connected waste piping and with inlet large enough for associated indirect waste piping.

E. Sleeve Flashing Device:
1. Description: Manufactured, cast-iron fitting, with clamping device, that forms sleeve for pipe floor penetrations of floor membrane. Include galvanized-steel pipe extension in top of fitting that will extend 2 inches (51 mm) above finished floor and galvanized-steel pipe extension in bottom of fitting that will extend through floor slab.
2. Size: As required for close fit to riser or stack piping.

F. Stack Flashing Fittings:
1. Description: Counterflashing-type, cast-iron fitting, with bottom recess for terminating roof membrane, and with threaded or hub top for extending vent pipe.
2. Size: Same as connected stack vent or vent stack.

G. Vent Caps:
1. Description: Cast-iron body with threaded or hub inlet and vandal-proof design. Include vented hood and setscrews to secure to vent pipe.
2. Size: Same as connected stack vent or vent stack.

H. Frost-Resistant Vent Terminals:
1. Description: Manufactured or shop-fabricated assembly constructed of copper, lead-coated copper, or galvanized steel.
2. Design: To provide 1-inch (25-mm) enclosed air space between outside of pipe and inside of flashing collar extension, with counterflashing.

I. Expansion Joints:
1. Standard: ASME A112.21.2M.
2. Body: Cast iron with bronze sleeve, packing, and gland.
3. End Connections: Matching connected piping.
4. Size: Same as connected soil, waste, or vent piping.

2.7 FLASHING MATERIALS

A. Lead Sheet: ASTM B 749, Type L51121, copper bearing, with the following minimum weights and thicknesses, unless otherwise indicated:

1. General Use: 4.0-lb/sq. ft. (20-kg/sq. m), 0.0625-inch (1.6-mm) thickness.
2. Vent Pipe Flashing: 3.0-lb/sq. ft. (15-kg/sq. m), 0.0469-inch (1.2-mm) thickness.
3. Burning: 6-lb/sq. ft. (30-kg/sq. m), 0.0938-inch (2.4-mm) thickness.

B. Copper Sheet: ASTM B 152/B 152M, of the following minimum weights and thicknesses, unless otherwise indicated:
1. General Applications: 12 oz./sq. ft. (3.7 kg/sq. m or 0.41-mm thickness).
2. Vent Pipe Flashing: 8 oz./sq. ft. (2.5 kg/sq. m or 0.27-mm thickness).

C. Zinc-Coated Steel Sheet: ASTM A 653/A 653M, with 0.20 percent copper content and 0.04-inch (1.01-mm) minimum thickness, unless otherwise indicated. Include G90 (Z275) hot-dip galvanized, mill-phosphatized finish for painting if indicated.

D. Elastic Membrane Sheet: ASTM D 4068, flexible, chlorinated polyethylene, 40-mil (1.01-mm) minimum thickness.

E. Fasteners: Metal compatible with material and substrate being fastened.

F. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.

G. Solder: ASTM B 32, lead-free alloy.

H. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic.

2.8 SOLIDS INTERCEPTORS

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Josam Company; Josam Div.
   b. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
   c. Tyler Pipe; Wade Div.
   d. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Type: Factory-fabricated interceptor made for removing and retaining plaster from wastewater.
3. Body Material: Cast iron or steel.
4. Interior Separation Device: Screens.
5. Interior Lining: Corrosion-resistant enamel.
6. Exterior Coating: Corrosion-resistant enamel.
7. Body Dimensions: Per Mfg.
8. Flow Rate: Not required.
9. Inlet and Outlet Size: 2″.
10. End Connections: Threaded.
11. Mounting: Inline.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Refer to Division 22 Section "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.

B. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
   1. Size same as drainage piping up to NPS 4 (DN 100). Use NPS 4 (DN 100) for larger drainage piping unless larger cleanout is indicated.
   2. Locate at each change in direction of piping greater than 45 degrees.
   3. Locate at minimum intervals of 50 feet (15 m) for piping NPS 4 (DN 100) and smaller and 100 feet (30 m) for larger piping.
   4. Locate at base of each vertical soil and waste stack.

C. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.

D. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.

E. 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 (750 mm) or Less: Equivalent to 1 percent slope, but not less than 1/4-inch (6.35-mm) total depression.
      b. Radius, 30 to 60 Inches (750 to 1500 mm): Equivalent to 1 percent slope.
      c. Radius, 60 Inches (1500 mm) or Larger: Equivalent to 1 percent slope, but not greater than 1-inch (25-mm) 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.

F. Install trench drains at low points of surface areas to be drained. Set grates of drains flush with finished surface, unless otherwise indicated.

G. Install fixture air-admittance valves on fixture drain piping.

H. Install stack air-admittance valves at top of stack vent and vent stack piping.

I. Install air-admittance-valve wall boxes recessed in wall.

J. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof.

K. Install flashing fittings on sanitary stack vents and vent stacks that extend through roof.

L. Install through-penetration firestop assemblies in plastic stacks at floor penetrations.

M. Assemble open drain fittings and install with top of hub 2 inches (51 mm) above floor.

N. Install deep-seal traps on floor drains and other waste outlets, if indicated.

O. 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.

P. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.

Q. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.

R. Install vent caps on each vent pipe passing through roof.

S. Install frost-resistant vent terminals on each vent pipe passing through roof. Maintain 1-inch (25-mm) clearance between vent pipe and roof substrate.

T. Install expansion joints on vertical stacks and conductors. Position expansion joints for easy access and maintenance.

U. Install frost-proof vent caps on each vent pipe passing through roof. Maintain 1-inch (25-mm) clearance between vent pipe and roof substrate.

V. Install solids interceptors with cleanout immediately downstream from interceptors that do not have integral cleanout on outlet. Install trap on interceptors that do not have integral trap and are connected to sanitary drainage and vent systems.

W. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

X. Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding pipe fittings.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment to allow service and maintenance.

3.3 FLASHING INSTALLATION

A. Fabricate flashing from single piece unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:
   1. Lead Sheets: Burn joints of lead sheets 6.0-lb/sq. ft. (30-kg/sq. m), 0.0938-inch (2.4-mm) thickness or thicker. Solder joints of lead sheets 4.0-lb/sq. ft. (20-kg/sq. m), 0.0625-inch (1.6-mm) thickness or thinner.
   2. Copper Sheets: Solder joints of copper sheets.

B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.
   1. Pipe Flashing: Sleeve type, matching pipe size, with minimum length of 10 inches (250 mm), and skirt or flange extending at least 8 inches (200 mm) around pipe.
   2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches (200 mm) around sleeve.
   3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches (200 mm) around specialty.

C. Set flashing on floors and roofs in solid coating of bituminous cement.

D. Secure flashing into sleeve and specialty clamping ring or device.

E. Install flashing for piping passing through roofs with counterflashing or commercially made flashing fittings, according to Division 07 Section "Sheet Metal Flashing and Trim."

F. Extend flashing up vent pipe passing through roofs and turn down into pipe, or secure flashing into cast-iron sleeve having calking recess.

G. Fabricate and install flashing and pans, sumps, and other drainage shapes.

3.4 LABELING AND IDENTIFYING

A. Equipment Nameplates and Signs: Install engraved plastic-laminate equipment nameplate or sign on or near each of the following:
   1. Solids interceptors.

B. Distinguish among multiple units, inform operator of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations, in addition to identifying unit. Nameplates and signs are specified in Division 22 Section "Identification for Plumbing Piping and Equipment."

3.5 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

This page is intentionally left blank.

SECTION 22 13 29

SANITARY SEWERAGE PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following sewage pumps and accessories for sanitary drainage piping systems in buildings:
   1. Submersible sewage pumps.

B. Related Sections include the following:
   1. Division 22 Section "Sump Pumps" for applications in storm-drainage systems.

1.3 SUBMITTALS

A. Product Data: For each type and size of sewage pump specified. Include certified performance curves with operating points plotted on curves; and rated capacities of selected models, furnished specialties, and accessories.

B. Shop Drawings: Diagram power, signal, and control wiring.

C. Operation and Maintenance Data: For each sewage pump to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of sewage pumps and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Retain shipping flange protective covers and protective coatings during storage.

B. Protect bearings and couplings against damage.

C. Comply with pump manufacturer's written rigging instructions for handling.

1.6 COORDINATION

A. Coordinate size and location of concrete pits. Concrete, reinforcement, and formwork requirements are specified in Division 03.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

2.2 SUBMERSIBLE SEWAGE EJECTOR PUMPS (SE-B-1)

A. Manufacturers:
   1. Weil Pump Company, Inc.
   2. Weinman Div.; Crane Pumps & Systems.
   3. Yeomans Chicago Corporation.

B. Description: FURNISH WHERE SHOWN ON PLANS WEIL Pump Co. DUPLEX 23" submersible SLICER pump set.

C. Pumps shall be WEIL Series 2500 Model 2536 submersible SLICER PUMPS. Each pump shall be rated to provide 250 GPM @ 25' TDH. Pumps to have 300 series stainless steel shafts, cast iron impellers, stainless steel slicing blades and 25' power cables.

D. Pump motors shall be submersible and not less than 7.5 hp 3 phase, 60 HZ, 480 Volt and 1750 RPM.

E. Motor(s) shall be housed in watertight cast iron shell with extended cooling fins. Oil filled motors will not be considered equal. Motor(s) shall have Class 'F' insulation and permanently lubricated double seal ball bearings. Motor(s) using sleeve type bearing will not be considered equal. Mating surfaces between the motor and bell, motor shell and seal housing shall be sealed by means of 'O' rings. The motor shaft shall be Series 300 stainless steel with keyway for positive positioning of the impeller. Carbon steel and 400 series stainless steel shafts are not considered equal.

F. Impeller shall be multi-vane, semi-open type and accurately machined to the proper diameter. All impellers are to be trimmed to suit job conditions and then dynamically balanced.

G. 4 –Suspended mechanical type float switches suspended from cover, each with 30' cables

H. 1 – 8138P PLC NEMA 4X 8136 Duplex control panel color touchscreen with UL Listed label: (PANELS USING PRINTED CIRCUIT BOARDS WILL NOT BE CONSIDERED EQUAL)
   1. Qty. 1 - Padlocking Hasp on outer door (Padlock NOT Included)

2. Qty. 1 - PLC with Color Touchscreen
3. Qty. 2 - Isolated Contacts for HW, Pump on and General Fault
4. Qty. 1 - Transient Surge Voltage Protection
5. Qty. 2 - Hour Re-Settable Meters
6. Qty. 1 - Preventable Maintenance Reminder
7. Qty. 1 - Automatic Alternator with Exercise Feature
8. Qty. 2 - Motor Overload Protection
9. Qty. 1 - HW Alarm with Silence touchscreen
10. Qty. 1 - Control Terminal Board Numbered & Wired

PLC displays

- HW & General Alarm indication
- Pump(s) Status icons for Off, Run and Disabled
- Sump Tank Level Bar Graph
- Alarm History Dated and Time Stamped
- Lead Pump Display. Next pump to Start on Sequence Alternation.
- Alarms Have Self-help Diagnostics to Assist Fault Troubleshooting
- Fully Interactive

I. Basin/cover:
1. 48”x 48” Square CONCRETE PIT (refer to structural plans)
2. 53” x 53” Square. gastight steel cover all necessary openings and matching curb frame.

J. Each pump shall have Weil model 2613-4 rail removal system

K. Pumps to have the Weil 2616-3 duplex VALVE ASSEMBLY

2.3 BUILDING AUTOMATION SYSTEM INTERFACE

A. Provide auxiliary contacts in pump controllers for interface to building automation system. Include the following:
1. On-off status of each pump.
2. Alarm status.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for plumbing piping to verify actual locations of sanitary drainage and vent piping connections before sewage pump installation.

3.2 CONCRETE

A. Install concrete bases of dimensions indicated for pumps and controllers. Refer to Division 22 Section "Common Work Results for Plumbing."
1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around full perimeter of base.
2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.

3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to supported equipment.

B. Cast-in-place concrete materials and placement requirements are specified in Division 03.

3.3 INSTALLATION

A. Excavating, trenching, and backfilling are specified in Division 31 Section "Earth Moving."

B. Install sewage pumps according to applicable requirements in HI 1.4.

C. Install pumps and arrange to provide access for maintenance including removal of motors, impellers, couplings, and accessories.

D. Set submersible sewage pumps on pit floors. Make direct connections to sanitary drainage piping.
1. Anchor guide-rail supports to pit bottoms and sidewalls or covers. Install pumps so pump and discharge pipe disconnecting flanges make positive seals when pumps are lowered into place.

E. Construct sewage pump pits and connect to drainage and vent piping. Set pit curb frame recessed in and anchored to concrete. Fasten pit cover to pit curb flange. Install cover so top surface is flush with finished floor.

F. Support piping so weight of piping is not supported by pumps.

3.4 CONNECTIONS

A. Piping installation requirements are specified in Division 22 Section "Sanitary Waste and Vent Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to sewage pumps to allow service and maintenance.

C. Connect sanitary drainage and vent piping to pumps. Install discharge piping equal to or greater than size of pump discharge piping. Install vent piping equal to or greater than size of pump basin vent connection. Refer to Division 22 Section "Sanitary Drainage and Vent Piping."
1. Install flexible connectors adjacent to pumps in discharge piping.
2. Install check and shutoff valves on discharge piping from each pump. Install unions on pumps having threaded pipe connections. Install valves same size as connected piping. Refer to Division 22 Section "General-Duty Valves for Plumbing Piping" for general-duty valves for sanitary waste piping.

D. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

E. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

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 bearing lubrication.
3. Disconnect couplings and check motors for proper direction of rotation.
4. Verify that each pump is free to rotate by hand. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
5. Verify that pump controls are correct for required application.

B. Start pumps without exceeding safe motor power:
1. Start motors.
2. Open discharge valves slowly.
3. Check general mechanical operation of pumps and motors.

C. Test and adjust controls and safeties.

D. Remove and replace damaged and malfunctioning components.
1. Pump Controls: Set pump controls for automatic start, stop, and alarm operation as required for system application.
2. Set field-adjustable switches and circuit-breaker trip ranges as indicated, or if not indicated, for normal operation.

E. 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 outside normal occupancy hours for this purpose.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain[controls and] pumps. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION

This page is intentionally left blank.

SECTION 22 14 23

STORM DRAINAGE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following storm drainage piping specialties:
   1. Cleanouts.
   2. Through-penetration firestop assemblies.
   3. Roof drains.
   4. Miscellaneous storm drainage piping specialties.
   5. Flashing materials.

B. Related Sections include the following:
   1. Division 22 Section "Sanitary Waste Piping Specialties" for backwater valves, floor drains, trench drains and channel drainage systems connected to sanitary sewer, air admittance valves.

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. PUR: Polyurethane plastic.

H. PVC: Polyvinyl chloride plastic.

1.4 SUBMITTALS

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

1.5 QUALITY ASSURANCE

A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

1.6 COORDINATION

A. Coordinate size and location of roof penetrations.

PART 2 - PRODUCTS

2.1 CLEANOUTS

A. Exposed Metal Cleanouts:
   1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   3. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
      a. Josam Company; Josam Div.
      b. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
      c. Tyler Pipe; Wade Div.
      d. Zurn Plumbing Products Group; Specification Drainage Operation.
   4. Standard: ASME A112.36.2M for cast iron for cleanout test tee.
   5. Size: Same as connected drainage piping
   6. Body Material: Hub-and-spigot, cast-iron soil pipe T-branch and Hubless, cast-iron soil pipe test tee as required to match connected piping.
   7. Closure: Countersunk Raised-head, brass plug.
   8. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
   9. Closure: Stainless-steel plug with seal.

B. Metal Floor Cleanouts:
   1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   3. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
      a. Josam Company; Josam Div.
      b. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
      c. Tyler Pipe; Wade Div.
      d. Zurn Plumbing Products Group; Specification Drainage Operation.
   4. Standard: ASME A112.36.2M for cast-iron soil pipe with cast-iron ferrule cleanout.
   5. Size: Same as connected branch.
   6. Type: Cast-iron soil pipe with cast-iron ferrule.
   7. Body or Ferrule: Cast iron.
   8. Clamping Device: Required.
   9. Outlet Connection: Inside calk.
   10. Closure: Brass plug with straight threads and gasket.
   11. Adjustable Housing Material: Cast iron with threads.

12. Frame and Cover Material and Finish: Nickel-bronze, copper alloy.
13. Frame and Cover Shape: Round.
14. Top Loading Classification: Extra Heavy Duty.
15. Riser: ASTM A 74, Extra-Heavy class, cast-iron drainage pipe fitting and riser to cleanout.
16. Standard: ASME A112.3.1.
17. Size: Same as connected branch.
18. Housing: Stainless steel.
19. Closure: Stainless steel with seal.
20. Riser: Stainless-steel drainage pipe fitting to cleanout.

C. Cast-Iron Wall Cleanouts:
1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
3. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
   a. Josam Company; Josam Div.
   b. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
   c. Tyler Pipe; Wade Div.
   d. Zurn Plumbing Products Group; Specification Drainage Operation.
4. Standard: ASME A112.36.2M. Include wall access.
5. Size: Same as connected drainage piping.
6. Body: Hub-and-spigot, cast-iron soil pipe T-branch, Hubless, cast-iron soil pipe test tee as required to match connected piping.
7. Closure: Countersunk, brass plug.
8. Closure Plug Size: Same as or not more than one size smaller than cleanout size.
9. Wall Access: Round, flat, chrome-plated brass or stainless-steel cover plate with screw.
10. Wall Access: Round, stainless-steel wall-installation frame and cover.

2.2 THROUGH-PENETRATION FIRESTOP ASSEMBLIES

A. Through-Penetration Firestop Assemblies:
1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. ProSet Systems Inc.
3. Standard: UL 1479 assembly of sleeve and stack fitting with firestopping plug.
4. Size: Same as connected pipe.
5. 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.
6. 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.

7. Special Coating: Corrosion resistant on interior of fittings.

2.3 ROOF DRAINS

A. Metal Roof Drains:
1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
3. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
   a. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.
   b. Tyler Pipe; Wade Div.
4. Standard: ASME A112.21.2M.
5. Pattern: Roof drain.
6. Body Material: Cast iron.
7. Dimensions of Body: As noted on the drawings.
8. Combination Flashing Ring and Gravel Stop: Required.
9. Flow-Control Weirs: Not required.
10. Outlet: Bottom.
11. Dome Material: Cast iron.
12. Extension Collars: Required.
13. Underdeck Clamp: Required.
14. Sump Receiver: Required.

2.4 MISCELLANEOUS STORM DRAINAGE PIPING SPECIALTIES

A. Expansion Joints:
1. Standard: ASME A112.21.2M.
2. Body: Cast iron with bronze sleeve, packing, and gland.
3. End Connections: Matching connected piping.
4. Size: Same as connected piping.

2.5 FLASHING MATERIALS

A. Copper Sheet: ASTM B 152/B 152M, 12 oz./sq. ft. (3.7 kg/sq. m or 0.41-mm) thickness.

B. Zinc-Coated Steel Sheet: ASTM A 653/A 653M, with 0.20 percent copper content and 0.04-inch (1.01-mm) minimum thickness, unless otherwise indicated. Include G90 (Z275) hot-dip galvanized, mill-phosphatized finish for painting if indicated.

C. Elastic Membrane Sheet: ASTM D 4068, flexible, chlorinated polyethylene, 40-mil (1.01-mm) minimum thickness.

D. Fasteners: Metal compatible with material and substrate being fastened.

E. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.

F. Solder: ASTM B 32, lead-free alloy.

G. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Refer to Division 22 Section "Common Work Results for Plumbing" for piping joining materials, joint construction, and basic installation requirements.

B. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
   1. Size same as drainage piping up to NPS 4 (DN 100). Use NPS 4 (DN 100) for larger drainage piping unless larger cleanout is indicated.
   2. Locate at each change in direction of piping greater than 45 degrees.
   3. Locate at minimum intervals of 50 feet (15 m) for piping NPS 4 (DN 100) and smaller and 100 feet (30 m) for larger piping.
   4. Locate at base of each vertical soil and waste stack.

C. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.

D. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.

E. Install trench drains at low points of surface areas to be drained. Set grates of drains flush with finished surface, unless otherwise indicated.

F. Install through-penetration firestop assemblies in plastic conductors and stacks at floor penetrations.

G. Install roof drains at low points of roof areas according to roof membrane manufacturer's written installation instructions. Roofing materials are specified in Division 07.
   1. Install roof-drain flashing collar or flange so that there will be no leakage between drain and adjoining roofing. Maintain integrity of waterproof membranes where penetrated.
   2. Position roof drains for easy access and maintenance.

H. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.

I. Install expansion joints on vertical stacks and conductors. Position expansion joints for easy access and maintenance.

J. Install conductor nozzles at exposed bottom of conductors where they spill onto grade.

K. Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding pipe fittings.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

3.3 FLASHING INSTALLATION

A. Fabricate flashing from single piece unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:
   1. Lead Sheets: Burn joints of lead sheets 6.0-lb/sq. ft. (30-kg/sq. m), 0.0938-inch (2.4-mm) thickness or thicker. Solder joints of lead sheets 4.0-lb/sq. ft. (20-kg/sq. m), 0.0625-inch (1.6-mm) thickness or thinner.
   2. Copper Sheets: Solder joints of copper sheets.

B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.
   1. Pipe Flashing: Sleeve type, matching pipe size, with minimum length of 10 inches (250 mm), and skirt or flange extending at least 8 inches (200 mm) around pipe.
   2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches (200 mm) around sleeve.
   3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches (200 mm) around specialty.

C. Set flashing on floors and roofs in solid coating of bituminous cement.

D. Secure flashing into sleeve and specialty clamping ring or device.

E. Fabricate and install flashing and pans, sumps, and other drainage shapes.

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

SECTION 22 14 29

SUMP PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following sump pumps and accessories, inside the building, for building storm drainage systems:
   1. Submersible sump pumps.

B. Related Sections include the following:
   1. Division 22 Section "Sanitary Sewerage Pumps" for application in sanitary drainage systems.

1.3 SUBMITTALS

A. Product Data: For each type and size of sump pump specified. Include certified performance curves with operating points plotted on curves, and rated capacities of selected models, furnished specialties, and accessories.

B. Shop Drawings: Diagram power, signal, and control wiring.

C. Operation and Maintenance Data: For each sump pump to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of sump pumps and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Retain shipping flange protective covers and protective coatings during storage.

B. Protect bearings and couplings against damage.

C. Comply with pump manufacturer's written rigging instructions for handling.

1.6 COORDINATION

A. Coordinate size and location of concrete [bases] [bases and pits] [pits]. Concrete, reinforcement, and formwork requirements are specified in Division 03.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
   1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
   2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 SUBMERSIBLE SUMP PUMPS (SP-B-1)

A. Manufacturers:
   1. Weil Pump Company, Inc.
   2. Zoeller Company.
   3. Grundfos Pumps Corp.

B. FURNISH WHERE SHOWN ON PLANS WEIL Pump Co. DUPLEX 3” submersible sewage pump set.

C. Pumps shall be WEIL Series 2500 Model 2554 submersible. Each pump shall be rated to provide 50 GPM @ 25’ TDH. Pumps to have 300 series stainless steel shafts, cast iron impellers, and 25’ power cables.

D. Pump motors shall be submersible and not less than 2 HP 3 phase, 60 HZ, 480 Volt and 1750 RPM.

E. Motor(s) shall be housed in watertight cast iron shell with extended cooling fins. Oil filled motors will not be considered equal. Motor(s) shall have Class ‘F’ insulation and permanently lubricated double seal ball bearings. Motor(s) using sleeve type bearing will not be considered equal. Mating surfaces between the motor and bell, motor shell and seal housing shall be sealed by means of ‘O’ rings. The motor shaft shall be Series 300 stainless steel with keyway for positive positioning of the impeller. Carbon steel and 400 series stainless steel shafts are not considered equal.

F. Impeller shall be multi-vane, semi-open type and accurately machined to the proper diameter. All impellers are to be trimmed to suit job conditions and then dynamically balanced.

G. 4 –Suspended mechanical type float switches suspended from cover, each with 30’ cables

H. 8138P PLC DUPLEX NEMA 4X CONTROL PANEL COLOR TOUCHSCREEN UL Listed Label: (PANELS USING PRINTED CIRCUIT BOARDS WILL NOT BE CONSIDERED EQUAL)

1. Qty. 1 - Padlocking Hasp on outer door (Padlock NOT Included)
2. Qty. 1 - PLC with Color Touchscreen
3. Qty. 2 - Isolated Contacts for HW, Pump on and General Fault
4. Qty. 1 - Transient Surge Voltage Protection
5. Qty. 2 - Hour Re-Settable Meters
6. Qty. 1 - Preventable Maintenance Reminder
7. Qty. 1 - Automatic Alternator with Exercise Feature
8. Qty. 2 - Motor Overload Protection
9. Qty. 1 - HW Alarm with Silence touchscreen
10. Qty. 1 - Control Terminal Board Numbered & Wired

Qty. 1 - PLC with Color Touchscreen

Qty. 2 - Isolated Contacts for HW, Pump on and General Fault

Qty. 1 - Transient Surge Voltage Protection

Qty. 2 - Hour Re-Settable Meters

Qty. 1 - Preventable Maintenance Reminder

Qty. 1 - Automatic Alternator with Exercise Feature

Qty. 2 - Motor Overload Protection

Qty. 1 - HW Alarm with Silence touchscreen

Qty. 1 - Control Terminal Board Numbered & Wired

PLC displays

- HW & General Alarm indication
- Pump(s) Status icons for Off, Run and Disabled
- Sump Tank Level Bar Graph
- Alarm History Dated and Time Stamped
- Lead Pump Display. Next pump to Start on Sequence Alternation.
- Alarms Have Self-help Diagnostics to Assist Fault Troubleshooting
- Fully Interac

I. Basin/cover: 48”x 48” Square CONCRETE PIT (Refer to structural plans)
   1. 53” x 53” Square gastight steel cover all necessary openings and matching angle curb frame.

J. Each pump shall have Weil model 2613-2 rail removal system

K. Refer to schedules on drawings for further information

2.3 BUILDING AUTOMATION SYSTEM INTERFACE

A. Provide auxiliary contacts in pump controllers for interface to building automation system. Include the following:
   1. On-off status of each pump.
   2. Alarm status.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in of plumbing piping to verify actual locations of storm drainage piping connections before sump pump installation.

3.2 CONCRETE

A. Install concrete bases of dimensions indicated for pumps and controllers. Refer to Division 22 Section "Common Work Results for Plumbing."
   1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around full perimeter of base.
   2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
   3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   4. Install anchor bolts to elevations required for proper attachment to supported equipment.

B. Cast-in-place concrete materials and placement requirements are specified in Division 03.

3.3 SUMP PUMP INSTALLATION

A. Excavating, trenching, and backfilling are specified in Division 31 Section "Earth Moving."

B. Install sump pumps according to applicable requirements in HI 1.4.

C. Install pumps and arrange to provide access for maintenance including removal of motors, impellers, couplings, and accessories.

D. Suspend wet-pit-mounted, vertical sump pumps from [basin] [basin and pit] [pit] covers. Make direct connections to storm drainage piping.

E. Set submersible sump pumps on [basin] [basin or pit] [pit] floor. Make direct connections to storm drainage piping.

F. Install sump pump basins and connect to drainage piping. Brace interior of basins according to manufacturer's written instructions to prevent distortion or collapse during concrete placement. Set basin cover and fasten to basin top flange. Install cover so top surface is flush with finished floor.

G. Construct sump pump pits and connect to drainage piping. Set pit curb frame recessed in and anchored to concrete. Fasten pit cover to pit curb flange. Install cover so top surface is flush with finished floor.

H. Install packaged, pedestal, drainage pump units and make direct connection to storm drainage piping.

I. Install packaged, submersible, drainage pump unit basins on floor or concrete base unless recessed installation is indicated. Make direct connections to storm drainage piping.

J. Support piping so weight of piping is not supported by pumps.

3.4 CONNECTIONS

A. Piping installation requirements are specified in Division 22 Section "Facility Storm Drainage Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to sump pumps to allow service and maintenance.

C. Connect storm drainage piping to pumps. Install discharge piping equal to or greater than size of pump discharge piping. Refer to Division 22 Section "Facility Storm Drainage Piping."
   1. Install flexible connectors adjacent to pumps in discharge piping.
   2. Install check and shutoff valves on discharge piping from each pump. Install unions on pumps having threaded pipe connections. Install valves same size as connected piping. Refer to Division 22 Section "General-Duty Valves for Plumbing Piping" for general-duty valves for drainage piping.

D. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

E. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

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 bearing lubrication.
   3. Disconnect couplings and check motors for proper direction of rotation.
   4. Verify that each pump is free to rotate by hand. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.
   5. Verify that pump controls are correct for required application.
   6. <Insert additional startup steps if any.>

B. Start pumps without exceeding safe motor power:
   1. Start motors.
   2. Open discharge valves slowly.
   3. Check general mechanical operation of pumps and motors.

C. Test and adjust controls and safeties.

D. Remove and replace damaged and malfunctioning components.

1. Pump Controls: Set pump controls for automatic start, stop, and alarm operation as required for system application.
2. Set field-adjustable switches and circuit-breaker trip ranges as indicated, or if not indicated, for normal operation.

E. 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 outside normal occupancy hours for this purpose.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain[controls and] pumps. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION

SECTION 22 32 00

DOMESTIC WATER FILTRATION EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following types of water filtration equipment for water systems in buildings:
   1. Vertical pressure type filter system

B. Related Sections include the following:
   1. Division 22 Section "Domestic Water Piping Specialties" for small cartridge-type water filters for plumbing fixtures and for plumbing piping strainers.
   2. Division 23 Section "Hydronic Piping" for hydronic piping strainers.
   3. Division 23 Section "Steam and Condensate Heating Piping" for steam piping system strainers.
   4. Division 23 Section "HVAC Water Treatment" for HVAC condenser water filtration units and hot-water/chilled-water filtration units.

1.3 DEFINITIONS

A. ABS: Acrylonitrile-butadiene-styrene plastic.

B. FRP: Fiberglass-reinforced plastic.

C. NBR: Acrylonitrile-butadiene rubber.

D. PE: Polyethylene plastic.

E. PP: Polypropylene plastic.

F. ppm: Parts per million.

G. PVC: Polyvinyl chloride plastic.

1.4 SUBMITTALS

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

B. Shop Drawings: Detail water filtration equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   1. Wiring Diagrams: Power, signal, and control wiring.

C. Field quality-control test reports.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of water filtration equipment through one source from a single manufacturer.

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.

1.6 COORDINATION

A. Coordinate size and location of concrete bases with Architectural and Structural Drawings.

PART 2 - PRODUCTS

2.1 SCOPE

A.

B. See Editing Instruction No. 1 in the Evaluations for cautions about naming manufacturers and products.

C. Edit this Article with other Part 2 articles in which manufacturers are named. See Division 01 Section "Product Requirements" for an explanation of the terms "Available Manufacturers" and "Manufacturers" and the effect these terms have on "Comparable Product" and "Product Substitution" requirements.

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

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 SOURCE QUALITY CONTROL

A. Hydrostatically test before shipment to minimum of one and one-half times pressure rating.

B. Prepare test reports.

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 [**filters**] [**and**] [**separators**].

B. Examine roughing-in for piping systems to verify actual locations of piping connections before equipment installation.

C. Examine walls and floors for suitable conditions where [**filters**] [**and**] [**separators**] will be installed.

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

3.2 CONCRETE BASES

A. Anchor [**filters**] [**and**] [**separators**] to concrete bases.

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around full perimeter of base.
2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to supported equipment.
5. Concrete base construction requirements are specified in Division 22 Section "Common Work Results for Plumbing."
6. Cast-in-place concrete materials and placement requirements are specified in Division 03.

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect[**, test, and adjust**] field-assembled components and equipment installation, including connections[**, and to assist in field testing**]. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:

1. Leak Test: After installation, 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 unit operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace water filtration equipment that does not pass tests and inspections and retest as specified above.

3.4 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service for [**carbon-**] [**and**] [**sand-**] filter water filtration equipment.

1. Complete installation and startup checks according to manufacturer's written instructions.
2. <**Insert startup steps if any.**>

B. Sample [**filter**] [**and**] [**separator**] filtrate after startup and at three consecutive seven-day intervals (total of four samples), and prepare certified test reports for required water performance characteristics.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain [**carbon-**] [**and**] [**sand-**] filter water filtration equipment. Refer to Division 01 Section " Demonstration and Training."

END OF SECTION 223200

S:\AKF-std\MASTSPEC\AIA-AKF Msterspec 2006\Plgb\223200_FL_AKF.DOC

SECTION 22 35 00

DOMESTIC WATER HEAT EXCHANGERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following heat exchangers:
   1. Heating-fluid-in-coil, instantaneous heat exchangers.
   2. Compression tanks.
   3. Heat-exchanger accessories.

1.3 SUBMITTALS

A. Product Data: For each type and size of heat exchanger indicated. Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings: Diagram power, signal, and control wiring.

C. Product Certificates: For each type of instantaneous heat exchanger, signed by product manufacturer.

D. Manufacturer Seismic Qualification Certification: Submit certification that heat exchangers, accessories, and components will withstand seismic forces defined in Division 15 Section "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.
      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 Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
   3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

E. Source quality-control test reports.

F. Field quality-control test reports.

G. Operation and Maintenance Data: For heat exchangers to include in emergency, operation, and maintenance manuals.

H. Warranty: Special warranty specified in this Section.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain same type of heat exchangers through one source from a single manufacturer.

B. Product Options: Drawings indicate size, profiles, and dimensional requirements of heat exchangers and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. ASME Compliance: Where ASME-code construction is indicated, fabricate and label heat-exchanger storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

E. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9" for all components that will be in contact with water.

1.5 COORDINATION

A. Coordinate size and location of concrete bases with Architectural and Structural Drawings.

1.6 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of heat exchangers that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Structural failures including heat exchanger, storage tank, and supports.
      b. Faulty operation of controls.
      c. Deterioration of metals, metal finishes, and other materials beyond normal use.
   2. Warranty Period(s): From date of Substantial Completion:
      a. Instantaneous Heat Exchangers:
         1) Tube Coil and Shell: One year(s).
         2) Controls and Other Components: One year(s).
      b. Compression Tanks: One year(s).

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
   1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.

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

2.2 INSTANTANEOUS HEAT EXCHANGERS

A. Furnish and install where shown on the plans, the number and model of Compact water heaters as indicated below, or on the drawing water heater schedule, as manufactured by the Patterson-Kelley Company. Heaters are to have Double-Wall tubes and provision for external evidence of tube wall leaks. The double-wall design shall prevent possible contamination of the domestic water supply.

1. Each heater shall be a factory package with a capacity to heat the specified rating while maintaining the set outlet temperature within 4° F at all flow rates. Each heater shall have a mounted all bronze pump to constantly circulate water in the heater to prevent fouling of the heater tubes and formation of corrosion cells on the tubes and shell by the gases entrained in the raw water.

2. Each heater shall be ASME Code constructed and stamped for 155 psig at 210° F in the shell and 150 psig at 20° F above the operating steam temperature in the tube circuit. A National Board registration number shall be indicated on the nameplate. A nameplate as required by state authorities, shall be mounted on the heater. The manufacturer shall furnish copies of the ASME data form U-1 to the owner.

3. Each heater shall be capable of being disassembled and the heat exchanger removed for inspection or service without disconnecting the water inlet and outlet piping. Isolation type bolting shall be provided between the tube sheet and shell flange so the steam bonnet can be removed allowing inspection of the tubes while maintaining the city water pressure on the shell circuit. No overhead clearance shall be required for servicing.

4. Each Compact Water Heater shall be furnished with the follow components:

   a. Compact basic heater with 90-10 cupro-nickel shell and double wall tubes; solid Teflon heat exchanger, non-abrasive baffles; a water-side tube sheet of solid copper silicon and steam side tube sheet of carbon steel; steam chamber of cast iron and a steel vertical, support base.
   b. Steam strainer, furnished loose for field mounting.
   c. Steam control valve, self-contained, with separate control sensor. Valves 3” and larger are furnished loose for field mounting.
   d. Float and thermostatic steam trap, furnished loose for field mounting.
   e. Water outlet thermometer, 2-1/2” diameter.
   f. Steam pressure gage, 2-1/2” diameter.
   g. Steam vacuum breaker, stainless steel ball and spring type.
   h. P-K integral Anticipator® control system.
   i. ASME rated temperature and pressure relief set at 150 psig and 210° F, loose for field mounting.
   j. Insulation, 1-1/2” thick, high density foam, bonded to a PVC jacket rated to meet the current state and ASHRAE standards.

k. Bronze circulator of a size indicated below or in the schedule, wired for 120V, single phase and continuous running. Pipe with type "L" copper.
l. Temperature limit system with 2-way solenoid to shut steam valve and 2-way solenoid to dump overheated water. Limit system to be controlled by and adjustable thermostat to be set 20° F above the desired operating temperature.
m. Control panel with on/off switch and operating light for limit system and pump.

B. The manufacturer shall guarantee the operation capability of all components furnished as part of the factory package. The factory package shall require only connection to the electrical, water, steam, condensate, mounting the steam strainer, steam trap and control valve if 3" IPS or larger.

1. Guarantees:

a. The manufacturer shall guarantee all components of the package and workmanship for a period of one (1) year after start up, provided the start up occurs with six (6) months of the date of shipment.
b. The manufacturer shall guarantee the heater will perform at its rated capacity.
c. The shell of the heater shall have a non-prorated guarantee against leakage due to internal corrosion for a period of twenty (20) years from the date of shipment.
d. The P-K Anticipator® system shall have a non-prorated guarantee against failure for a period of twenty (20) years.
e. The heat exchanger, from the steam inlet to the condensate outlet, including tubes and tube sheet, shall have a non-prorated ten (10) year guarantee against failure due to thermal shock, mechanical failure or erosion.

C. Start Up Policy:

1. The manufacturer's representative shall supply supervision of the start up of the heaters by the contractor. If the installation deviates from the manufacturer's recommended practice, the representative shall advise the contractor and the design engineer and not proceed with start up until corrective measures are taken.

2.3 Domestic Water Heaters:

A. Three (3) Model PK10D water heaters each rated to heat 45 GPM of water from 40°F to ~~140°F~~ 160°F with 2,361 lbs./hour of steam to the control valve at 10 PSIG. The water pressure drop through the heater shall not exceed 0.3 PSI at 45 GPM. The bronze pump shall be 1-1/4" IPS with a 1/12 HP motor. Pump shall be equal to B&G PL30B.

2.4 ~~Dialysis~~ Tempered Water Heater:

A. One (1) Model PK08D water heater rated to heat 30 GPM of water from 40°F to ~~140°F~~ 160°F with 1,574 lbs./hour of steam to the control valve at 10 PSIG. The water pressure drop through the heater shall not exceed 0.4 PSI at 30 GPM. The bronze pump shall be 1-1/4" IPS with a 1/12 HP motor. Pump shall be equal to B&G PL30B.

2.5 COMPRESSION TANKS

A. Description: Steel, pressure-rated tank constructed with welded joints and factory-installed, butyl-rubber diaphragm. Include air precharge to minimum system-operating pressure at tank.
   1. Manufacturers:
      a. AMTROL Inc.
      b. Watts Regulator Co.
      c. Wessels Co.
   2. Construction:
      a. Tappings: Factory-fabricated steel, welded to tank before testing and labeling. Include ASME B1.20.1 pipe thread.
      b. Interior Finish: Comply with NSF 61 barrier materials for potable-water tank linings, including extending finish into and through tank fittings and outlets.
      c. Air-Charging Valve: Factory installed.
   3. Capacity and Characteristics:
      a. Working-Pressure Rating150 psig.
      b. Capacity Acceptable 7 gal. 10 gal. minimum.

2.6 HEAT-EXCHANGER ACCESSORIES

A. Combination Temperature and Pressure Relief Valves: ASME rated and stamped and complying with ASME PTC 25.3. Include relieving capacity at least as great as heat input, and include pressure setting less than working-pressure rating of heat exchanger. Select relief valves with sensing element that extends into heat-exchanger storage tank.

B. Pressure Relief Valves: ASME rated and stamped and complying with ASME PTC 25.3. Include pressure setting less than working-pressure rating of heat exchanger.

C. Piping-Type Heat Traps: Field-fabricated piping arrangement according to ASHRAE/IESNA 90.1 or ASHRAE 90.2.

2.7 SOURCE QUALITY CONTROL

A. Test and inspect heat-exchanger storage tanks, specified to be ASME-code construction, according to ASME Boiler and Pressure Vessel Code.

B. Hydrostatically test commercial heat-exchanger storage tanks before shipment to minimum of one and one-half times pressure rating.

C. Prepare test reports.

PART 3 - EXECUTION

3.1 HEAT-EXCHANGER INSTALLATION

A. Install heat exchangers on concrete bases.
   1. Concrete base construction requirements are specified in Division 22 Section "Common Work Results for Plumbing."

B. The heating section and the storage tank shall be completely factory packaged on individual skids and will be plumbed together at the job site. The tank- to-exchanger plumbing will be factory pre-built but shipped separately for field assembly. The entire heating package shall fit properly in the space provided and installation shall conform to all local, state, and national codes.

C. Install heat exchangers 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.

D. Anchor heat exchangers to substrate.

E. Install seismic restraints for heat exchangers. Anchor to substrate.

F. Install temperature and pressure relief valves in top portion of storage tank shells of heat exchangers with domestic water storage. Use relief valves with sensing elements that extend into shells. Extend relief-valve outlet, with drain piping same as water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.

G. Install combination temperature and pressure relief valves in water piping for heat exchangers without storage. Extend relief-valve outlet, with drain piping same as water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.

H. Install heat-exchanger 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 heat exchangers that do not have tank drains. Refer to Division 22 Section "Domestic Water Piping Specialties" for hose-end drain valves.

I. Install thermometer on each heat-exchanger domestic-water inlet and outlet piping, and install thermometer on each heat-exchanger heating-fluid inlet and outlet piping. Refer to Division 22 Section "Meters and Gages for Plumbing Piping" for thermometers.

J. Install pressure gages on heat-exchanger heating-fluid piping. Refer to Division 22 Section "Meters and Gages for Plumbing Piping" for pressure gages.

K. Fill heat exchangers with water.

L. Charge compression tanks with air.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to heat exchangers to allow service and maintenance. Arrange piping for easy removal of heat exchangers.

C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

D. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:
   1. Leak Test: After installation, test for leaks. Repair leaks and retest until no leaks exist.
   2. Operational Test: After electrical circuitry has been energized, confirm proper operation.
   3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace heat exchangers that do not pass tests and inspections and retest as specified above.

3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain heat exchangers. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION

This page is intentionally left blank.

SECTION 22 40 00

PLUMBING FIXTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following conventional plumbing fixtures and related components:
1. Faucets for lavatories.
2. Laminar-flow faucet-spout outlets.
3. Flushometers.
4. Toilet seats.
5. Protective shielding guards.
6. Fixture supports.
7. Shower receptors.
8. Water closets.
9. Urinals.
10. Lavatories.
11. Commercial sinks.
12. Individual showers.
13. Service sinks.

B. Related Sections include the following:
1. Division 10 Section "Toilet, Bath, and Laundry Accessories."
2. Division 22 Section "Domestic Water Piping Specialties" for backflow preventers, floor drains, and specialty fixtures not included in this Section.
3. Division 22 Section "Domestic Water Filtration Equipment" for water filters.
4. ~~Division 22 Section "Healthcare Plumbing Fixtures."~~
5. ~~Division 22 Section "Emergency Plumbing Fixtures."~~
6. ~~Division 22 Section "Security Plumbing Fixtures."~~
7. ~~Division 22 Section "Drinking Fountains and Water Coolers."~~
8. ~~Division 31 Section "Facility Water Distribution Piping" for exterior plumbing fixtures and hydrants.~~

1.3 DEFINITIONS

A. ABS: Acrylonitrile-butadiene-styrene plastic.

B. Accessible Fixture: Plumbing fixture that can be approached, entered, and used by people with disabilities.

C. Cast Polymer: Cast-filled-polymer-plastic material. This material includes cultured-marble and solid-surface materials.

D. Cultured Marble: Cast-filled-polymer-plastic material with surface coating.

E. Fitting: Device that controls the flow of water into or out of the plumbing fixture. Fittings specified in this Section include supplies and stops, faucets and spouts, shower heads and tub spouts, drains and tailpieces, and traps and waste pipes. Piping and general-duty valves are included where indicated.

F. FRP: Fiberglass-reinforced plastic.

G. PMMA: Polymethyl methacrylate (acrylic) plastic.

H. PVC: Polyvinyl chloride plastic.

I. Solid Surface: Nonporous, homogeneous, cast-polymer-plastic material with heat-, impact-, scratch-, and stain-resistance qualities.

1.4 SUBMITTALS

A. Product Data: For each type of plumbing fixture indicated. Include selected fixture and trim, fittings, accessories, appliances, appurtenances, equipment, and supports. Indicate materials and finishes, dimensions, construction details, and flow-control rates.

B. Shop Drawings: Diagram power, signal, and control wiring.

C. Operation and Maintenance Data: For plumbing fixtures to include in emergency, operation, and maintenance manuals.

D. Warranty: Special warranty specified in this Section.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain plumbing fixtures, faucets, and other components of each category through one source from a single manufacturer.
   1. Exception: If fixtures, faucets, or other components are not available from a single manufacturer, obtain similar products from other manufacturers specified for that category.

B. 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. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities "Americans with Disabilities Act" for plumbing fixtures for people with disabilities.

D. Regulatory Requirements: Comply with requirements in Public Law 102-486, "Energy Policy Act," about water flow and consumption rates for plumbing fixtures.

E. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.

F. Select combinations of fixtures and trim, faucets, fittings, and other components that are compatible.

G. Comply with the following applicable standards and other requirements specified for plumbing fixtures:
   1. Enameled, Cast-Iron Fixtures: ASME A112.19.1M.
   2. Porcelain-Enameled, Formed-Steel Fixtures: ASME A112.19.4M.
   3. Slip-Resistant Bathing Surfaces: ASTM F 462.
   4. Solid-Surface-Material Lavatories and Sinks: ANSI/ICPA SS-1.
   5. Stainless-Steel Commercial, Handwash Sinks: NSF 2 construction.
   6. Vitreous-China Fixtures: ASME A112.19.2M.
   7. Water-Closet, Flush Valve, ASME A112.19.5.

H. Comply with the following applicable standards and other requirements specified for lavatory faucets:
   1. Backflow Protection Devices for Faucets with Side Spray: ASME A112.18.3M.
   2. Backflow Protection Devices for Faucets with Hose-Thread Outlet: ASME A112.18.3M.
   3. Diverter Valves for Faucets with Hose Spray: ASSE 1025.
   4. Faucets: ASME A112.18.1.
   5. Hose-Connection Vacuum Breakers: ASSE 1011.
   6. Hose-Coupling Threads: ASME B1.20.7.
   7. Integral, Atmospheric Vacuum Breakers: ASSE 1001.
   8. NSF Potable-Water Materials: NSF 61.
   9. Pipe Threads: ASME B1.20.1.
   10. Sensor-Actuated Faucets and Electrical Devices: UL 1951.
   11. Supply Fittings: ASME A112.18.1.
   12. Brass Waste Fittings: ASME A112.18.2.

I. Comply with the following applicable standards and other requirements specified for shower faucets:
   1. Backflow Protection Devices for Hand-Held Showers: ASME A112.18.3M.
   2. Combination, Pressure-Equalizing and Thermostatic-Control Antiscald Faucets: ASSE 1016.
   3. Faucets: ASME A112.18.1.
   4. Hand-Held Showers: ASSE 1014.
   5. High-Temperature-Limit Controls for Thermal-Shock-Preventing Devices: ASTM F 445.
   6. Hose-Coupling Threads: ASME B1.20.7.
   7. Manual-Control Antiscald Faucets: ASTM F 444.
   8. Pipe Threads: ASME B1.20.1.
   9. Pressure-Equalizing-Control Antiscald Faucets: ASTM F 444 and ASSE 1016.
   10. Thermostatic-Control Antiscald Faucets: ASTM F 444 and ASSE 1016.

J. Comply with the following applicable standards and other requirements specified for miscellaneous fittings:
   1. Atmospheric Vacuum Breakers: ASSE 1001.
   2. Brass and Copper Supplies: ASME A112.18.1.
   3. Manual-Operation Flushometers: ASSE 1037.
   4. Brass Waste Fittings: ASME A112.18.2.
   5. Sensor-Operation Flushometers: ASSE 1037 and UL 1951.

K. Comply with the following applicable standards and other requirements specified for miscellaneous components:
   1. Flexible Water Connectors: ASME A112.18.6.

2. Floor Drains: ASME A112.6.3.
3. Hose-Coupling Threads: ASME B1.20.7.
4. Off-Floor Fixture Supports: ASME A112.6.1M.
5. Pipe Threads: ASME B1.20.1.
6. Plastic Toilet Seats: ANSI Z124.5.
7. Supply and Drain Protective Shielding Guards: ICC A117.1.

1.6 WARRANTY

A. Special Warranties: Manufacturer's standard form in which manufacturer agrees to repair or replace components of whirlpools that fail in materials or workmanship within specified warranty period.
   1. Failures include, but are not limited to, the following:
      a. Structural failures of unit shell.
      b. Faulty operation of controls, blowers, pumps, heaters, and timers.
      c. Deterioration of metals, metal finishes, and other materials beyond normal use.
   2. Warranty Period for Commercial Applications: 1 year from date of Substantial Completion.

1.7 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Faucet 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.
   3. Flushometer Valve, Repair Kits: Equal to 10 percent of amount of each type installed, but no fewer than12 of each type.

PART 2 - PRODUCTS

2.1 LAVATORY FAUCETS

A. Lavatory Faucets:
   1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   3. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
      a. Chicago Faucets.
      b. Toto, Inc.
      c. T & S Brass and Bronze Works, Inc.

4. Description: Two-handle mixing valve. Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture holes; coordinate outlet with spout and fixture receptor.
   a. Body Material: Commercial, solid brass.
   b. Finish: Polished chrome plate.
   c. Maximum Flow Rate: 0.5 gpm (1.5 L/min.).
   d. Centers: 4 inches (102 mm).
   e. Mounting: Deck, exposed.
   f. Valve Handle(s): Wrist blade, 4 inches (102 mm).
   g. Inlet(s): NPS 1/2 (DN 15) male shank] [NPS 1/2 (DN 15) female shank.
   h. Spout: Rigid, gooseneck type.
   i. Spout Outlet: Aerator, 0.5 gpm (1.5L/min.).
   j. Operation: Compression, manual.
   k. Drain: Grid.
   l. Tempering Device: Not required.

2.2 SHOWER FAUCETS

A. Shower Faucets:
   1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   3. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
      a. Chicago Faucets.
      b. Leonard Valve Company.
      c. Symmons Industries, Inc.
   4. Description: Single-handle pressure-balance valve. Include hot- and cold-water indicators; check stops; and shower head, arm, and flange. Coordinate faucet inlets with supplies and outlet with diverter valve.
      a. Body Material: Solid brass.
      b. Finish: Polished chrome plate.
      c. Maximum Flow Rate: 2.5 gpm (9.5 L/min.), unless otherwise indicated.
      d. Diverter Valve: Not required.
      e. Mounting: Concealed.
      f. Backflow Protection Device for Hand-Held Shower: Required.
      g. Operation: Compression, manual.
      h. Antiscald Device: Integral with mixing valve.
      i. Check Stops: Check-valve type, integral with or attached to body; on hot- and cold-water supply connections.
      j. Supply Connections: NPS 1/2 (DN 15)
      k. Shower Head Type: Ball joint and head integral with mounting flange
      l. Shower Head Material: Metallic with chrome-plated finish.
      m. Spray Pattern: Fixed
      n. Integral Volume Control: Required
      o. Shower-Arm Flow-Control Fitting: Not required
      p. Temperature Indicator: Not required

2.3 SINK FAUCETS

A. Sink Faucets:
   1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   3. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
      a. Chicago Faucets.
      b. Moen, Inc.
      c. T & S Brass and Bronze Works, Inc.
   4. Description: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture holes; coordinate outlet with spout and fixture receptor.
      a. Body Material: Commercial, solid brass
      b. Finish: Polished chrome plate
      c. Maximum Flow Rate: 2.5 gpm (9.5 L/min.), unless otherwise indicated.
      d. Mixing Valve: Two-lever handle.
      e. Backflow Protection Device for Hose Outlet: Not required.
      f. Backflow Protection Device for Side Spray: Not required
      g. Centers: 4 inches (102 mm)
      h. Mounting: Deck
      i. Handle(s): Wrist blade, 4 inches (102 mm)
      j. Inlet(s): NPS 1/2 (DN 15) female shank
      k. Spout Type: Rigid gooseneck
      l. Spout Outlet: Aerator
      m. Vacuum Breaker: Not required
      n. Operation: Compression, manual.
      o. Drain: Grid

2.4 LAMINAR-FLOW FAUCET-SPOUT OUTLETS

A. Laminar-Flow Faucet-Spout Outlets:
   1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   3. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
      a. Chronomite Laboratories, Inc.
      b. NEOPERL, Inc.
   4. Description: Chrome-plated-brass faucet-spout outlet that produces non-aerating, laminar stream. Include male or female thread that mates with faucet outlet for attachment to faucets where indicated and flow-rate range that includes flow of faucet.

2.5 FLUSHOMETERS

A. Flushometers:
1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
3. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
   a. Zurn Plumbing Products Group; Commercial Brass Operation.
   b. Sloan Company.
   c. TOTO USA, Inc.
4. Description: Flushometer for urinal and water-closet-type fixture. Include brass body with corrosion-resistant internal components, non-hold-open feature, control stop with check valve, vacuum breaker, copper or brass tubing, and polished chrome-plated finish on exposed parts.
   a. Internal Design: Diaphragm operation.
   b. Style: Exposed
   c. Inlet Size: [NPS 3/4 (DN 20)] [NPS 1 (DN 25)].
   d. Trip Mechanism: Oscillating, lever-handle actuator
   e. Consumption: 1.6 gal./flush (6.0 L/flush)
   f. Tailpiece Size: NPS 1-1/2 (DN 40) length to top of bowl.

2.6 TOILET SEATS

A. Toilet Seats:
1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
3. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
   a. Bemis Manufacturing Company.
   b. Church Seats.
   c. Olsonite Corp.
4. Description: Toilet seat for water-closet-type fixture.
   a. Material: Molded, solid plastic with antimicrobial agent
   b. Configuration: Open front without cover.
   c. Size: Elongated
   d. Hinge Type: CK, check
   e. Class: Heavy-duty commercial.
   f. Color: White

2.7 PROTECTIVE SHIELDING GUARDS

A. Protective Shielding Pipe Covers:

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Insul-Tect Products Co.; a Subsidiary of MVG Molded Products.
   b. Plumberex Specialty Products Inc.
   c. TRUEBRO, Inc.
3. 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. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. TRUEBRO, Inc.
3. Description: Manufactured plastic enclosure for covering plumbing fixture hot- and cold-water supplies and trap and drain piping. Comply with ADA requirements.

2.8 FIXTURE SUPPORTS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Josam Company.
2. Smith, Jay R. Mfg. Co.
3. Tyler Pipe; Wade Div.
4. Zurn Plumbing Products Group; Specification Drainage Operation.

C. Water-Closet Supports:
1. Description: Combination carrier designed for accessible and standard mounting height of wall-mounting, water-closet-type fixture. Include single or double, vertical or horizontal, hub-and-spigot or hubless waste fitting as required for piping arrangement; faceplates; couplings with gaskets; feet; and fixture bolts and hardware matching fixture. Include additional extension coupling, faceplate, and feet for installation in wide pipe space. Carrier shall be rated at 500-750 lbs for bariatric use similar to J.R Smith 0220Y-M5A-XX

D. Urinal Supports:
1. Description: Type I, urinal carrier with fixture support plates and coupling with seal and fixture bolts and hardware matching fixture for wall-mounting, urinal-type fixture. Include steel uprights with feet.
2. Accessible-Fixture Support: Include rectangular steel uprights.

E. Lavatory Supports:

1. Description: Type III, lavatory carrier with hanger plate and tie rod for wall-mounting, lavatory-type fixture. Include steel uprights with feet.
2. Accessible-Fixture Support: Include rectangular steel uprights.

F. Sink Supports:
1. Description: Type I, sink carrier with exposed arms and tie rods for sink-type fixture. Include steel uprights with feet.

2.9 SHOWER RECEPTORS

A. Shower Receptors:
1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   a. Best Bath Systems
2. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
   a. Crane Plumbing, L.L.C./Fiat Products.
   b. American Standard Companies, Inc.
   c. Stern-Williams Co., Inc.
3. Description: One piece gel coat/ fiber glass with integral ply wood backing and with the following factory installed accessories: Grab bar, folding seat, mixing value, vacuum breaker and soap dish.
   a. Type: Handicapped/wheelchair.
   b. Size: As shown on the drawings.
   c. Color: White.
   d. Outlet: Drain with NPS 2 (DN 50) outlet.

2.10 WATER CLOSETS

A. Water Closets:
1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
3. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
   a. American Standard Companies, Inc.
   b. Eljer.
   c. Kohler Co.
4. Description Accessible, wall mounting, back-outlet, vitreous-china fixture designed for flushometer valve operation.
   a. Style: One piece.
      1) Bowl Type: Elongated with siphon-jet design.
      2) Design Consumption: 1.6 gal./flush (6 L/flush)
      3) Trip Mechanism: Lever-handle actuator.
      4) Color: White.
   b. Supply: 1 1/4” chrome-plated brass or copper with screwdriver stop.

c. Style: Flushometer valve.
   1) Bowl Type: Elongated with siphon-jet design.
   2) Design Consumption: 1.6 gal./flush (6 L/flush).
   3) Color: White.

2.11 URINALS

A. Urinals:
   1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   3. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
      a. American Standard Companies, Inc.
      b. Eljer.
      c. Kohler Co.
   4. Description: Accessible, wall-mounting, back-outlet, vitreous-china fixture designed for flushometer valve operation.
      a. Type: Siphon jet.
      b. Strainer or Trapway: Integral cast strainer with integral trap.
      c. Design Consumption: 1 gal./flush (3.8 L/flush).
      d. Color: White.
      e. Supply Spud Size: NPS 1-1/4 (DN 32).
      f. Outlet Size: NPS 2 (DN 50)

2.12 LAVATORIES

A. Lavatories:
   1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   3. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
      a. American Standard Companies, Inc.
      b. Eljer.
   4. Description: Accessible, wall-mounting, vitreous-china fixture.
      a. Type: Slab.
      b. Size: 20 by 18 inches (508 by 457 mm) rectangular.
      c. Faucet Hole Punching: Three holes, 4-inch (102-mm) centers.
      d. Faucet Hole Location: Top.
      e. Pedestal: Not required.
      f. Color: White.
      g. Faucet: Lavatory.
      h. Supplies: NPS 3/8 (DN 10) chrome-plated copper with stops.

i. Drain: Grid.
   1) Location: Near back of bowl.
j. Drain Piping: chrome-plated, cast-brass P-trap; NPS 1-1/2 (DN 40), thick tubular brass waste to wall; and wall escutcheon.
   1) Exception: Omit P-trap if hair interceptor is required.
k. Hair Interceptor:
l. Protective Shielding Guard(s):
m. Fixture Support: Lavatory

2.13 COMMERCIAL SINKS

A. Commercial Sinks:
   1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   3. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
      a. Elkay Manufacturing Co.
      b. Just Manufacturing Company.
   4. Description: One-compartment, counter-mounting, stainless-steel commercial sink with backsplash.
      a. Overall Dimensions: 22” x 19” x 7 ½”
      b. Metal Thickness: 0.050 inch (1.3 mm).
      c. Compartment:
         1) Dimensions: As shown on drawings
         2) Drain: Grid with NPS 2 (DN 50) tailpiece and twist drain
            a) Location: Near back of compartment.

2.14 SERVICE SINKS

A. Service Sinks:
   1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   3. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
      a. American Standard Companies, Inc.
      b. Eljer.
      c. Kohler Co.
   4. Description: Trap-standard- and wall-mounting, enameled, cast-iron fixture with roll-rim vitreous-china fixture with two faucet holes in back and rim guard on front and sides.
      a. Size: 24 by 20 inches (610 by 510 mm).
      b. Size: 22 by 20 inches (560 by 510 mm).

c. Color: White.
d. Faucet: Sink.
e. Drain: Grid with NPS 3 (DN 80) outlet.
f. Trap Standard: NPS 3 (DN 80) enameled, cast iron with cleanout and floor flange.
g. Fixture Support: Sink.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before plumbing fixture installation.

B. Examine cabinets, counters, floors, and walls for suitable conditions where fixtures will be installed.

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

3.2 INSTALLATION

A. Assemble plumbing fixtures, trim, fittings, and other components according to manufacturers' written instructions.

B. Install off-floor supports, affixed to building substrate, for wall-mounting fixtures.
1. Use carrier supports with waste fitting and seal for back-outlet fixtures.
2. Use carrier supports without waste fitting for fixtures with tubular waste piping.
3. Use chair-type carrier supports with rectangular steel uprights for accessible fixtures.

C. Install back-outlet, wall-mounting fixtures onto waste fitting seals and attach to supports.

D. Install floor-mounting fixtures on closet flanges or other attachments to piping or building substrate.

E. Install wall-mounting fixtures with tubular waste piping attached to supports.

F. Install floor-mounting, back-outlet water closets attached to building floor substrate and wall bracket and onto waste fitting seals.

G. Install counter-mounting fixtures in and attached to casework.

H. Install fixtures level and plumb according to roughing-in drawings.

I. Install water-supply piping with stop on each supply to each fixture to be connected to water distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.
1. Exception: Use ball, gate, or globe valves if supply stops are not specified with fixture. Valves are specified in Division 22 Section "General-Duty Valves for Plumbing Piping."

J. Install trap and tubular waste piping on drain outlet of each fixture to be directly connected to sanitary drainage system.

K. Install tubular waste piping on drain outlet of each fixture to be indirectly connected to drainage system.

L. Install flushometer valves for accessible water closets and urinals with handle mounted on wide side of compartment. Install other actuators in locations that are easy for people with disabilities to reach.

M. Install toilet seats on water closets.

N. Install faucet-spout fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.

O. Install water-supply flow-control fittings with specified flow rates in fixture supplies at stop valves.

P. Install faucet flow-control fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.

Q. Install shower flow-control fittings with specified maximum flow rates in shower arms.

R. Install traps on fixture outlets.
   1. Exception: Omit trap on fixtures with integral traps.
   2. Exception: Omit trap on indirect wastes, unless otherwise indicated.

S. Install disposer in outlet of each sink indicated to have disposer. Install switch where indicated or in wall adjacent to sink if location is not indicated.

T. Install escutcheons at piping wall ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding fittings. Escutcheons are specified in Division 22 Section "Common Work Results for Plumbing."

U. Set shower receptors and service basins in leveling bed of cement grout. Grout is specified in Division 22 Section "Common Work Results for Plumbing."

V. Seal joints between fixtures and walls, floors, and countertops using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Sealants are specified in Division 07 Section "Joint Sealants."

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

D. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Verify that installed plumbing fixtures are categories and types specified for locations where installed.

B. Check that plumbing fixtures are complete with trim, faucets, fittings, and other specified components.

C. Inspect installed plumbing fixtures for damage. Replace damaged fixtures and components.

D. Test installed fixtures after water systems are pressurized for proper operation. Replace malfunctioning fixtures and components, then retest. Repeat procedure until units operate properly.

E. Install fresh batteries in sensor-operated mechanisms.

3.5 ADJUSTING

A. Operate and adjust faucets and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.

B. Operate and adjust disposers. Replace damaged and malfunctioning units.

C. Adjust water pressure at faucets and flushometer valves to produce proper flow and stream.

D. Replace washers and seals of leaking and dripping faucets and stops.

E. Install fresh batteries in sensor-operated mechanisms.

3.6 CLEANING

A. Clean fixtures, faucets, and other fittings with manufacturers' recommended cleaning methods and materials. Do the following:
   1. Remove faucet spouts and strainers, remove sediment and debris, and reinstall strainers and spouts.
   2. Remove sediment and debris from drains.

B. After completing installation of exposed, factory-finished fixtures, faucets, and fittings, inspect exposed finishes and repair damaged finishes.

3.7 PROTECTION

A. Provide protective covering for installed fixtures and fittings.

B. Do not allow use of plumbing fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION

SECTION 22 61 13

COMPRESSED-AIR PIPING FOR LABORATORY AND HEALTHCARE FACILITIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:
   1. Medical air piping and specialties, designated "medical air," operating at [50 to 55 psig] <Insert pressure range>.
   2. Gas-powered-tool air piping and specialties, designated "instrument air," operating at [175 psig] <Insert pressure>.

B. Related Sections include the following:
   1. Division 22 Section "Compressed-Air Equipment for Laboratory and Healthcare Facilities" for [laboratory air] [and] [medical air] compressors.

1.3 DEFINITIONS

A. D.I.S.S.: Diameter-index safety system.

B. 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.

C. Medical Compressed-Air Piping Systems: Include [medical air] [dental air] [instrument air] [and] [medical laboratory air] piping systems.

1.4 SUBMITTALS

A. Product Data: For the following:
   1. Compressed-air tubes and fittings.
   2. Compressed-air valves and valve boxes.
   3. Medical compressed-air service connections.
   4. Medical compressed-air alarm system components.

B. Shop Drawings: Diagram power, signal, and control wiring.

C. Piping Material Certification: Signed by Installer certifying that medical compressed-air piping materials comply with NFPA 99 requirements.

D. Qualification Data: For [Installer] [and] [testing agency].

E. Brazing certificates.

F. Field quality-control test reports.

G. Operation and Maintenance Data: For compressed-air piping specialties to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Installer Qualifications:
   1. Medical Compressed-Air Piping Systems for Healthcare Facilities: Qualify installers according to ASSE Standard #6010.
   2. Pressure-Seal Joining Procedure for Copper Tubing: Qualify operators according to training provided by Viega; Plumbing and Heating Systems.

B. Testing Agency Qualifications: An independent testing agency, with the experience and capability to conduct the vacuum piping testing indicated, that is[a member of the Medical Gas Professional Healthcare Organization or is] an NRTL, and that is acceptable to authorities having jurisdiction.
   1. Qualify testing personnel according to ASSE Standard #6020 for inspectors and ASSE Standard #6030 for verifiers.

C. Source Limitations: Obtain compressed-air service connections of same type and from same manufacturer as service connections provided for in Division 22 Section "Gas Piping for Laboratory and Healthcare Facilities."

D. Brazing: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications," or AWS B2.2, "Standard for Brazing Procedure and Performance Qualification."

E. 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.

F. ASME Compliance:
   1. Comply with ASME B31.1, "Power Piping," for laboratory compressed-air piping operating at more than 150 psig.
   2. Comply with ASME B31.9, "Building Services Piping," for laboratory compressed-air piping operating at 150 psig or less.

G. Comply with NFPA 99, "Health Care Facilities," for medical compressed-air system materials and installation in healthcare facilities.

1.6 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

B. Coordinate medical compressed-air service connections with other service connections. Medical vacuum service connections are specified in Division 22 Section "Vacuum Piping for Laboratory and Healthcare Facilities," and medical gas service connections are specified in Division 22 Section "Gas Piping for Laboratory and Healthcare Facilities."

1.7 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Quick-Coupler Service Connections: Furnish complete noninterchangeable medical compressed-air pressure outlets.
      a. Medical Compressed-Air Service Connections: Equal to <Insert number> percent of amount installed, but no fewer than <Insert number> units.
      b. Gas-Powered-Tool, Compressed-Air Service Connections: Equal to <Insert number> percent of amount installed, but no fewer than <Insert number> units.
   2. D.I.S.S. Connections: Furnish complete noninterchangeable medical compressed-air pressure outlets complying with CGA V-5.
      a. Compressed-Air D.I.S.S. No. 1160: Equal to <Insert number> percent of amount installed, but no fewer than <Insert number> units.
      b. Gas-Powered-Tool, Compressed-Air D.I.S.S. No. 1160: Equal to <Insert number> percent of amount installed, but no fewer than <Insert number> units.

PART 2 - PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

A. Copper Medical Gas Tube: ASTM B 819, [Types K and L], seamless, drawn temper, that has been manufacturer cleaned, purged, and sealed for medical gas service or according to CGA G-4.1 for oxygen service. Include standard color marking "OXY," "MED," "OXY/MED," "OXY/ACR," or "ACR/MED" in green for Type K tube and in blue for Type L tube.
   1. General Requirements for Copper Fittings: Manufacturer cleaned, purged, and bagged for oxygen service according to CGA G-4.1.
   2. Wrought-Copper Fittings: ASME B16.22, solder-joint pressure type or MSS SP-73, with dimensions for brazed joints.
   3. Copper Unions: ASME B16.22 or MSS SP-123, wrought copper or cast-copper alloy.

B. Memory-Metal Couplings: Cryogenic compression fitting made of ASTM F 2063, nickel-titanium, shape-memory alloy, and that has been manufacturer cleaned, purged, and sealed for oxygen service according to CGA G-4.1.
   1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Smart Technology, Inc.
      b. <Insert manufacturer's name>.

2.2 JOINING MATERIALS

A. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

2.3 VALVES

A. General Requirements for Valves: Manufacturer cleaned, purged, and bagged according to CGA G-4.1 for oxygen service.

B. Ball Valves: MSS SP-110, 3-piece body, brass or bronze.
   1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   3. Basis-of-Design Product: Subject to compliance with requirements, provide [the product indicated on Drawings] <Insert manufacturer's name; product name or designation> or a comparable product by one of the following:
      a. Amico Corporation.
      b. BeaconMedaes.
      c. Conbraco Industries, Inc.
      d. Tri-Tech Medical.
   4. Pressure Rating: 300 psig minimum.
   5. Ball: Full-port, chrome-plated brass.
   6. Seats: PTFE or TFE.
   7. Handle: Lever[type with locking device].
   8. Stem: Blowout proof with PTFE or TFE seal.
   9. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.

C. Check Valves: In-line pattern, bronze.
   1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   3. Basis-of-Design Product: Subject to compliance with requirements, provide [the product indicated on Drawings] <Insert manufacturer's name; product name or designation> or a comparable product by one of the following:
      a. Amico Corporation.
      b. BeaconMedaes.
      c. Tri-Tech Medical.
   4. Pressure Rating: 300 psig minimum.
   5. Operation: Spring loaded.
   6. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.

D. Zone Valves: MSS SP-110, 3-piece-body, brass or bronze ball valve with gage.
   1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

3. Basis-of-Design Product: Subject to compliance with requirements, provide [the product indicated on Drawings] <Insert manufacturer's name; product name or designation> or a comparable product by one of the following:
   a. Amico Corporation.
   b. BeaconMedaes.
   c. Tri-Tech Medical.
4. Pressure Rating: 300 psig minimum.
5. Ball: Full-port, chrome-plated brass.
6. Seats: PTFE or TFE.
7. Handle: Lever[type with locking device].
8. Stem: Blowout proof with PTFE or TFE seal.
9. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.
10. Pressure Gage: Manufacturer installed on one copper-tube extension.

E. Zone Valve Boxes: Formed steel with anchors for recessed mounting, holes with grommets in box sides for tubing extension protection, and of size for single or multiple valves with pressure gages and in sizes required to permit manual operation of valves.
1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
3. Basis-of-Design Product: Subject to compliance with requirements, provide [the product indicated on Drawings] <Insert manufacturer's name; product name or designation> or a comparable product by one of the following:
   a. Amico Corporation.
   b. BeaconMedaes.
4. Interior Finish: Factory-applied white enamel.
5. Cover Plate: [Aluminum or extruded-anodized aluminum] [Satin-chrome finish steel] [Stainless steel with NAAMM AMP 503, No. 4 finish] with frangible or removable windows.
6. Valve-Box Windows: Clear or tinted transparent plastic with labeling that includes rooms served, according to NFPA 99.

F. Zone Valve Boxes: Formed or extruded aluminum with anchors for recessed mounting, holes with grommets in box sides for tubing extension protection, and of size for single or multiple valves with pressure gages and in sizes required to permit manual operation of valves.
1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
3. Basis-of-Design Product: Subject to compliance with requirements, provide [the product indicated on Drawings] <Insert manufacturer's name; product name or designation> or a comparable product by one of the following:
   a. Tri-Tech Medical.
   b. <Insert manufacturer's name>.
4. Interior Finish: Factory-applied white enamel.

5. Cover Plate: [Aluminum or extruded-anodized aluminum] [Stainless steel with NAAMM AMP 503, No. 4 finish] with frangible or removable windows.
6. Valve-Box Windows: Clear or tinted transparent plastic with labeling that includes rooms served, according to NFPA 99.

G. Safety Valves: Bronze-body, ASME-construction, poppet, pressure-relief type with settings to match system requirements.

H. Pressure Regulators: Bronze body and trim; spring-loaded, diaphragm-operated relieving type; manual pressure-setting adjustment; rated for [250-psig] <Insert pressure> minimum inlet pressure; and capable of controlling delivered air pressure within 0.5 psig for each 10-psig inlet pressure.

I. Automatic Drain Valves: Stainless-steel body and internal parts, rated for [200-psig] <Insert pressure> minimum working pressure, capable of automatic discharge of collected condensate.[Include mounting bracket where wall mounting is indicated.]

2.4 MEDICAL COMPRESSED-AIR SERVICE CONNECTIONS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

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

C. Basis-of-Design Product: Subject to compliance with requirements, provide [the product indicated on Drawings] <Insert manufacturer's name; product name or designation> or a comparable product by one of the following:
1. Amico Corporation.
2. BeaconMedaes.
3. Tri-Tech Medical.
4. <Insert manufacturer's name>.

D. Connection Devices: For specific medical compressed-air pressure and service listed. Include roughing-in assemblies, finishing assemblies, and cover plates. Individual cover plates are not required if service connection is in multiple unit or assembly with cover plate. Furnish recessed-type units made for concealed piping unless otherwise indicated.
1. Roughing-in Assembly:
   a. Steel outlet box for recessed mounting and concealed piping.
   b. Brass-body outlet block with secondary check valve that will prevent gas flow when primary valve is removed.
   c. Double seals that will prevent air leakage.
   d. ASTM B 819, NPS 3/8 copper outlet tube brazed to valve with service marking and tube-end dust cap.
2. Finishing Assembly:
   a. Brass housing with primary check valve.
   b. Double seals that will prevent air leakage.
   c. Cover plate with gas-service label.
3. Quick-Coupler Service Connections: Pressure outlet with noninterchangeable keyed indexing to prevent interchange between services, constructed to

permit one-handed connection and removal of equipment, and with positive-locking ring that retains equipment stem in valve during use.

4. D.I.S.S. Service Connections: Pressure outlets, complying with CGA V-5, with threaded indexing to prevent interchange between services, constructed to permit one-handed connection and removal of equipment.
   a. Medical Air Service Connections: CGA V-5, D.I.S.S. No. 1160.
   b. Instrument Air Service Connections: CGA V-5, D.I.S.S. No. 1160.
5. Cover Plates: One piece, [stainless steel, with NAAMM AMP 503, No. 4 finish] [metal, with chrome-plated finish] [anodized aluminum] and permanent, color-coded, identifying label matching corresponding service.

2.5 MEDICAL COMPRESSED-AIR-PIPING ALARM SYSTEMS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

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

C. Basis-of-Design Product: Subject to compliance with requirements, provide [the product indicated on Drawings] <Insert manufacturer's name; product name or designation> or a comparable product by one of the following:
   1. Amico Corporation.
   2. BeaconMedaes.
   3. Tri-Tech Medical.

D. Panels for medical compressed-air piping systems may be combined in single panels with medical vacuum and medical gas piping systems.

E. Components: Designed for continuous service and to operate on power supplied from [120] [240] [277]-V ac power source to alarm panels and with connections for low-voltage wiring to remote sensing devices. Include step-down transformers if required.

F. Dew Point Monitors: Continuous line monitoring, having panel with gage or digital display, pipeline sensing element, electrical connections for alarm system, factory- or field-installed valved bypass, and visual and cancelable audio signal for dryer site and master alarm panels. Alarm signals when pressure dew point rises above 39 deg F at 55 psig.
   1. Operation: [Chilled-mirror method] [Chilled-mirror method or hygrometer moisture analyzer with sensor probe] [Hygrometer moisture analyzer with sensor probe].

G. Pressure Switches or Transducer Sensors: Continuous line monitoring with electrical connections for alarm system.
   1. Low-Pressure Operating Range: 0- to 100-psig.
   2. High-Pressure Operating Range: Up to 250-psig.

H. Carbon Monoxide Monitors: Panel with gage or digital display, pipeline sensing element, electrical connections for alarm system, and factory- or field-installed valved bypass. Alarm signals when carbon monoxide level rises above 10 ppm.

I. General Requirements for Medical Compressed-Air Alarm Panels: Factory wired with audible and color-coded visible signals to indicate specified functions.
   1. Mounting: [Exposed, surface] [Recessed] installation.
   2. Enclosures: Fabricated from minimum 0.047-inch-thick steel or minimum 0.05-inch-thick aluminum, with knockouts for electrical and piping connections.

J. Master Alarm Panels: Separate trouble alarm signals, pressure gages, and indicators for medical compressed-air piping systems.
   1. Include alarm signals when the following conditions exist:
      a. Medical Air: Pressure drops below [40 psig] <Insert pressure> or rises above [60 psig] <Insert pressure>, backup air compressor is in operation, pressure drop across filter assembly increases more than 2 psig, dew point rises above 39 deg F at 55 psig, carbon monoxide level rises above 10 ppm, and high water level is reached in receiver for liquid-ring, medical air compressor systems.
      b. Dental Air: Pressure drops below [65 psig] <Insert pressure> or rises above [110 psig] <Insert pressure>, backup air compressor is in operation, pressure drop across filter assembly increases more than 2 psig, dew point rises above [50 deg F] <Insert temperature> at [125 psig] <Insert pressure>, and carbon monoxide level rises above 10 ppm.
      c. Instrument Air: Pressure drops below [165 psig] <Insert pressure> or rises above [185 psig] <Insert pressure>.
      d. Medical Laboratory Air: Pressure drops below [90 psig] <Insert pressure> or rises above [110 psig] <Insert pressure>.

K. Anesthetizing-Area Alarm Panels: Separate trouble alarm signals, pressure gages, and indicators for medical compressed-air piping systems.
   1. Include alarm signals when the following conditions exist:
      a. Medical Air: Pressure drops below [40 psig] <Insert pressure> or rises above [60 psig] <Insert pressure>.
      b. Instrument Air: Pressure drops below [165 psig] <Insert pressure> or rises above [185 psig] <Insert pressure>.

L. Area Alarm Panels: Separate trouble alarm signals, pressure gages, and indicators for medical compressed-air piping systems.
   1. Include alarm signals when the following condition exists:
      a. Medical Air: Pressure drops below [40 psig] <Insert pressure> or rises above [60 psig] <Insert pressure>.

2.6 COMPUTER INTERFACE CABINET

A. Description: Wall-mounting, welded-steel control cabinet with gasketed door, mounting brackets, grounding device, and white-enamel finish for connection of medical compressed-air- piping-system alarms to facility computer. Include factory-installed signal circuit boards, power transformer, circuit breaker, wiring terminal board, and internal wiring capable of interfacing [20] <Insert number> alarm signals.

2.7 SLEEVES

A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

B. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
   1. Underdeck Clamp: Clamping ring with set screws.

2.8 ESCUTCHEONS

A. General Requirements for Escutcheons: Manufactured wall and ceiling escutcheons and floor plates, with ID to closely fit around pipe and tube and OD that completely covers opening.

B. One-Piece, Deep-Pattern Escutcheons: Deep-drawn, box-shaped brass with polished chrome-plated finish.

C. One-Piece, Cast-Brass Escutcheons: With set screw.
   1. Finish: [Polished chrome-plated] [Rough brass] [Polished chrome-plated and rough brass].

D. Split-Casting, Cast-Brass Escutcheons: With concealed hinge and set screw.
   1. Finish: [Polished chrome-plated] [Rough brass] [Polished chrome-plated and rough brass].

E. One-Piece, Stamped-Steel Escutcheons: With [set screw] [spring clips] [set screw or spring clips] and chrome-plated finish.

F. Split-Plate, Stamped-Steel Escutcheons: With [concealed] [exposed-rivet] hinge, [set screw] [spring clips] [set screw or spring clips], and chrome-plated finish.

G. One-Piece, Floor-Plate Escutcheons: Cast iron.

H. Split-Casting, Floor-Plate Escutcheons: Cast brass with concealed hinge and set screw.

2.9 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
   1. Characteristics: Post-hardening, volume adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
   2. Design Mix: 5000-psi, 28-day compressive strength.
   3. Packaging: Premixed and factory packaged.

2.10 NITROGEN

A. Description: Comply with USP 28 - NF 23 for oil-free dry nitrogen.

PART 3 - EXECUTION

3.1 PREPARATION

A. Cleaning of Medical Gas Tubing: If manufacturer-cleaned and -capped fittings or tubing are not available or if precleaned fittings or tubing must be recleaned because of exposure, have supplier or separate agency acceptable to authorities having jurisdiction perform the following procedures:
   1. Clean medical gas tube and fittings, valves, gages, and other components of oil, grease, and other readily oxidizable materials as required for oxygen service according to CGA G-4.1, "Cleaning Equipment for Oxygen Service."
   2. Wash medical gas tubing and components in hot, alkaline-cleaner-water solution of sodium carbonate or trisodium phosphate in proportion of 1 lb of chemical to 3 gal. of water.
      a. Scrub to ensure complete cleaning.
      b. Rinse with clean, hot water to remove cleaning solution.

3.2 PIPING APPLICATIONS

A. Medical Air Piping: Use Type L, copper medical gas tube; wrought-copper fittings; and brazed joints.

B. Instrument Air Piping:
   1. NPS 3 and Smaller: Use [Type K] [Type L], copper medical gas tube; wrought-copper fittings; and brazed joints.
   2. NPS 3-1/2 and Larger: Use Type K, copper medical gas tube; wrought-copper fittings; and brazed joints.

3.3 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of compressed-air piping. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, air-compressor sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

B. Comply with ASSE Standard #6010 for installation of compressed-air piping.

C. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal and coordinate with other services occupying that space.

F. Install piping adjacent to equipment and specialties to allow service and maintenance.

G. Install air and drain piping with 1 percent slope downward in direction of flow.

H. Install nipples, unions, special fittings, and valves with pressure ratings same as or higher than system pressure rating used in applications below unless otherwise indicated.

I. Install eccentric reducers, if available, where compressed-air piping is reduced in direction of flow, with bottoms of both pipes and reducer fitting flush.

J. Install branch connections to compressed-air mains from top of main. Provide drain leg and drain trap at end of each main and branch and at low points.

K. Install thermometer and pressure gage on discharge piping from each air compressor and on each receiver. Comply with requirements in Division 22 Section "Meters and Gages for Plumbing Piping."

L. Install piping to permit valve servicing.

M. Install piping free of sags and bends.

N. Install fittings for changes in direction and branch connections.

O. Install medical compressed-air piping to medical compressed-air service connections specified in this Section, to medical compressed-air service connections in equipment specified in Division 22 Section "Gas Piping for Laboratory and Healthcare Facilities," and to equipment specified in other Sections requiring medical compressed-air service.

P. Install seismic restraints on compressed-air piping. Seismic-restraint devices are specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."

Q. Install compressed-air service connections recessed in walls. Attach roughing-in assembly to substrate; attach finishing assembly to roughing-in assembly.

R. Connect compressed-air piping to air compressors and to compressed-air outlets and equipment requiring compressed-air service.

S. Install unions in copper compressed-air tubing adjacent to each valve and at final connection to each piece of equipment, machine, and specialty.

3.4 VALVE INSTALLATION

A. Install shutoff valve at each connection to and from compressed-air equipment and specialties.

B. Install check valves to maintain correct direction of compressed-air flow from compressed-air equipment.

C. Install valve boxes recessed in wall and anchored to substrate. Single boxes may be used for multiple valves that serve same area or function.

D. Install zone valves and gages in valve boxes. Rotate valves to angle that prevents closure of cover when valve is in closed position.

E. Install safety valves on compressed-air receivers where required by NFPA 99 and where recommended by specialty manufacturers.

F. Install pressure regulators on compressed-air piping where reduced pressure is required.

G. Install automatic drain valves on equipment, specialties, and piping with drain connection. Run drain piping to floor drain so contents spill over or into it.

H. Install flexible pipe connectors in discharge piping and in inlet air piping from remote air-inlet filter] of each air compressor.

3.5 JOINT CONSTRUCTION

A. Ream ends of PVC pipes and remove burrs.

B. Remove scale, slag, dirt, and debris from outside of cleaned tubing and fittings before assembly.

C. Threaded Joints: Apply appropriate tape to external pipe threads.

D. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" Chapter. Continuously purge joint with oil-free dry nitrogen during brazing.

E. Soldered Joints: Apply ASTM B 813, water-flushable flux to tube end. Join copper tube and fittings according to ASTM B 828.

F. Memory-Metal Coupling Joints: Join new copper tube to existing tube according to procedures developed by fitting manufacturer for installation of memory-metal coupling joints.

3.6 COMPRESSED-AIR SERVICE COMPONENT INSTALLATION

3.7 MEDICAL COMPRESSED-AIR-PIPING ALARM SYSTEM INSTALLATION

A. Alarm panels for medical compressed-air piping systems may be combined in single panels with medical vacuum piping systems and medical gas piping systems.

B. Install alarm system components for medical compressed-air-piping according to and in locations required by NFPA 99.

C. Install area and master alarm panels for medical compressed-air piping system where indicated.

D. Install computer interface cabinet with connection to medical compressed-air-piping alarm system and to facility computer.

3.8 SLEEVE INSTALLATION

A. Sleeves are not required for core-drilled holes.

B. Permanent sleeves are not required for holes formed by removable PE sleeves.

C. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs using [galvanized-steel pipe] [galvanized-steel sheet] [stack sleeve fittings] [PVC pipe].
   1. Wall Penetrations: Cut sleeves to length for mounting flush with both surfaces.
   2. Floor Penetrations: Extend sleeves installed in floors of mechanical equipment areas or other wet areas [2 inches] <Insert dimension> above

finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.

D. Install sleeves in new walls and slabs as new walls and slabs are constructed.

E. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
   1. [PVC] [Steel] Pipe Sleeves: For pipes smaller than [NPS 6] <Insert pipe size>.
   2. Steel Sheet Sleeves: For pipes [NPS 6] <Insert pipe size> and larger penetrating gypsum board partitions.
   3. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to [2 inches] <Insert dimension> above finished floor level. Comply with requirements in Division 07 Section "Sheet Metal Flashing and Trim" for flashing.
      a. Seal space outside of sleeve fittings with grout.

F. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements in Division 07 Section "Penetration Firestopping."

3.9 ESCUTCHEON INSTALLATION

A. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
   1. New Piping:
      a. Piping with Fitting or Sleeve Protruding from Wall: One piece, deep pattern.
      b. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One piece, [cast brass with polished chrome-plated finish] [stamped steel with set screw] [stamped steel with set screw or spring clips] [stamped steel with spring clips].
      c. Bare Piping at Ceiling Penetrations in Finished Spaces: [One piece, cast brass with polished chrome-plated finish] [One piece or split casting, cast brass with polished chrome-plated finish] [Split casting, cast brass with polished chrome-plated finish] [One piece, stamped steel with set screw] [One piece or split plate, stamped steel with set screw] [Split plate, stamped steel with set screw].
      d. Bare Piping in Unfinished Service Spaces: One piece, [cast brass with polished chrome-plated finish] [cast brass with rough-brass finish] [stamped steel with set screw] [stamped steel with spring clips] [stamped steel with set screw or spring clips].
      e. Bare Piping in Equipment Rooms: One piece, [cast brass] [stamped steel with set screw] [stamped steel with spring clips] [stamped steel with set screw or spring clips].
      f. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece floor plate.

3.10 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment" for seismic-restraint devices.

B. Comply with requirements in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support devices.

C. Vertical Piping: MSS Type 8 or 42, clamps.

D. Individual, Straight, Horizontal Piping Runs:
   1. 100 Feet and Less: MSS Type 1, adjustable, steel, clevis hangers.
   2. Longer Than 100 Feet: MSS Type 43, adjustable, roller hangers.

E. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze. Comply with requirements in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment" for trapeze hangers.

F. Base of Vertical Piping: MSS Type 52, spring hangers.

G. Support horizontal piping within [12 inches] <Insert dimension> of each fitting and coupling.

H. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.

I. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 1/4: 60 inches with 3/8-inch rod.
   2. NPS 3/8 and NPS 1/2: 72 inches with 3/8-inch rod.
   3. NPS 3/4: 84 inches with 3/8-inch rod.
   4. NPS 1: 96 inches with 3/8-inch rod.
   5. NPS 1-1/4: 108 inches with 3/8-inch rod.
   6. NPS 1-1/2: 10 feet with 3/8-inch rod.
   7. NPS 2: 11 feet with 3/8-inch rod.
   8. NPS 2-1/2: 13 feet with 1/2-inch rod.
   9. NPS 3: 14 feet with 1/2-inch rod.
   10. NPS 3-1/2: 15 feet with 1/2-inch rod.
   11. NPS 4: 16 feet with 1/2-inch rod.

J. Install supports for vertical copper tubing every 10 feet.

3.11 LABELING AND IDENTIFICATION

A. Install identifying labels and devices for nonmedical laboratory compressed-air piping, valves, and specialties. Comply with requirements in Division 22 Section "Identification for Plumbing Piping and Equipment."

B. Install identifying labels and devices for medical compressed-air piping systems according to NFPA 99. Use the following or similar captions and color-coding for piping products where required by NFPA 99:
   1. Medical Air: Black letters on yellow background.
   2. Dental Air: Black letters on yellow-and-white diagonal stripe background.
   3. Instrument Air: White letters on red background.

4. Medical Laboratory Air: Black letters on yellow-and-white checkerboard background.

3.12 FIELD QUALITY CONTROL FOR COMPRESSED-AIR PIPING IN NONMEDICAL LABORATORY FACILITIES

A. Testing Agency: [Owner will engage] [Engage] qualified testing agency to perform field tests and inspections of compressed-air piping in nonmedical laboratory facilities and prepare test reports.

B. Perform tests and inspections of compressed-air piping in nonmedical laboratory facilities and prepare test reports.

C. Tests and Inspections:
1. Piping Leak Tests for Compressed-Air Piping: Test new and modified parts of existing piping. Cap and fill general-service compressed-air piping with oil-free dry nitrogen to pressure of 50 psig above system operating pressure, but not less than [150 psig] <Insert pressure>. Isolate test source and let stand for four hours to equalize temperature. Refill system, if required, to test pressure; hold for two hours with no drop in pressure.
2. Repair leaks and retest until no leaks exist.
3. Inspect [filters] [and] [pressure regulators] for proper operation.

3.13 FIELD QUALITY CONTROL FOR MEDICAL COMPRESSED-AIR PIPING IN HEALTHCARE FACILITIES

A. Testing Agency: [Owner will engage] [Engage] a qualified testing agency to perform tests and inspections of medical compressed-air piping in healthcare facilities and prepare test reports.

B. Perform tests and inspections of medical compressed-air piping systems in healthcare facilities and prepare test reports.

C. Tests and Inspections:
1. Medical Compressed-Air Testing Coordination: Perform tests, inspections, verifications, and certification of medical compressed-air piping systems concurrently with tests, inspections, and certification of [medical vacuum piping] [and] [medical gas piping] systems.
2. Preparation: Perform the following Installer tests according to requirements in NFPA 99 and ASSE Standard #6010:
   a. Initial blowdown.
   b. Initial pressure test.
   c. Cross-connection test.
   d. Piping purge test.
   e. Standing pressure test for positive-pressure medical compressed-air piping.
   f. Repair leaks and retest until no leaks exist.
3. System Verification: Comply with requirements in NFPA 99, ASSE Standard #6020, and ASSE Standard #6030 for verification of medical compressed-air piping systems and perform the following tests and inspections:
   a. Standing pressure test.

b. [Individual-pressurization] [Individual-pressurization or pressure-differential] [Pressure-differential] cross-connection test.
c. Valve test.
d. Master and area alarm tests.
e. Piping purge test.
f. Piping particulate test.
g. Piping purity test.
h. Final tie-in test.
i. Operational pressure test.
j. Medical air purity test.
k. Verify correct labeling of equipment and components.

4. Testing Certification: Certify that specified tests, inspections, and procedures have been performed and certify report results. Include the following:
   a. Inspections performed.
   b. Procedures, materials, and gases used.
   c. Test methods used.
   d. Results of tests.

D. Remove and replace components that do not pass tests and inspections and retest as specified above.

3.14 DEMONSTRATION

A. [Engage factory-authorized service representative to train] [Train] Owner's maintenance personnel to adjust, operate, and maintain medical compressed-air alarm systems. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION

SECTION 22 62 13

VACUUM PIPING FOR HEALTHCARE FACILITIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:
   1. Medical surgical vacuum piping and specialties, designated "medical vacuum" operating at 15 inches mercury
   2. Waste anesthetic gas disposal piping and specialties, designated "WAGD evacuation" operating at 15 inches mercury

B. Related Sections include the following:
   1. Division 12 Section "Healthcare Casework" for vacuum outlets in metal medical casework.
   2. Division 22 Section "Vacuum Equipment for Healthcare Facilities" for vacuum producers.

1.3 DEFINITIONS

A. D.I.S.S.: Diameter-index safety system.

B. 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.

C. WAGD: Waste anesthetic gas disposal.

D. Medical vacuum piping systems include medical vacuum WAGD evacuation piping systems.

1.4 SUBMITTALS

A. Product Data: For the following:
   1. Vacuum pipes and fittings.
   2. Vacuum valves and valve boxes.
   3. Medical vacuum service connections and vacuum-bottle brackets.

B. Shop Drawings: Diagram power, signal, and control wiring.

C. Piping Material Certification: Signed by Installer certifying that medical vacuum piping materials comply with NFPA 99 requirements.

D. Qualification Data: For Installer and testing agency.

E. Brazing certificates.

F. Field quality-control test reports.

G. Operation and Maintenance Data: For vacuum piping specialties to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Installer Qualifications:
   1. Medical Vacuum Piping Systems for Healthcare Facilities: Qualify installers according to ASSE Standard #6010.
   2. Extruded-Tee Outlet Procedure: Qualify operators according to training provided by T-DRILL Industries Inc., for making branch outlets.

B. Testing Agency Qualifications: An independent testing agency, with the experience and capability to conduct the vacuum piping testing indicated, that is a member of the Medical Gas Professional Healthcare Organization or is an NRTL, and that is acceptable to authorities having jurisdiction.
   1. Qualify testing personnel according to ASSE Standard #6020 for inspectors and ASSE Standard #6030 for verifiers.

C. Source Limitations: Obtain vacuum service connections of same type and from same manufacture as service connections provided for in Division 22 Section "Gas Piping for Laboratory and Healthcare Facilities."

D. Brazing: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications," or AWS B2.2, "Standard for Brazing Procedure and Performance Qualification."

E. 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.

F. Comply with ASME B31.9, "Building Services Piping," for vacuum piping in laboratory facilities.

G. NFPA Compliance: Comply with NFPA 99, "Health Care Facilities," for medical vacuum system materials and installation in healthcare facilities.

1.6 COORDINATION

A. Coordinate medical vacuum service connections with other service connections. Medical compressed-air service connections are specified in Division 22 Section "Compressed-Air Piping for Laboratory and Healthcare Facilities," and medical gas service connections are specified in Division 22 Section "Gas Piping for Laboratory and Healthcare Facilities."

1.7 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Quick-Coupler Service Connections: Furnish complete noninterchangeable medical vacuum suction inlets.
      a. Medical Vacuum Service Connections: Equal to <Insert number> percent of amount installed, but no fewer than <Insert number> units.

b. WAGD Evacuation Service Connections: Equal to <Insert number> percent of amount installed, but no fewer than <Insert number> units.

2. D.I.S.S. Connections: Furnish complete noninterchangeable medical vacuum suction inlets complying with CGA V-5.
   a. Medical Vacuum D.I.S.S. No. 1220: Equal to <Insert number> percent of amount installed, but no fewer than <Insert number> units.
   b. WAGD Evacuation D.I.S.S. No. 2220: Equal to <Insert number> percent of amount installed, but no fewer than <Insert number> units.
3. Medical Vacuum Bottle Brackets: Equal to <Insert number> percent of amount installed, but no fewer than <Insert number> units.

PART 2 - PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

A. Copper Medical Gas Tube: ASTM B 819, Type L, seamless, drawn temper that has been manufacturer cleaned, purged, and sealed for medical gas service or according to CGA G-4.1 for oxygen service. Include standard color marking "OXY," "MED," "OXY/MED," "OXY/ACR," or "ACR/MED" in blue.
   1. General Requirements for Copper Fittings: Manufacturer cleaned, purged, and bagged for oxygen service according to CGA G-4.1.
   2. Wrought-Copper Fittings: ASME B16.22, solder-joint pressure type or MSS SP-73, with dimensions for brazed joints.
   3. Copper Unions: ASME B16.22 or MSS SP-123, wrought copper or cast-copper alloy.

B. Copper Water Tube: ASTM B 88, Type M, seamless, drawn temper.

C. Memory-Metal Couplings: Cryogenic compression fitting made of ASTM F 2063, nickel-titanium, shape-memory alloy, and that has been manufacturer cleaned, purged, and sealed for oxygen service according to CGA G-4.1.
   1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Smart Technology, Inc.
      b. <Insert manufacturer's name>.

2.2 JOINING MATERIALS

A. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for general-duty brazing unless otherwise indicated.

B. Threaded-Joint Tape: PTFE.

C. Pipe-Flange Gasket Materials: ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness, full-face type.

D. Flange Bolts and Nuts: ASME B18.2.1, carbon steel.

2.3 VALVES

A. General Requirements for Valves: Manufacturer cleaned, purged, and bagged according to CGA G-4.1 for oxygen service.
   1. Exception: Factory cleaning and bagging are not required for valves for WAGD service.

B. Copper-Alloy Ball Valves: MSS SP-110, 3-piece body, brass or bronze.
   1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   3. Basis-of-Design Product: Subject to compliance with requirements, provide [the product indicated on Drawings] <Insert manufacturer's name; product name or designation> or a comparable product by one of the following:
      a. Amico Corporation.
      b. BeaconMedaes.
      c. Conbraco Industries, Inc.
   4. Pressure Rating: 300 psig minimum.
   5. Ball: Full-port, chrome-plated brass.
   6. Seats: PTFE or TFE.
   7. Handle: Lever type with locking device.
   8. Stem: Blowout proof with PTFE or TFE seal.
   9. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.

C. Bronze Check Valves: In-line pattern.
   1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   3. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
      a. Amico Corporation.
      b. BeaconMedaes.
      c. Conbraco Industries, Inc.
   4. Pressure Rating: 300 psig minimum.
   5. Operation: Spring loaded.
   6. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.

D. Zone Valves: MSS SP-110, 3-piece-body, brass or bronze ball valve with gage.
   1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   3. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
      a. Amico Corporation.
      b. BeaconMedaes.

c. Squire-Cogswell/Aeros Instruments, Inc.

4. Pressure Rating: 300 psig minimum.
5. Ball: Full-port, chrome-plated brass.
6. Seats: PTFE or TFE.
7. Handle: Lever type with locking device.
8. Stem: Blowout proof with PTFE or TFE seal.
9. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.
10. Vacuum Gage: Manufacturer installed on one copper-tube extension.

E. Zone Valve Boxes: Formed steel with anchors for recessed mounting, holes with grommets in box sides for tubing extension protection, and of size for single or multiple valves with vacuum gages and in sizes required to permit manual operation of valves.

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
3. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
   a. Amico Corporation.
   b. BeaconMedaes.
4. Interior Finish: Factory-applied white enamel.
5. Cover Plate: Aluminum or extruded-anodized aluminum with frangible or removable windows.
6. Valve-Box Windows: Clear or tinted transparent plastic with labeling that includes rooms served, according to NFPA 99.

F. Zone Valve Boxes: Formed or extruded aluminum with anchors for recessed mounting, holes with grommets in box sides for tubing extension protection, and of size for single or multiple valves with vacuum gages and in sizes required to permit manual operation of valves.

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
3. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
   a. Beacon Medaes
   b. Tri-Tech Medical.
4. Interior Finish: Factory-applied white enamel.
5. Cover Plate: Aluminum or extruded-anodized aluminum with frangible or removable windows.
6. Valve-Box Windows: Clear or tinted transparent plastic with labeling that includes rooms served, according to NFPA 99.

2.4 MEDICAL VACUUM SERVICE CONNECTIONS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

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

C. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
   1. Amico Corporation.
   2. BeaconMedaes.
   3. Tri-Tech Medical.

D. Connection Devices: For specific medical vacuum service listed. Include roughing-in assemblies, finishing assemblies, and cover plates. Individual cover plates are not required if service connection is in multiple unit or assembly with cover plate. Furnish recessed-type units made for concealed piping unless otherwise indicated.
   1. Roughing-in Assembly:
      a. Steel outlet box for recessed mounting and concealed piping.
      b. Brass-body inlet block.
      c. Seals that will prevent vacuum leakage.
      d. ASTM B 819, NPS 3/8 copper outlet tube brazed to valve with service marking and tube-end dust cap.
   2. Finishing Assembly:
      a. Brass housing with primary check valve.
      b. Seals that will prevent vacuum leakage.
      c. Cover plate with gas-service label.
   3. Quick-Coupler Service Connections: Suction inlets for [medical vacuum] [medical vacuum and WAGD evacuation] [WAGD evacuation] service outlets with noninterchangeable keyed indexing to prevent interchange between services, constructed to permit one-handed connection and removal of equipment, and with positive-locking ring that retains equipment stem in valve during use.
   4. D.I.S.S. Service Connections: Suction inlets, complying with CGA V-5, with threaded indexing to prevent interchange between services, constructed to permit one-handed connection and removal of equipment.
      a. Medical Vacuum Service Connections: CGA V-5, D.I.S.S. No. 1220.
      b. WAGD Evacuation Service Connections: CGA V-5, D.I.S.S. No. 2220.
   5. Vacuum Bottle Brackets: One piece, with pattern and finish matching corresponding service cover plate.
   6. Cover Plates: One piece, stainless steel, with NAAMM AMP 503, No. 4 finish and permanent, color-coded, identifying label matching corresponding service.

2.5 MEDICAL VACUUM PIPING ALARM SYSTEMS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

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

C. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
   1. Amico Corporation.
   2. BeaconMedaes.
   3. Squire-Cogswell/Aeros Instruments, Inc.

D. Panels for medical vacuum piping systems may be combined in single panels with medical compressed-air and medical gas piping systems.

E. Components: Designed for continuous service and to operate on power supplied from 120 V ac power source to alarm panels and with connections for low-voltage wiring to remote sensing devices. Include step-down transformers if required.

F. Vacuum Switches or Transducer Sensors: Continuous line monitoring with electrical connections for alarm system.
   1. Vacuum Operating Range: 0- to 30-in. Hg.

G. General Requirements for Medical Vacuum Alarm Panels: Factory wired with audible and color-coded visible signals to indicate specified functions.
   1. Mounting: Recessed installation.
   2. Enclosures: Fabricated from minimum 0.047-inch thick steel or minimum 0.05-inch thick aluminum, with knockouts for electrical and piping connections.

H. Master Alarm Panels: With separate trouble alarm signals, vacuum gages, and indicators for medical vacuum piping systems.
   1. Include alarm signals when the following conditions exist:
      a. Medical Vacuum: Vacuum drops below 12-in. Hg and backup vacuum pump is in operation.
      b. WAGD Evacuation: Vacuum drops below 12-in. Hg

I. Anesthetizing-Area Alarm Panels: Separate trouble alarm signals; vacuum gages; and indicators for medical vacuum piping systems.
   1. Include alarm signals when the following conditions exist:
      a. Medical Vacuum: Vacuum drops below 12-in. Hg .
      b. WAGD Evacuation: Vacuum drops below 12-in. Hg .

J. Area Alarm Panels: Separate trouble alarm signals; vacuum gages; and indicators for medical vacuum piping systems.
   1. Include alarm signals when the following condition exists:
      a. Medical Vacuum: Vacuum drops below 12-in. Hg

2.6 COMPUTER INTERFACE CABINET

A. Description: Wall-mounting, welded-steel, control cabinet with gasketed door, mounting brackets, grounding device, and white-enamel finish for connection of medical vacuum piping system alarms to facility computer. Include factory-installed signal circuit boards, power transformer, circuit breaker, wiring terminal board, and internal wiring capable of interfacing 20 alarm signals.

2.7 FLEXIBLE PIPE CONNECTORS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Metraflex, Inc.
   2. Unaflex.
   3. Universal Metal Hose; a Hyspan Co.

C. Description: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.
   1. Working-Pressure Rating: 200 psig .
   2. End Connections: Threaded copper pipe or plain-end copper tube.

2.8 SLEEVES

A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

B. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
   1. Underdeck Clamp: Clamping ring with set screws.

2.9 ESCUTCHEONS

A. General Requirements for Escutcheons: Manufactured wall and ceiling escutcheons and floor plates, with ID to closely fit around pipe and tube and OD that completely covers opening.

B. One-Piece, Deep-Pattern Escutcheons: Deep-drawn, box-shaped brass with polished chrome-plated finish.

C. One-Piece, Cast-Brass Escutcheons: With set screw.
   1. Finish: Polished chrome-plated

D. Split-Casting, Cast-Brass Escutcheons: With concealed hinge and set screw.
   1. Finish: Polished chrome-plated

E. One-Piece, Stamped-Steel Escutcheons: With set screw and chrome-plated finish.

F. Split-Plate, Stamped-Steel Escutcheons: With concealed hinge, set screw, and chrome-plated finish.

G. One-Piece, Floor-Plate Escutcheons: Cast iron.

H. Split-Casting, Floor-Plate Escutcheons: Cast brass with concealed hinge and set screw.

2.10 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
   1. Characteristics: Post-hardening, volume adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
   2. Design Mix: 5000-psi , 28-day compressive strength.
   3. Packaging: Premixed and factory packaged.

2.11 NITROGEN

A. Description: Comply with USP 28 - NF 23 for oil-free dry nitrogen.

PART 3 - EXECUTION

3.1 PREPARATION

A. Cleaning of Medical Gas Tubing: If manufacturer-cleaned and -capped fittings or tubing are not available or if precleaned fittings or tubing must be recleaned because of exposure, have supplier or separate agency acceptable to authorities having jurisdiction perform the following procedures:
   1. Clean medical gas tube and fittings, valves, gages, and other components of oil, grease, and other readily oxidizable materials as required for oxygen service according to CGA G-4.1, "Cleaning Equipment for Oxygen Service."
   2. Wash medical gas tubing and components in hot, alkaline-cleaner-water solution of sodium carbonate or trisodium phosphate in proportion of 1 lb of chemical to 3 gal. of water.
      a. Scrub to ensure complete cleaning.
      b. Rinse with clean, hot water to remove cleaning solution.

3.2 PIPING APPLICATIONS

A. Connect new copper tubing to existing tubing with memory-metal couplings.

B. Medical Vacuum Piping: Use[one of] the following piping materials for each size range:
   1. NPS 4 and Smaller: Type[L, copper medical gas tube; wrought-copper fittings; and brazed joints.

C. WAGD Evacuation Piping: Use[one of] the following piping materials for each size range:
   1. NPS 4 and Smaller: Type L, copper medical gas tube; wrought-copper fittings; and brazed joints.

D. Drain Piping: Use[one of] the following piping materials:
   1. Copper water tube, wrought-copper fittings and soldered fittings joints.

3.3 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of vacuum piping. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, air-compressor sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

B. Comply with ASSE Standard #6010 for installation of vacuum piping.

C. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal and coordinate with other services occupying that space.

F. Install piping adjacent to equipment and specialties to allow service and maintenance.

G. Install vacuum and drain piping with 1 percent slope downward in direction of flow.

H. Install nipples, unions, and special fittings, and valves with pressure ratings same as or higher than piping pressure rating used in applications below unless otherwise indicated.

I. Install eccentric reducers, if available, where vacuum piping is reduced in direction of flow, with bottoms of both pipes and reducer fitting flush.

J. Provide drain leg and drain trap at end of each main and branch and at low points.

K. Install thermometer and vacuum gage on inlet piping to each vacuum producer and on each receiver[and separator]. Comply with requirements in Division 22 Section "Meters and Gages for Plumbing Piping."

L. Install piping to permit valve servicing.

M. Install piping free of sags and bends.

N. Install fittings for changes in direction and for branch connections. Extruded-tee branch outlets in copper tubing may be made where specified.

O. Install medical vacuum piping to medical vacuum service connections specified in this Section and to equipment specified in other Sections requiring medical vacuum service.

P. Install seismic restraints on vacuum piping. Seismic-restraint devices are specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."

Q. Install medical vacuum service connections recessed in walls. Attach roughing-in assembly to substrate; attach finishing assembly to roughing-in assembly.

R. Install medical vacuum bottle bracket adjacent to each wall-mounted medical vacuum service connection suction inlet.

S. Connect vacuum piping to vacuum producers and to equipment requiring vacuum service.

T. Install unions, in copper vacuum tubing adjacent to each valve and at final connection to each piece of equipment, machine, and specialty.

3.4 VALVE APPLICATIONS

A. Valves for Copper Vacuum Tubing: Use copper alloy ball and bronze check types.

B. Valves for PVC Vacuum Piping:
   1. NPS 4 and Smaller: Use copper alloy ball and bronze types.

3.5 VALVE INSTALLATION

A. Install shutoff valve at each connection to and from vacuum equipment and specialties.

B. Install check valves to maintain correct direction of vacuum flow to vacuum-producing equipment.

C. Install valve boxes recessed in wall and anchored to substrate. Single boxes may be used for multiple valves that serve same area or function.

D. Install zone valves and gages in valve boxes. Rotate valves to angle that prevents closure of cover when valve is in closed position.

E. Install safety valves on vacuum receivers, where required by NFPA 99, and where recommended by specialty manufacturers.

F. Install automatic drain valves on equipment, specialties, and piping with drain connection. Run drain piping to floor drain, so contents spill over or into it.

G. Install flexible pipe connectors in suction inlet piping to each vacuum producer.

3.6 JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs.

B. Remove scale, slag, dirt, and debris from outside of cleaned tubing and fittings before assembly.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Threaded Joints: Apply appropriate tape to external pipe threads.

E. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" Chapter. Continuously purge joint with oil-free dry nitrogen during brazing.

F. Memory-Metal Coupling Joints: Join new copper tube to existing tube according to procedures developed by fitting manufacturer for installation of memory-metal coupling joints.

3.7 MEDICAL VACUUM PIPING ALARM SYSTEM INSTALLATION

A. Panels for medical vacuum piping systems may be combined in single panels with medical compressed-air piping systems and medical gas piping systems.

B. Install medical vacuum piping system alarm system components in locations required by and according to NFPA 99.

C. Install medical vacuum piping system area and master alarm panels where indicated.

D. Install computer interface cabinet with connection to medical vacuum piping alarm system and to facility computer.

3.8 SLEEVE INSTALLATION

A. Sleeves are not required for core-drilled holes.

B. Permanent sleeves are not required for holes formed by removable PE sleeves.

C. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs using galvanized-steel pipe

1. Wall Penetrations: Cut sleeves to length for mounting flush with both surfaces.
2. Floor Penetrations: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.

D. Install sleeves in new walls and slabs as new walls and slabs are constructed.

E. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
1. Steel Pipe Sleeves: For pipes smaller than NPS 6
2. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Comply with requirements in Division 07 Section "Sheet Metal Flashing and Trim" for flashing.
   a. Seal space outside of sleeve fittings with grout.

F. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements in Division 07 Section "Penetration Firestopping."

3.9 ESCUTCHEON INSTALLATION

A. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
1. New Piping:
   a. Piping with Fitting or Sleeve Protruding from Wall: One piece, deep pattern.
   b. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish
   c. Bare Piping at Ceiling Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish
   d. Bare Piping in Unfinished Service Spaces: One piece, cast brass with polished chrome-plated finish
   e. Bare Piping in Equipment Rooms: One piece, cast brass.
   f. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece floor plate.

3.10 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support devices.

B. Vertical Piping: MSS Type 8 or 42, clamps.

C. Individual, Straight, Horizontal Piping Runs:
1. 100 Feet and Less: MSS Type 1, adjustable, steel, clevis hangers.
2. Longer Than 100 Feet : MSS Type 43, adjustable, roller hangers.

D. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze. Comply with requirements in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment" for trapeze hangers.

E. Base of Vertical Piping: MSS Type 52, spring hangers.

F. Support horizontal piping within 12 inches of each fitting and coupling.

G. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.

H. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 1/4 : 60 inches with 3/8-inch rod.
   2. NPS 3/8 and NPS 1/2 : 72 inches with 3/8-inch rod.
   3. NPS 3/4 : 84 inches with 3/8-inch rod.
   4. NPS 1 : 96 inches with 3/8-inch rod.
   5. NPS 1-1/4: 108 inches with 3/8-inch rod.
   6. NPS 1-1/2 : 10 feet with 3/8-inch rod.
   7. NPS 2: 11 feet with 3/8-inch rod.
   8. NPS 2-1/2 : 13 feet with 1/2-inch rod.
   9. NPS 3 : 14 feet with 1/2-inch rod.
   10. NPS 3-1/2 : 15 feet with 1/2-inch rod.
   11. NPS 4 : 16 feet with 1/2-inch rod.

I. Install supports for vertical copper tubing every 10 feet .

3.11 LABELING AND IDENTIFICATION

A. Install identifying labels and devices for laboratory vacuum piping, valves, and specialties. Comply with requirements in Division 22 Section "Identification for Plumbing Piping and Equipment."

B. Install identifying labels and devices for medical vacuum piping systems according to NFPA 99. Use the following or similar captions and color-coding for piping products where required by NFPA 99:
   1. Medical Vacuum: Black letters on white background.
   2. WAGD: White letters on violet background.

3.12 FIELD QUALITY CONTROL FOR LABORATORY FACILITY NONMEDICAL VACUUM PIPING

A. Testing Agency: Owner will engage qualified testing agency to perform field tests and inspections of vacuum piping in nonmedical laboratory facilities.

B. Perform tests and inspections of vacuum piping in nonmedical laboratory facilities.

C. Tests and Inspections:
   1. Piping Leak Tests for Vacuum Piping: Test new and modified parts of existing piping. Cap and fill vacuum piping with oil-free, dry nitrogen. Isolate test source and let stand for four hours to equalize temperature. Refill system, if required, to test pressure; hold for two hours with no drop in pressure.
      a. Test Pressure for Copper Tubing: 100 psig
   2. Repair leaks and retest until no leaks exist.
   3. Inspect filters for proper operation.

D. Prepare test reports.

3.13 FIELD QUALITY CONTROL FOR HEALTHCARE FACILITY MEDICAL VACUUM PIPING

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections of medical vacuum piping systems in healthcare facilities and prepare test reports.

B. Perform tests and inspections of medical vacuum piping systems in healthcare facilities and prepare test reports.

C. Tests and Inspections:
   1. Medical Vacuum Testing Coordination: Perform tests, inspections, verifications, and certification of medical vacuum piping systems concurrently with tests, inspections, and certification of medical compressed-air piping and medical gas piping systems.
   2. Perform the following Installer tests according to requirements in NFPA 99 and ASSE Standard #6010:
      a. Initial blow down.
      b. Initial pressure test.
      c. Cross-connection test.
      d. Piping purge test.
      e. Standing pressure test for vacuum systems.
      f. Repair leaks and retest until no leaks exist.
   3. System Verification: Comply with requirements in NFPA 99, ASSE Standard #6020, and ASSE Standard #6030 for verification of medical vacuum piping systems and perform the following tests and inspections:
      a. Standing pressure test.
      b. Individual-pressurization Pressure-differentil cross-connection test.
      c. Valve test.
      d. Master and area alarm tests.
      e. Piping purge test.
      f. Final tie-in test.
      g. Operational vacuum test.
      h. Verify correct labeling of equipment and components.
   4. Testing Certification: Certify that specified tests, inspections, and procedures have been performed and certify report results. Include the following:
      a. Inspections performed.
      b. Procedures, materials, and gases used.
      c. Test methods used.
      d. Results of tests.

D. Remove and replace components that do not pass tests and inspections and retest as specified above.

3.14 DEMONSTRATION

A. Engage factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain medical vacuum alarm systems. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION

SECTION 22 63 13

MEDICAL GAS PIPING FOR HEALTHCARE FACILITIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:
   1. Nitrogen piping and specialties designated "medical nitrogen" operating at 160 to 185 psig.
   2. Nitrous oxide piping and specialties designated "medical nitrous oxide" operating at 50 to 55 psig.
   3. Oxygen piping and specialties designated "medical oxygen" operating at 50 to 55 psig.
   4. Carbon Dioxide piping and specialties designated "Carbon Dioxide" operating at 50 to 55 psig.

B. Owner-Furnished Material:
   1. Ceiling columns.
   2. Owner will furnish gases for medical gas concentration testing specified in this Section.
   3. Supply of gases in cylinders or containers as appropriate for manifolds.
   4. Initial supply of liquid oxygen.
   5. Bulk cryogenic systems. Coordinate all plumbing and alarm connections to the bulk gas source, source start-up and system testing, providing the owner with systems ready for use.

C. Related Sections include the following
   1. Division 22 Section "Compressed-Air Piping for Laboratory and Healthcare Facilities" for compressed-air piping systems for laboratory and healthcare facilities.
   2. Division 22 Section "Vacuum Piping for Laboratory and Healthcare Facilities" for vacuum piping systems for laboratory and healthcare facilities.

1.3 DEFINITIONS

A. CR: Chlorosulfonated polyethylene synthetic rubber.

B. D.I.S.S.: Diameter-index safety system.

C. 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.

D. Medical gas piping systems include medical carbon dioxide, medical nitrogen, medical nitrous oxide and medical oxygen nonflammable gas for healthcare facility patient care or for healthcare laboratory applications.

E. Specialty Gas: Gas, other than medical gas, for nonmedical laboratory facility applications.

1.4 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Gas manifolds and bulk gas storage tanks and piping 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."

1.5 SUBMITTALS

A. Product Data: For the following:
   1. Tubes and fittings.
   2. Valves and valve boxes.
   3. Medical gas service connections.
   4. Electrical service connections.
   5. Medical nitrogen pressure control panels.
   6. Ceiling columns. Include integral service connections.
   7. Gas manifolds.
   8. Bulk gas storage tanks. Include rated capacities and operating weights.
   9. Medical gas alarm system components.
   10. Gas cylinder storage racks.
   11. Buried and insulated oxygen piping.

B. Shop Drawings: Diagram power, signal, and control wiring.

C. Piping Material Certification: Signed by Installer certifying that medical gas piping materials comply with NFPA 99 requirements.

D. Qualification Data: For Installer.

E. Brazing certificates.

F. Manufacturer Seismic Qualification Certification: Submit certification that gas manifolds and bulk gas storage tanks, accessories, and components will withstand seismic forces defined in Division 22 Section "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.

G. Certificates of Shop Inspection and Data Report for Bulk Gas Storage Tanks: As required by ASME Boiler and Pressure Vessel Code.

H. Field quality-control test reports.

I. Operation and Maintenance Data: For medical gas piping specialties to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Installer Qualifications:

1. Medical Gas Piping Systems for Healthcare Facilities: Qualify installers according to ASSE Standard #6010 for installers.
2. All materials used shall be new and of the best grade and quality obtainable and workmanship shall be first class in every respect. Contractor shall be responsible for compliance with all local, state or federal codes.
3. Provide all elements and accessories required for complete system per NFPA 99 most recent edition.
4. Contractor shall make all necessary connections to owner furnished equipment.
5. Install all piping as shown on drawings, as described herein and as described in section 1050,basic materials and methods, using methods of fabrication, grading, testing, repairing, cleaning and other procedures as described.
6. Electrical power wiring for vacuum pumps, medical air compressors, WAGD producers, ceiling columns, alarms and modular accessories associated with the system shall be part of the electrical contract. Any equipment supplied by this contractor that require additional electrical services shall be the responsibility of this contractor to supply these services.
7. Perform installer pressure testing, cross connection testing and final testing per NFPA 99 most recent edition and using procedures as specified.

B. Testing Agency Qualifications: An independent testing agency, with the experience and capability to conduct the medical gas piping testing indicated, that is an NRTL as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
   1. Qualify testing personnel according to ASSE Standard #6020 for inspectors and ASSE Standard #6030 for verifiers.

C. Brazing: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications"; or AWS B2.2, "Standard for Brazing Procedure and Performance Qualification."

D. 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.

E. ASME Compliance: Fabricate and label bulk medical gas storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

F. NFPA Compliance:
   1. Comply with NFPA 50, "Bulk Oxygen Systems at Consumer Sites," for bulk oxygen storage tanks.
   2. Comply with NFPA 99, "Health Care Facilities," for medical gas piping system materials and installation.

G. CGA Compliance: Comply with CGA G-8.1, "Nitrous Oxide Systems at Consumer Sites," for bulk nitrous oxide storage tanks.

H. UL Compliance:
   1. Comply with UL 498, "Attachment Plugs and Receptacles," for electrical service connections.
   2. Comply with UL 544, "Medical and Dental Equipment," for medical gas specialties.

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 Division 03.

B. Coordinate medical gas service connections with other service connections. Compressed-air service connections are specified in Division 22 Sections "Compressed-Air Piping for Laboratory and Healthcare Facilities" and "Vacuum Piping for Laboratory and Healthcare Facilities."

C. Work with metal and stud partition installer and/or mason to ensure anchors, sleeves and similar items are provided in sufficient time to avoid delays, chases and openings are properly sized and prepared.

D. Medical gas contractor shall supply and install the master alarm system and area alarm systems, including the signal wiring. The electrical contractor shall provide power wiring to each alarm panel. The medical gas contractor is responsible for proper termination, testing and marking of alarm panels. Termination shall be done under supervision of manufacturer of alarm panels.

1.8 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Quick-Coupler Service Connections: Furnish complete noninterchangeable medical gas pressure outlets and suction inlets.
      a. Medical Air: Equal to 10 percent of amount installed.
      b. Medical Carbon Dioxide: Equal to 10 percent of amount installed.
      c. Medical Nitrous Oxide: Equal to 10 percent of amount installed.
      d. Medical Oxygen: Equal to 10 percent of amount installed.
      e. Medical Vacuum: Equal to 10 percent of amount installed.
      f. WAGD Evacuation: Equal to 10 percent of amount installed.
   2. D.I.S.S. Service Connections: Furnish complete noninterchangeable medical gas pressure outlets and suction inlets complying with CGA V-5.
      a. Medical Air D.I.S.S. No. 1160: Equal to 10 percent of amount installed.
      b. Medical Carbon Dioxide D.I.S.S. No. 1080: Equal to 10 percent of amount installed.
      c. Medical Nitrogen D.I.S.S. No. 1120: Equal to 10 percent of amount installed.
      d. Medical Nitrous Oxide D.I.S.S. No. 1040: Equal to 10 percent of amount installed.
      e. Medical Oxygen D.I.S.S. No. 1240: Equal to 10 percent of amount installed.
      f. Medical Vacuum D.I.S.S. No. 1220: Equal to 10 percent of amount installed.
      g. WAGD Evacuation D.I.S.S. No. 2220: Equal to 10 percent of amount installed.
   3. Vacuum Bottle Brackets: Equal to 10 percent of amount installed.

PART 2 - PRODUCTS

2.1 PIPES, TUBES, AND FITTINGS

A. Copper Medical Gas Tube: ASTM B 819, Types K and L, seamless, drawn temper that has been manufacturer cleaned, purged, and sealed for medical gas service or according to CGA G-4.1 for oxygen service. Include standard color marking "OXY," "MED," "OXY/MED," "OXY/ACR," or "ACR/MED" in green for Type K tube and blue for Type L tube.

1. General Requirements for Copper Fittings: Manufacturer cleaned, purged, and bagged for oxygen service according to CGA G-4.1.
2. Wrought-Copper Fittings: ASME B16.22, solder-joint pressure type or MSS SP-73, with dimensions for brazed joints.
3. Copper Unions: ASME B16.22 or MSS SP-123, wrought copper or cast-copper alloy.
4. Memory-Metal Couplings: Cryogenic compression fitting made of ASTM F 2063, nickel-titanium, shape-memory-alloy, and that has been manufacturer cleaned, purged, and sealed for oxygen service according to CGA G-4.1.
   a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   b. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      1) Smart Technology, Inc.

2.2 JOINING MATERIALS

A. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys.

B. Threaded-Joint Tape: PTFE.

2.3 BURIED OXYGEN

A. All underground oxygen lines with design temperatures up to 250 degrees shall be XTRU-THERM as manufactured by PERMA-PIPE. All straight sections, fittings, anchors and other accessories shall be factory fabricated, insulated and jacketed. The piping system layout shall be analyzed by the piping system manufacturer to determine the stresses and displacements of the service pipe. The piping system design and manufacturer shall be in strict conformance with ASME B31.1, latest edition. Installation of the piping system shall be in accordance with the manufacturers instructions. Factory trained field technical assistance shall be provided for critical periods of installation, unloading, field joint instruction and testing.

B. The service pipe shall be hard drawn seamless copper ASTM C-819 Type L. Tubes, fittings and other components in medical gas systems shall be cleaned and capped in accordance with CGA-G-4.1. Where possible, straight sections shall be supplied in 20-foot random lengths with piping exposed at each end for field joint fabrication.

C. Elbows, tees, reducers, anchors, field joints, and end seals shall be designed and factory fabricated to prevent the ingress of moisture into the system.

D. The service pipe insulation shall be polyurethane foam with 2.0 lbs/ft^2 minimum density, 90% minimum closed cell content and initial thermal conductivity of 0.16 Btu in/hr FT^2 ^{0} F. The insulation shall completely fill the annular space between the service pipe and jacket shall be bonded to both. Systems using open cell insulation of a non-bonded design shall not be allowed. Insulation for piping 1" to 4" shall be 1 ½".

E. The outer protective insulation jacket shall be seamless high-density polyethylene (HDPE) in accordance with ASTM D1248, type 3, Class C. PVC or tape materials are not allowed. The minimum thickness of the HDPE jacket shall be 0.125".

F. All fittings shall be factory prefabricated and pre-insulated. Straight tangent lengths shall be added to all ends so that all field joints are at straight sections of pipe. Elbow jackets shall be molded HDPE. Tee jackets shall be extrusion welded or butt fusion welded HDPE. Gluing, taping or hot air welding shall not be allowed.

G. The service pipe shall be hydrostatically tested to 15- psig or 1 ½ times the design pressures whichever is greater. Insulation shall then be poured in place into the field joint area. All field-applied insulation shall bep laced only in straight sections of pipe. Field insulation of fittings is not acceptable. The installed shall seal with field joint area with a heat shrinkable adhesive backed sleeve. Backfilling shall not begin until the heat shrink sleeve has cooled. All insulation and jacketing materials for the field joint shall be furnished by PERMA-PIPE.

H. A 4" layer of sand or fine gravel shall be placed and tamped in the trench to provide a uniform bedding for the pipe. The entire trench width shall be evenly backfilled with a similar material as the bedding in 6" compacted layers to a minimum height of 6" above the top of the insulated pipe. The remaining trench shall be evenly and continuously backfilled and compacted in uniform layers with suitable excavated soil.

2.4 VALVES

A. General Requirements for Valves: Manufacturer cleaned, purged, and bagged according to CGA G-4.1 for oxygen service.

B. Ball Valves: MSS SP-110, 3-piece body, brass or bronze.
   1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   3. Basis-of-Design Product: Subject to compliance with requirements, provide a comparable product by one of the following:

      a. BeaconMedaes.
      b. Conbraco Industries, Inc.
      c. NIBCO INC.
   4. Pressure Rating: 300 psig minimum.
   5. Ball: Full-port, chrome-plated brass.
   6. Seats: PTFE or TFE.
   7. Handle: Lever type with locking device.
   8. Stem: Blowout proof with PTFE or TFE seal.
   9. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.

C. Check Valves: In-line pattern, bronze.
   1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   3. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings a comparable product by one of the following:
      a. Allied Healthcare Products, Inc.; Chemetron Div.
      b. BeaconMedaes.
      c. Conbraco Industries, Inc.
   4. Pressure Rating: 300 psig minimum.
   5. Operation: Spring loaded.
   6. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.

D. Zone Valves: MSS SP-110, 3-piece-body, brass or bronze ball valve with gage.
   1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   3. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings a comparable product by one of the following:
      a. Allied Healthcare Products, Inc.; Chemetron Div.
      b. Amico Corporation.
      c. BeaconMedaes.
   4. Pressure Rating: 300 psig minimum.
   5. Ball: Full-port, chrome-plated brass.
   6. Seats: PTFE or TFE.
   7. Handle: Lever type with locking device.
   8. Stem: Blowout proof with PTFE or TFE seal.
   9. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.
   10. Pressure Gage: Manufacturer-installed on one copper-tube extension.

E. Zone Valve Boxes: Formed steel with anchors for recessed mounting, holes with grommets in box sides for tubing extension protection, and of size for single or multiple valves with pressure gages and in sizes required to permit manual operation of valves.
   1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   3. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings a comparable product by one of the following:
      a. Allied Healthcare Products, Inc.; Chemetron Div.
      b. Amico Corporation.
      c. BeaconMedaes.
   4. Interior Finish: Factory-applied white enamel.

5. Cover Plate: Aluminum or extruded-anodized aluminum with frangible or removable windows.
6. Valve-Box Windows: Clear or tinted transparent plastic with labeling that includes rooms served, according to NFPA 99.

F. Zone Valve Boxes: Formed or extruded aluminum with anchors for recessed mounting, holes with grommets in box sides for tubing extension protection, and of size for single or multiple valves with pressure gages and in sizes required to permit manual operation of valves.
1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
3. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings a comparable product by one of the following:
   a. Tri-Tech Medical.
   b. BeaconMedaes.
   c. Chemetron Div.
4. Interior Finish: Factory-applied white enamel.
5. Cover Plate: Aluminum or extruded-anodized aluminum with frangible or removable windows.
6. Valve-Box Windows: Clear or tinted transparent plastic with labeling that includes rooms served, according to NFPA 99.

G. Emergency Oxygen Connections: Low-pressure oxygen inlet assembly for connection to building oxygen piping systems.
1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
3. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings a comparable product by one of the following:
   a. Allied Healthcare Products, Inc.; Chemetron Div.
   b. Amico Corporation.
   c. BeaconMedaes.
4. Enclosure: Weatherproof hinged locking cover with caption similar to "Emergency Low-Pressure Gaseous Oxygen Inlet."
5. Inlet: Manufacturer-installed, NPS 1 or NPS 1-1/4, ASTM B 819, copper tubing with NPS 1 minimum ball valve and plugged inlet.
6. Safety Valve: Bronze-body, pressure relief valve set at 75 or 80 psig.
7. Instrumentation: Pressure gage.

H. Safety Valves: Bronze-body, ASME-construction, poppet, pressure-relief type with settings to match system requirements.

I. Pressure Regulators: Bronze body and trim; spring-loaded, diaphragm-operated, relieving type; manual pressure-setting adjustment; rated for 250-psig minimum inlet pressure; and capable of controlling delivered gas pressure within 0.5 psig for each 10-psig inlet pressure.

2.5 MEDICAL GAS SERVICE CONNECTIONS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

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

C. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings a comparable product by one of the following:
   1. Allied Healthcare Products, Inc.; Chemetron Div.
   2. Amico Corporation.
   3. BeaconMedaes.

D. General Requirements for Medical Gas Service Connections,: For specific medical gas pressure and suction service listed. Include roughing-in assemblies, finishing assemblies, and cover plates. Individual cover plates are not required if service connection is in multiple unit or assembly with cover plate. Furnish recessed-type units made for concealed piping unless otherwise indicated.
   1. Roughing-in Assembly:
      a. Steel outlet box for recessed mounting and concealed piping.
      b. Brass-body outlet block with secondary check valve that will prevent gas flow when primary valve is removed. Suction inlets to be without secondary valve.
      c. Double seals that will prevent gas leakage.
      d. ASTM B 819, NPS 3/8 copper outlet tube brazed to valve with service marking and tube-end dust cap.
   2. Finishing Assembly:
      a. Brass housing with primary check valve.
      b. Double seals that will prevent gas leakage.
      c. Cover plate with gas-service label.
   3. Quick-Coupler Service Connections: Pressure outlets for nitrogen service connections with noninterchangeable keyed indexing to prevent interchange between services, constructed to permit one-handed connection and removal of equipment, and with positive-locking ring that retains equipment stem in valve during use.
   4. D.I.S.S. Service Connections: Pressure outlets, complying with CGA V-5, with threaded indexing to prevent interchange between services, constructed to permit one-handed connection and removal of equipment.
      a. Medical Nitrogen Service Connections: D.I.S.S. No. 1120.
   5. Cover Plates: One piece, stainless steel, with NAAMM AMP 503, No. 4 finish and permanent, color-coded, identifying label matching corresponding service.

2.6 MEDICAL NITROGEN PRESSURE CONTROL PANELS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

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

C. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings a comparable product by one of the following:
   1. BeaconMedaes (Nitrogen Control Panel Series 6-120276-XX) (IA Control Panel Series 6-12-274-00) (Air Control Panel Series 6-120881-00)

D. Description: Steel box and support brackets for recessed roughing-in with stainless-steel or anodized-aluminum cover plate with printed operating instructions. Include manifold assembly consisting of inlet supply valve, inlet supply pressure gage, line-pressure control regulator, outlet supply pressure gage, D.I.S.S. service connection, and piping outlet for remote service connection.
   1. Minimum Working Pressure: 200 psig.
   2. Line-Pressure Control Regulator: Self-relieving diaphragm type with precision manual adjustment.
   3. Pressure Gages: 0- to 300-psig range.
   4. Service Connection: CGA V-5, D.I.S.S. No. 1120, nitrogen outlet.
   5. Before final assembly, provide temporary dust shield and U-tube for testing.
   6. Label cover plate "Nitrogen Pressure Control."

2.7 MEDICAL GAS PIPING ALARM SYSTEMS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

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

C. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings a comparable product by one of the following:
   1. Allied Healthcare Products, Inc.; Chemetron Div.
   2. Amico Corporation.
   3. BeaconMedaes.

D. Panels for medical gas piping systems may be combined in single panels with medical compressed-air and medical vacuum piping systems.

E. Components: Designed for continuous service and to operate on power supplied from 120-V ac power source to alarm panels and with connections for low-voltage wiring to remote sensing devices. Include step-down transformers if required.

F. Pressure Switches or Pressure Transducer Sensors: Continuous line monitoring with electrical connections for alarm system.
   1. Low-Pressure Operating Range: 0- to 100-psig.
   2. High-Pressure Operating Range: Up to 250-psig.

G. General Requirements for Medical Gas Alarm Panels: Factory wired with audible and color-coded visible signals to indicate specified functions.
   1. Mounting: Recessed installation.
   2. Enclosures: Fabricated from minimum 0.047-inch-thick steel or minimum 0.05-inch-thick aluminum, with knockouts for electrical and piping connections.

H. Master Alarm Panels: With separate trouble alarm signals, pressure gages, and indicators for medical gas piping systems.
   1. Include alarm signals when the following conditions exist:

a. Medical Carbon Dioxide: Pressure drops below 40 psig or rises above 60 psig and changeover is made to alternate bank.
b. Medical Nitrogen: Pressure drops below 145 psigor rises above 200 psig and changeover is made to alternate bank.
c. Medical Nitrous Oxide: Liquid level is low, pressure downstream from main shutoff valve drops below 40 psig or rises above 60 psig, changeover is made to reserve, reserve is in use, and reserve level is low.
d. Medical Nitrous Oxide: Pressure drops below 40 psig or rises above 60 psig and changeover is made to alternate bank.
e. Medical Oxygen: Liquid level is low, pressure downstream from main shutoff valve drops below 40 psig or rises above 60 psig, changeover is made to reserve, reserve is in use, reserve level is low, and reserve pressure is low.
f. Medical Oxygen: Pressure downstream from main shutoff valve drops below 40 psig or rises above 60 psig and changeover is made to alternate bank.

I. Anesthetizing-Area Alarm Panels: Separate trouble alarm signals; pressure gages; and indicators for medical gas piping systems.
1. Include alarm signals when the following conditions exist:
a. Medical Carbon Dioxide: Pressure drops below 40 psig or rises above 60 psig.
b. Medical Nitrous Oxide: Pressure drops below 40 psig or rises above 60 psig.
c. Medical Nitrogen: Pressure drops below 145 psig or rises above 200 psig.
d. Medical Oxygen: Pressure drops below 40 psig or rises above 60 psig.

J. Area Alarm Panels: Separate trouble alarm signals; pressure and vacuum gages; and indicators for medical gas piping systems.
1. Include alarm signals when the following conditions exist:
a. Oxygen: Pressure drops below 40 psig or rises above 60 psig.

2.8 COMPUTER INTERFACE CABINET

A. Description: Wall-mounting, welded-steel, control cabinet with gasketed door, mounting brackets, grounding device, and white-enamel finish for connection of medical gas system alarms to facility computer. Include factory-installed signal circuit boards, power transformer, circuit breaker, wiring terminal board, and internal wiring capable of interfacing 20 alarm signals.

2.9 SLEEVES

A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

B. Stack Sleeve Fittings: Manufactured, cast-iron sleeve with integral clamping flange. Include clamping ring and bolts and nuts for membrane flashing.
1. Underdeck Clamp: Clamping ring with set screws.

2.10 ESCUTCHEONS

A. General Requirements for Escutcheons: Manufactured wall and ceiling escutcheons and floor plates, with ID to closely fit around pipe and tube and OD that completely covers opening.

B. One-Piece, Deep-Pattern Escutcheons: Deep-drawn, box-shaped brass with polished chrome-plated finish.

C. One-Piece, Cast-Brass Escutcheons: With set screw.
   1. Finish: Polished chrome-plated.

D. Split-Casting, Cast-Brass Escutcheons: With concealed hinge and set screw.
   1. Finish: Polished chrome-plated.

E. One-Piece, Stamped-Steel Escutcheons: With set screw and chrome-plated finish.

F. Split-Plate, Stamped-Steel Escutcheons: With concealed hinge, set screw, and chrome-plated finish.

G. One-Piece, Floor-Plate Escutcheons: Cast iron.

H. Split-Casting, Floor-Plate Escutcheons: Cast brass with concealed hinge and set screw.

2.11 GROUT

A. Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
   1. Characteristics: Post-hardening, volume adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
   2. Design Mix: 5000-psi, 28-day compressive strength.
   3. Packaging: Premixed and factory packaged.

2.12 NITROGEN

A. Description: Comply with USP 28 - NF 23 for oil-free dry nitrogen.

PART 3 - EXECUTION

3.1 PREPARATION

A. Cleaning of Medical Gas Tubing: If manufacturer-cleaned and -capped fittings or tubing are not available or if precleaned fittings or tubing must be recleaned because of exposure, have supplier or separate agency acceptable to authorities having jurisdiction, perform the following procedures:
   1. Clean medical gas tube and fittings, valves, gages, and other components of oil, grease, and other readily oxidizable materials as required for oxygen service according to CGA G-4.1, "Cleaning Equipment for Oxygen Service."
   2. Wash medical gas tubing and components in hot, alkaline-cleaner-water solution of sodium carbonate or trisodium phosphate in proportion of 1 lb of chemical to 3 gal. of water.
      a. Scrub to ensure complete cleaning.

b. Rinse with clean, hot water to remove cleaning solution.

3.2 PIPING APPLICATIONS

A. Medical Gas Piping: Use Type L, copper medical gas tube; wrought-copper fittings; and brazed joints.

B. Medical Nitrogen Piping: Type K, copper medical gas tube; wrought-copper fittings; and brazed joints.

C. Medical Nitrogen Piping NPS 2-1/2 and Smaller: Type K, copper medical gas tube; wrought-copper fittings; and brazed joints.

D. Medical Nitrogen Piping NPS 3 and Larger: Type K, copper tube; wrought-copper fittings; and brazed joints.

3.3 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of gas piping. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, air-compressor sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

B. Comply with ASSE Standard #6010 for installation of medical gas piping.

C. Install piping concealed from view and protected from physical contact by building occupants unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal and coordinate with other services occupying that space.

F. Install piping adjacent to equipment and specialties to allow service and maintenance.

G. Install nipples, unions, and special fittings, and valves with pressure ratings same as or higher than system pressure rating used in applications below unless otherwise indicated.

H. Install piping to permit valve servicing.

I. Install piping free of sags and bends.

J. Install fittings for changes in direction and branch connections.

K. Install medical gas piping to medical gas service connections specified in this Section, to medical gas service connections in equipment specified in this Section, and to equipment specified in other Sections requiring medical gas service.

L. Install exterior, buried medical gas piping in protective conduit fabricated with PVC pipe and fittings. Do not extend conduit through foundation wall.

M. Install seismic restraints on gas piping. Seismic-restraint devices are specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."

N. Install medical gas service connections recessed in walls. Attach roughing-in assembly to substrate; attach finishing assembly to roughing-in assembly.

O. Connect gas piping to gas sources and to gas outlets and equipment requiring gas service.

P. Install unions, in copper tubing adjacent to each valve and at final connection to each piece of equipment and specialty.

3.4 VALVE INSTALLATION

A. Install shutoff valve at each connection to gas laboratory and healthcare equipment and specialties.

B. Install check valves to maintain correct direction of gas flow from laboratory and healthcare gas supplies.

C. Install valve boxes recessed in wall and anchored to substrate. Single boxes may be used for multiple valves that serve same area or function.

D. Install zone valves and gages in valve boxes. Rotate valves to angle that prevents closure of cover when valve is in closed position.

E. Install pressure regulators on gas piping where reduced pressure is required.

F. Install emergency oxygen connection with pressure relief valve and full-size discharge piping to outside, with check valve downstream from pressure relief valve and with ball valve and check valve in supply main from bulk oxygen storage tank.

3.5 JOINT CONSTRUCTION

A. Remove scale, slag, dirt, and debris from outside of cleaned tubing and fittings before assembly.

B. Threaded Joints: Apply appropriate tape to external pipe threads.

C. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" Chapter. Continuously purge joint with oil-free, dry nitrogen during brazing.

D. Memory-Metal Coupling Joints: Join new copper tube to existing tube according to procedures developed by fitting manufacturer for installation of memory-metal coupling joints.

3.6 GAS SERVICE COMPONENT INSTALLATION

A. Assemble patient service console with service connections. Install with supplies concealed, in walls. Attach console box or mounting bracket to substrate.

B. Install nitrogen pressure-control panels in walls. Attach to substrate.

C. Assemble ceiling columns and install anchored to substrate. Provide structural steel, hanger rods, anchors, and fasteners in addition to components furnished with specialties necessary to fabricate supports.

D. Assemble ceiling assemblies and install anchored to substrate. Provide structural steel, hanger rods, anchors, and fasteners in addition to components furnished with specialties necessary to fabricate supports.

E. Install gas manifolds anchored to substrate.

F. Install gas cylinders and connect to manifold piping.

G. Install gas manifolds with seismic restraints as indicated.

H. Install bulk gas storage tanks and reserve supply tanks level on concrete bases. Set tanks and connect gas piping to tanks. Install tanks level and plumb, firmly anchored to concrete bases; maintain NFPA 50 and tank manufacturer's recommended clearances. Orient tanks so controls and devices are accessible for servicing.

I. Install bulk gas storage tanks and reserve supply tanks with seismic restraints.

3.7 MEDICAL GAS PIPING ALARM SYSTEM INSTALLATION

A. Install medical gas alarm system components in locations required by and according to NFPA 99.

B. Install medical gas area and master alarm panels where indicated.

C. Install computer interface cabinet with connection to medical gas piping alarm system and facility computer.

3.8 SLEEVE INSTALLATION

A. Sleeves are not required for core-drilled holes.

B. Permanent sleeves are not required for holes formed by removable PE sleeves.

C. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs using galvanized-steel pipe.
   1. Wall Penetrations: Cut sleeves to length for mounting flush with both surfaces.
   2. Floor Penetrations: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.

D. Install sleeves in new walls and slabs as new walls and slabs are constructed.

E. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
   1. Steel Pipe Sleeves: For pipes smaller than NPS 6.
   2. Steel Sheet Sleeves: For pipes NPS 6 and larger, penetrating gypsum board partitions.
   3. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Comply with requirements in Division 07 Section "Sheet Metal Flashing and Trim" for flashing.
      a. Seal space outside of sleeve fittings with grout.

F. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Comply with requirements in Division 07 Section "Penetration Firestopping."

3.9 ESCUTCHEON INSTALLATION

A. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
   1. New Piping:
      a. Piping with Fitting or Sleeve Protruding from Wall: One piece, deep pattern.
      b. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish.
      c. Bare Piping at Ceiling Penetrations in Finished Spaces: One piece, cast brass with polished chrome-plated finish.
      d. Bare Piping in Unfinished Service Spaces: One piece, cast brass with polished chrome-plated finish.
      e. Bare Piping in Equipment Rooms: One piece, cast brass.
      f. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece floor plate.

3.10 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment" for seismic-restraint devices.

B. Comply with requirements in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support devices.

C. Vertical Piping: MSS Type 8 or 42, clamps.

D. Individual, Straight, Horizontal Piping Runs:
   1. 100 Feet and Less: MSS Type 1, adjustable, steel, clevis hangers.
   2. Longer Than 100 Feet: MSS Type 43, adjustable, roller hangers.

E. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze. Comply with requirements in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment" for trapeze hangers.

F. Base of Vertical Piping: MSS Type 52, spring hangers.

G. Support horizontal piping within 12 inches of each fitting and coupling.

H. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.

I. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
   1. NPS 1/4: 60 inches with 3/8-inch rod.
   2. NPS 3/8 and NPS 1/2: 72 inches with 3/8-inch rod.
   3. NPS 3/4: 84 inches with 3/8-inch rod.
   4. NPS 1: 96 inches with 3/8-inch rod.
   5. NPS 1-1/4: 108 inches with 3/8-inch rod.
   6. NPS 1-1/2: 10 feet with 3/8-inch rod.

7. NPS 2: 11 feet with 3/8-inch rod.
8. NPS 2-1/2: 13 feet with 1/2-inch rod.
9. NPS 3: 14 feet with 1/2-inch rod.
10. NPS 3-1/2: 15 feet with 1/2-inch rod.
11. NPS 4: 16 feet with 1/2-inch rod.

J. Install supports for vertical copper tubing every 10 feet.

3.11 LABELING AND IDENTIFICATION

A. Install identifying labels and devices for specialty gas piping, valves, and specialties. Comply with requirements in Division 22 Section "Identification for Plumbing Piping and Equipment."

B. Install identifying labels and devices for healthcare medical gas piping systems according to NFPA 99. Use the following or similar captions and color-coding for piping products where required by NFPA 99:
1. Carbon Dioxide: Black or white letters on gray background.
2. Nitrogen: White letters on black background.
3. Nitrous Oxide: White letters on blue background.
4. Oxygen: White letters on green background or green letters on white background.

3.12 FIELD QUALITY CONTROL FOR LABORATORY FACILITY SPECIALTY GAS

A. Testing Agency: Engage qualified testing agency to perform field tests and inspections of specialty gas piping for nonhealthcare laboratory facilities and prepare test reports.

B. Perform field tests and inspections of specialty gas piping for nonhealthcare laboratory facilities and prepare test reports.

C. Tests and Inspections:
1. Piping Leak Tests for Specialty Gas Piping: Test new and modified parts of existing piping. Cap and fill specialty gas piping with oil-free, dry nitrogen to pressure of 50 psig above system operating pressure, but not less than 150 psig. Isolate test source and let stand for four hours to equalize temperature. Refill system, if required, to test pressure; hold for two hours with no drop in pressure.
2. Repair leaks and retest until no leaks exist.
3. Inspect specialty gas regulators for proper operation.

3.13 FIELD QUALITY CONTROL FOR HEALTHCARE FACILITY MEDICAL GAS

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections of medical gas piping systems in healthcare facilities and prepare test reports.

B. Perform tests and inspections of medical gas piping systems in healthcare facilities and prepare test reports.

C. Tests and Inspections:
1. Medical Gas Piping Testing Coordination: Perform tests, inspections, verifications, and certification of medical gas piping systems concurrently with

tests, inspections, and certification of medical compressed-air piping and medical vacuum piping systems.

2. Preparation: Perform the following Installer tests according to requirements in NFPA 99 and ASSE Standard #6010:
   a. Initial blow down.
   b. Initial pressure test.
   c. Cross-connection test.
   d. Piping purge test.
   e. Standing pressure test for positive pressure medical gas piping.
   f. Standing pressure test for vacuum systems.
   g. Repair leaks and retest until no leaks exist.
3. System Verification: Comply with requirements in NFPA 99, ASSE Standard #6020, and ASSE Standard #6030 for verification of medical gas piping systems and perform the following tests and inspections:
   a. Standing pressure test.
   b. Individual-pressurization cross-connection test.
   c. Valve test.
   d. Master and area alarm tests.
   e. Piping purge test.
   f. Piping particulate test.
   g. Piping purity test.
   h. Final tie-in test.
   i. Operational pressure test.
   j. Medical gas concentration test.
   k. Medical air purity test.
   l. Verify correct labeling of equipment and components.
   m. Verify the following source equipment:
      1) Medical gas supply sources.
4. Testing Certification: Certify that specified tests, inspections, and procedures have been performed and certify report results. Include the following:
   a. Inspections performed.
   b. Procedures, materials, and gases used.
   c. Test methods used.
   d. Results of tests.

D. Remove and replace components that do not pass tests and inspections and retest as specified above.

3.14 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain bulk gas storage tanks and medical gas alarm system. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION

SECTION 23 00 00

GENERAL PROVISIONS FOR HEATING, VENTILATING AND AIR CONDITIONING WORK

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Work in this Section includes the providing of labor, materials, equipment and services necessary for a complete and safe installation in accordance with the contract documents and all applicable codes and authorities having jurisdiction for heating, ventilating and air conditioning work covered by all sections within Division 23 of the specifications (including but not limited to HVAC systems and equipment).

B. Provide cutting and patching, except as noted in "AIA Document A210" and "Supplementary Conditions for Mechanical and Electrical Work."

C. Provide piping extensions and connections from capped Plumbing terminations, for makeup water and other such services.

D. Provide drainage from noted equipment to floor drains, roof, sink, or funnel drains.

E. Provide piping connections to equipment, as required, for kitchens, sterilizers, kitchenettes, and as indicated.

F. Provide 3/8" coordinated shop drawings with a sheetmetal construction drawing as the base drawing; and overlay plumbing, fire protection, and electrical systems for coordination.

G. Related Work And Requirements
1. Requirements of general conditions, supplementary conditions for mechanical and electrical work and Division No. 1.
2. Requirements noted under other Divisions of Work

H. Section 01 81 13 "Sustainable Design Requirements – LEED v4 for Building Design & Construction – New Construction" for sustainable design requirements and detailed sustainable design submittal requirements.

I. Section 01 74 19 "Construction and Demolition Waste Management and Disposal" for disposal of construction, demolition and packaging waste disposal requirements.

1.2 WORK NOT INCLUDED:

1. Providing temporary heat.
2. Providing finish painting.
3. Installing building construction access door filler.
4. Providing trench covers and frames.
5. Cutting and patching, except as noted in "AIA Document A201" and "Supplementary Conditions for Mechanical and Electrical Work."
6. Excavating and backfilling under building.
7. Excavating and backfilling.
8. Providing exterior louvers.

9. Providing undercut and louvers in doors.
10. Providing exterior wall louvers intake, screens and exterior attenuation panels.
11. Providing plenums other than sheet metal.
12. Providing flashing.
13. Providing shaft gratings.
14. Providing equipment platforms.

1.3 DESCRIPTION OF BID DOCUMENTS

A. Specifications, in general, describe quality and character of materials and equipment.

B. Drawings, in general are diagrammatic and indicate sizes, locations, connections to equipment and methods of installation. Provide additional offsets, fittings, hangers, supports, valves, drains as required for construction and coordination with work of other trades.

C. Scaled and indicated dimensions are approximate and are for estimating purposes only. Before proceeding with work, check and verify all dimensions.

D. Make adjustments that may be necessary or requested in order to resolve space problems, preserve headroom, and avoid architectural openings, structural members and work of other trades.

E. Typical details, where shown on the drawings, apply to each and every item of the project where such items are applicable. Typical details are not repeated in full on the plans, and are diagrammatic only, but with the intention that such details shall be incorporated in full.

F. If any part of Specifications or Drawings appears unclear or contradictory, consult Architect and/or Engineer for interpretation and decision as early as possible during bidding period. Do not proceed with work without the Architect's and/or Engineer's decision.

1.4 DEFINITIONS

A. "Furnish" or "provide": to supply, install and make complete, safe, and operable, the particular work referred to unless specifically indicated otherwise.

B. "Install": to erect, mount and make complete with all related accessories.

C. "Supply": to purchase, procure, acquire, and deliver complete with related accessories.

D. "Work": includes labor, materials, equipment, services, and all related accessories necessary for the proper and complete installation of complete systems.

E. "Piping": includes pipe, tube, fittings, flanges, valves, controls, strainers, hangers, supports, unions, traps, drains, insulation, and all related accessories.

F. "Wiring": includes raceway, fittings, wire, boxes, and all related accessories.

G. "Concealed": not in view, installed in masonry or other construction, within furred spaces, double partitions, hung ceilings, trenches, crawl spaces, or enclosures.

H. "Exposed": in view, not installed underground or "concealed" as defined above.

I. "Indicated," "shown," or "noted": as indicated, shown or noted on drawings or specifications.

J. "Similar" or "equal" of base bid manufacturer, equal in quality, materials, weight, size, performance, design and efficiency of specified product, conforming with "Base Bid Manufacturers."

K. "Reviewed," "satisfactory," "accepted," or "directed" as reviewed, satisfactory, accepted, or directed by or to Architect and/or Engineer.

L. "Motor Controllers": includes manual or magnetic starters with or without switches, individual pushbuttons or hand-off-automatic (HOA) switches controlling the operation of motors.

M. "Control or Actuating Devices": includes automatic sensing and switching devices such as thermostats, pressure, float, flow, electro-pneumatic switches and electrodes controlling operation of equipment.

1.5 QUALITY ASSURANCE

A. All equipment and accessories shall be the product of manufacturers regularly engaged in their manufacture. All items of a given type shall be the products of the same manufacturer.

B. Furnish all equipment and accessories new and free from defects.

C. All electrical equipment shall be listed by Underwriters' Laboratories, Inc. (UL) or bear UL labels.

D. Supply all equipment and accessories in complete compliance with and in accordance with the applicable standards listed in reference standards of this Section and with all applicable national, state and local codes.

1.6 JOB CONDITIONS

A. Inspection of Site Conditions:
   1. Before starting work, visit the site and examine the conditions under which the work has to be performed. Report in writing any conditions which might adversely affect the work.

B. Hazardous locations:
   1. Provide required material, equipment and installation applicable for hazardous location defined by codes.
   2. Provide material, equipment and installation as required for Class, Division and Group noted.

1.7 REFERENCE STANDARDS

A. Published specifications, standards tests, or recommended methods of trade, industry or governmental organizations apply to work in all Sections as noted below:
   1. ASHRAE - American Society of Heating, Refrigerating and Air Conditioning engineers.
   2. AABC - Associated Air Balance Controls.
   3. AMCA - Air Moving and Conditioning Association.
   4. ADC - Air Diffuser Council.
   5. NEMA - National Electrical Manufacturers' Association.

6. ANSI - American National Standards Institute.
7. ASME - American Society of Mechanical Engineers.
8. ASTM - American Society for Testing and Materials.
9. NFPA - National Fire Protection Association.
10. ARI - Air-Conditioning and Refrigeration Institute.
11. UL - Underwriters' Laboratories, Inc.
12. OSHA - Occupational Safety and Health Administration Regulations.

B. Codes:
1. This installation is to abide by all applicable codes including, but not limited to:
   a. International Building Code-2009/Maine State Building Code including all amendments.

1.8 SUBMITTALS

A. Submit shop drawings product data, samples and certificates of compliance required by contract documents, "AIA Document 201" and "SUPPLEMENTARY CONDITIONS FOR MECHANICAL AND ELECTRICAL WORK."

B. Operating instructions, maintenance manuals and parts lists.
1. Provide five sets of manufacturer's equipment brochures and service manuals consisting of the following:
   a. Descriptive literature for equipment and components.
   b. Model number and performance data.
   c. Installation and operating instructions.
   d. Maintenance and repair instructions.
   e. Recommended spare parts lists.
2. Assemble manufacturers' equipment manuals in chronological order following the specifications' numbering system using heavy duty three ring binders.
3. Submit valve tag chart.
4. Submit three sets of field test reports including instrument set points and normal operating valves.

C. Submit to the Construction Manager all testing and certification documentation as required to comply in all respects with the U.S. Green Building Council/LEED®.

1.9 AS-BUILT DRAWINGS

A. Provide as-built drawings of all work modified from the construction documents in the field during the construction phase.

1.10 CLEARANCE FROM ELECTRICAL EQUIPMENT

A. Piping and ductwork is prohibited in electric and telephone rooms and closets, elevator machine rooms, and for installations over or within 5 ft of transformers, substations, switchboards, motor control centers, standby power plants, and motors.

B. Branch piping to equipment is acceptable when installed over or within 5 ft of motors.

1.11 DRIP PANS

A. Provide drip pans under piping when installation over or within 5 ft of electrical apparatus is unavoidable or in rooms containing electrical equipment. Pan shall be reinforced, properly supported and made watertight. Provide enclosed type for pressure piping. Extend 1-1/4 in. drain pipe from pan to spill over nearest floor drain, janitors sink or as indicated.
   1. Construction shall be 18 gauge galvanized sheet steel. Pans shall be constructed to retain 3 inches of water minimum.
   2. BMS Contractor shall install a waterflow detector for BMS alarm in case of a water leak.

1.12 PRODUCT, DELIVERY, HANDLING AND STORAGE

A. Ship materials and equipment in crated sections of sizes to permit passing through available space, where required

B. Deliver equipment with protective crating and shrink-wrapped covering.

C. Receive and accept materials and equipment at the site, properly handle, house, and protect them from damage and the weather until installation. Replace equipment damaged in the course of handling without additional charge.

D. Store to prevent damage and protect from weather, dirt, fumes, water, and construction debris in clean dry space

E. Arrange for and provide storage space or area at the job site for all materials and equipment to be received and/or installed in this project

F. All exposed openings of equipment, piping and ductwork are to be covered nightly and/or when no work is anticipated for more than 4 hours.

G. Handle according to manufacturer's written rigging and installation instructions for unloading, transporting, and setting in final location

H. Protect units from physical damage. Leave factory shipping covers in place until installation

1.13 TEMPORARY HEAT

A. Temporary heat will be provided under General Construction Work.

1.14 ACCESSIBILITY

A. Install all work so that parts requiring periodic inspection, operation, maintenance, and repair are readily accessible. Minor deviations from the drawings may be made to accomplish this, but changes of substantial magnitude shall not be made without written approval.

B. Group concealed valves, expansion joints, controls, dampers, and equipment requiring access, so as to be freely accessible through access doors.

1.15 SPECIAL TOOLS

A. Provide one set of any special tools required to operate, adjust, dismantle or repair equipment furnished under this Division for the Owner's use at the completion of the work.

B. Provide one pressure grease gun with adapters for each type of grease required.

C. Provide one suitable tool case for special tools.

1.16 CUTTING AND PATCHING

A. Provide all carpentry, cutting and patching required for proper installation of materials and equipment specified. Do not cut or drill structural members without review by Architect and Structural Engineer.

1.17 PROTECTION OF MATERIALS

A. Protect from damage, water, dust, etc., materials, equipment and apparatus provided under this trade, both in storage and installed

1.18 SUBSTITUTIONS

A. No substitute material or manufacturer of equipment shall be permitted without a formal written submittal to the Construction Manager and Architect which includes all dimensional, performance and material specifications and is approved in writing by the engineer. Any changes in layout or design brought about by the use of a substitution shall be submitted to the Construction Manager and Architect fully designed for review in conjunction with the submittal of the alternate. Any substitution must be submitted with an explanation why a substitution is being proposed. If the substitute is being proposed for financial reasons, the associated credit must be simultaneously submitted. Final acceptance or rejection of any substitution is subject to the owner's review.

1.19 STANDARDS:

A. If any item in the specification, as furnished by the contractor, is manufactured in a location which does not certify ASME/ANSI standards, the contractor is to pay the Construction Manager/Owner for ALL expenses incurred by the Construction Manager/Owner for an outside testing company to confirm such compliance.

1.20 COORDINATION

A. Arrange for pipe spaces, duct spaces, space for equipment, chases, slots, and openings in building structure during progress of construction, to allow for mechanical installations.

B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

C. Coordinate requirements for access panels and doors for mechanical items requiring access that are concealed behind finished surfaces.

D. Provide coordination drawing for all areas of the work. The drawings shall have the following qualities:
   1. Minimum 3/8” scale
   2. Clearly show all the work for each trade including, but not limited to hangers, valves, dampers, actuators, access doors and service access requirements for all items.
   3. Indicate bottom elevations of all ductwork, electrical conduit, raceways, cable trays, control wiring and piping.

4. Ductwork, piping, and conduit 3 inches and smaller may be shown in single line.
5. Ductwork, piping, and conduit greater than 3 inches shall be shown in double line.
6. Color scheme:
   a. Architectural and structural background: Light grey.
   b. Ductwork: Black.
   c. Equipment and pads: Purple.
   d. HVAC piping and equipment: Green.
   e. Electrical conduits and equipment: Blue.
   f. Plumbing: Orange.
   g. Fire protection: Red.
   h. Control wiring: Pink.

1.21 GUARANTEE

A. In accordance with General Conditions (AIA Document 201) & Supplementary Conditions for Mechanical & Electrical Work.

B. The Contractor shall furnish a written guarantee to replace or repair promptly and assume responsibility for all expenses incurred for any workmanship and equipment in which defects develop within one year from the date of final certificate for payment and/or from date or actual use of equipment or occupancy of spaces by Owner included under the various parts of work, whichever date is earlier. This work shall be done as directed by the Owner. This guarantee shall also provide that where defects occur, the Contractor will assume responsibility for all expenses incurred in repairing and replacing work of other trades affected by defects, repairs or replacements in equipment supplied by the Contractor.

1.22 PERMITS AND FEES

A. In accordance with General Conditions (AIA Document 201) & Supplementary Conditions for Mechanical & Electrical Work.

B. The Contractor shall give necessary notice, file drawings and specifications with the department having jurisdiction, obtain permits or licenses necessary to carry out this work and pay all fees therefore. The Contractor shall arrange for inspection and test of any or all parts of the work if so required by authorities and pay all charges for same. The Contractor shall pay all costs for, furnish to the Owner before final billing, all certificates necessary as evidence that the work installed conforms with all regulations where they apply to this work.

1.23 RIGGING

A. This contractor shall provide all required rigging, hoisting and bracing to install the equipment as indicated on the plans. This work shall be performed by an insured certified licensed rigging company that is experienced in rigging equipment of the type indicated for the areas shown on the construction documents. This contractor shall submit rigging plans for approval prior to proceeding with the work.

B. All permits required from the authorities and agencies involved to perform the rigging are the responsibilities of this contractor.

C. All structural supports, modifications or additions are to be submitted to the structural engineer for approval prior to proceeding with the work. All supplemental structural supports, elevator charges /modifications, bracing and protection required for the rig is the responsibility of this contractor

D. The rigging contractor shall hire and pay for all charges and services of the building elevator contractor for the rigging of the equipment

1.24 COMMISSIONING

A. Provisions Included
1. Include Division 00 and applicable parts of Division 01 for conditions and requirements which may affect the work of this Section.
2. Examine all other Sections of the specifications for requirements which affect work under this Section whether or not such work is specifically mentioned in this Section.
3. Coordinate work with that of all other Trades affecting, or affected by work of this Section. Cooperate with such Trades to ensure the steady progress of all work under the Contract.
4. This scope is not all inclusive of the overall effort necessary to fully commission this project but rather serves as a guide. Refer to the Commissioning Plane and Section provided by the Construction Manager for further details. Refer to Sections 019100- Commissioning and Section 230800- Commissioning of HVAC for further scope and responsibility required.

B. Commissioning Effort
1. The Construction Manager shall be the prime contractor which is responsible for the overall commissioning program.
2. The Construction Manager and all Contractors/Subcontractors shall completely assist the Commissioning Agent in establishing and maintaining the schedule of commissioning events, as developed for the complete check out of each individual mechanical and electrical sub-system and the integration of all building systems.
3. The Contractor, BMS Contractor and TAB Contractor responsible for all work, installation, testing, balancing and controls under this Division shall be responsible to provide all set up, testing and services required in the commissioning of the systems under this Division.

C. Commissioning Team
1. A representative of each of the following parties shall be designated as a member of the Commissioning Team.
2. Each member must attend weekly "schedule of events" meetings, in accordance with the Commissioning Agent's schedule.
3. Each member must be closely associated with this design project to accommodate the actual scheduling of events upon mechanical and electrical systems which have been "completed" and thus in proper operation to be commissioned.
4. Commissioning Team
5. Commissioning Agent
   a. Construction Manager
   b. HVAC Contractor
   c. BMS Contractor
   d. Testing and Balancing Contractor (TAB)

e. Plumbing Contractor
f. Fire Protection Contractor
g. Electrical Contractor
h. Selective Equipment Manufacturers
i. Owners Designated Representative

D. Substantial Completion
1. The Construction Manager shall submit written notice that the project is substantially complete. Provide a detailed punch list of items not yet in conformance with the contract documents which require attention.
2. Submit preliminary copies of the Operation and Maintenance Manuals.
3. Submit the as-built drawings.
4. Submit warranties, workmanship/maintenance bonds, maintenance agreements, final certifications, and similar documents.
5. Obtain and submit releases enabling Owner's full and unrestricted use of the work and access to services and utilities, including occupancy permits, operating certifications, and similar releases.
6. The Contractor shall have completed all commissioning requirements in Division 21, 22, 23 and 26 except Functional Performance Testing of systems.
7. The Contractor shall have completed all training required for Owner's staff.
8. Submit a letter to the Architect requesting inspection and the Certificate of Substantial Completion, which will be signed and submitted to the Owner.

E. Functional Completion
1. The Construction Manager shall submit commissioning acceptance procedures test check-off sheets, signed by the Commissioning Agent, and the Commissioning Agent's letter recommending Functional Completion.
2. Formal records of all test procedures and results shall be included, as specified, in binders organized for convenient future reference by the Owner's operations staff.
3. The Commissioning Agent will submit a final commissioning report recommending Function Completion when all requirements have been met and when the final report is accepted by the Client. The Commissioning Agent's report will be a comprehensive summary regarding the commissioning program, which shall also include formal records and data accumulated by the Commissioning Agent during the commissioning process.
4. All Contractors shall participate in assisting the commissioning agent in indicating system compliance by performance ALL system tests to the satisfaction of the commissioning agent.

F. Final Completion And Final Acceptance
1. Final Completion occurs when the work is fully and finally completed in accordance with the Contract Documents and all deficiencies have been corrected. Final Acceptance is the written acceptance issued to the Contractor by the Construction Manager and Owner after the Contractor has achieved Final Completion. The specific requirements are:
a. Submit "Consent of Surety to Final Payment". This letter is to be completed by the surety and mailed to the Owner.
b. Submit final payment request with final releases and supporting documentation not previously submitted or accepted.
c. Submit a copy of the Architect's final punch list of itemized work to be completed or corrected, stating that each item is complete (or

otherwise resolved) for acceptance, endorsed and dated by the Architect.

d. Deliver tools, spare parts, extra stock of materials, and similar physical items to the Owner.

e. Make the final change-over of locks and transmit the new keys to the Owner. Return any loaned construction access keys. Advise Owner's personnel regarding change-over in security provisions.

f. Discontinue and remove from the project site temporary facilities and services, along with construction tools and facilities, mock-ups, and similar elements.

g. Complete final cleaning requirements, including touch-up of marred surfaces, and repair, restore and touch-up exposed finishes.

h. Submit a letter to the Architect requesting inspection and the Certificate of Final Acceptance, which will be signed and submitted to the Owner.

G. Commissioning Schedule

1. The Construction Managers schedule for construction, control implementation and completion, start, and point-by-point checkout must be complete for Owner occupancy, in accordance with the Construction Managers schedule.

H. Responsibilities

1. The Contractors shall cooperate with the Construction Manager and Commissioning Agent to accomplish the following tasks:

a. Review and approve all functional performance tests, results, and documentation required by the contract documents, for all equipment and systems, as performed by subcontractors, vendors, etc.

b. Develop schedules for all testing, integrate testing into the master construction activity schedule and coordinate all subcontractor testing as required.

c. Assist and participate in all equipment tests, system functional tests, and cross system functional tests. Test procedures shall be in accordance with equipment manufacturer's recommendations, where applicable. Test procedures shall fully describe system configuration and steps required for each test, appropriately documented so that another party can repeat the tests with virtually identical results.

d. Submit test procedure schedule, procedures, forms and other documentation to the Construction Manager and Owner for approval three months prior to starting any testing required and stipulated by the construction Manager.

e. Coordinate directly with subcontractor on the project specific to their responsibilities and contractual obligations.

f. Provide qualified personnel for participation in commissioning tests, including seasonal testing required after the initial commissioning.

g. Provide engineering and technical expertise to oversee and direct the correction of deficiencies found during the commissioning process.

h. Provide all start-up and initial testing of all systems and equipment by the Contractor and subcontractors, and then all final tests of equipment and systems in accordance with the Commissioning Agent procedures.

i. Manage all cross system testing such as HVAC, building fire alarm, emergency power, life safety, elevators, etc.

j. Note any inconsistencies or deficiencies in system operations and enforce system compliance or recommend to the Architect modifications to system design which will enhance system performance.

1) Coordinate with the Commissioning Agent and Construction Manager the required A/E and Owner testing participation and approval procedures, after verifying that pretests have been satisfactorily conducted and final testes are ready to be performed.

2) In the event that a functional test fails, the cause of failure shall be determined and rectified as soon as possible, and then retested. If more than three functional tests of the same system(s) are required, the Contractor shall reimburse all associated costs for the extraordinary participation of the A/E, Commissioning Agent, Construction Manager and Owner's staff, as required by the particular test being performed.

3) Review operation and maintenance information and as-built drawings provided by the various subcontractors and vendors for verification, organization and distribution.

4) Obtain all documentation from tests and assemble a final test report to be submitted to the Construction Manager, Commissioning Agent, Architect and the Owner for approval.

5) Oversee and/or provide training for the systems specified in the Division with coordination by the Division 23 Subcontractors.

I. Related Work

1. All start-up and testing procedures and documentation requirements specified within Divisions 21, 22, 23 and 26.
2. The Test, Adjust and Balance (TAB) firm shall provided the following:
   a. Allow sufficient time before final commissioning dates so that testing, adjusting and balancing can be accomplished.
   b. Put all heating, ventilating and air conditioning equipment and systems into full operation and continue the operation during each working day of testing, adjusting and balancing and commissioning so they are fully functional. This includes the complete installation of all equipment, materials, pipe, duct, wire, insulation, controls, etc., per the contract documents and related directives, clarifications, change orders, etc.
3. A commissioning plan will be developed by the Commissioning Agent. Divisions, 21, 22, 23 and 26 are obligated to assist the Commissioning Agent in preparing the commissioning plan by providing all necessary information pertaining to the actual equipment and installation. If system modifications/clarifications are in the contractual requirements of this and related sections of work, they will be made at no additional cost to the Owner. If Contractor initiated system changes have been made that alter the commissioning process, the Test Engineer will notify the Commissioning Agent and Owner's Representative for approval.
4. Normal start-up services required to bring each system into a fully operational state. This includes cleaning, filling, purging, leak testing, motor rotation check, control sequences of operation, full and part load performance, etc. The TAB firm will not begin the TAB work until each system is complete, including normal contractor start-up. The

Commissioning Agent will not begin the commissioning process until each system is complete, including normal contractor start-up and the TAB work has been completed.

5. Provide labor and material to make corrections when required, without undue delay.
6. The HVAC Contractor shall include the cost of exchanged sheaves and belts as may be required by the TAB firm.
7. Provide test holes in ducts and plenums where directed or necessary for pitot tubes to take air measurements and to balance the air systems. Test holes shall be provided with an approved removable plug or seal. At each location where ducts or plenums are insulated, test holes shall be provided with an approved extension with plug fitting.
8. Provide pressure and temperature taps as indicated on construction documents in locations as required by the TAB firm to adequately test and/or balance the hydronic systems.
9. The Contractor shall include a minimum of two week "flush out" period, in which the air handling systems are sequenced into a 100% outside air mode, to assist in the removal of any construction material off-gasing, in accordance with LEEDS.

J. Test Equipment

1. Provide test equipment as necessary for start-up and commissioning of the mechanical equipment and systems. The TAB firm will provide the test equipment required to perform their service.

K. Test Equipment - Proprietary

1. Proprietary test equipment required by the manufacturer, whether specified or not, shall be provided by the manufacturer of the equipment. Manufacturer shall provide the test equipment, demonstrate its use, and assist the Commissioning Test Engineer in the commissioning process. Proprietary test equipment shall become the property of the Owner upon completion of commissioning.
2. Identify the proprietary test equipment required in the test procedures submittals and in a separate list of equipment to be included in the operations and maintenance manuals.

L. Work Prior To Commissioning

1. Complete all phases of work so the system can be started, tested, adjusted, balanced, controlled and otherwise commissioned. Divisions 21, 22, 23 and 26 have primary start-up responsibilities with obligations to complete systems, including all sub-systems completion will not relieve these Divisions from completing those systems as per the Construction and Commissioning schedule.

M. Work To Resolve Deficiencies

1. In some systems, mis-adjustments, misapplied equipment and/or deficient performance under varying loads will result in additional work being required by the Contractors to commission the systems. This work will be completed under the direction of the Construction Manager, Architect and Owner's Representative, with input from the Contractor, equipment supplier, and Commissioning Agent. Whereas all members will have input and the opportunity to discuss the work and resolve problems, the Architect will have final jurisdiction on the necessary work to be done to achieve performance.
2. Corrective work shall be completed in a timely fashion to permit timely completion of the commissioning process. Experimentation to render system

performance will be permitted. If the Commissioning Agent deems the experimentation work to be ineffective or untimely as it relates to the commissioning process, the Commissioning Agent will notify the Owner indicating the nature of the problem, expected steps to be taken, and the deadline for completion of activities. If deadlines pass without resolution of the problem, the Owner reserves the right to obtain supplementary services and/or equipment to resolve the problem. Costs incurred to solve the problems in an expeditious manner will be the Contractor's responsibility.

N. Seasonal Commissioning And Occupancy Variations
1. Seasonal commissioning pertains to testing under full-load conditions during peak heating and peak cooling seasons, as well as part-load conditions in the spring and fall. Initial commissioning will be done as soon as contract work is completed regardless of season. Subsequent commissioning may be undertaken at any time thereafter to ascertain adequate performance during the different seasons.
2. All equipment and systems will be tested and commissioned in a peak season to observe full-load performance. Heating equipment will be tested during winter design extremes. Cooling equipment will be tested during summer design extremes, with a fully occupied building. Each Contractor and supplier will be responsible to participate in the initial and the alternate peak season test of the systems required to demonstrate performance, as scheduled by the Commission Agent, with three day (minimum) advance notification.
3. Subsequent commissioning may be required under conditions of minimum and/or maximum occupancy or use. All equipment and systems affected by occupancy variations will be tested and commissioned at the minimum and peak loads to observe system performance. The Contractor will be responsible to participate in the occupancy sensitive testing of systems to provide verification of adequate performance.

O. Recommissioning
1. Upon notification by the Commissioning Agent of successful system/equipment performance/checkout test, the Owner shall witness Test No. 1. If any system/equipment/component/device fails to perform correctly during Test No. 1, the Contractor and/or equipment supplier must correct any systems/wiring deficiencies, and must incur any travel/airfares/food/hotel expenses of the designated Agent, to be available for the Retest No. 1.

P. Training
1. Participate in the training of the Owner's engineering and maintenance staff, as required in Divisions 01, 21, 22, 23 and 26, on each system and related components. Training, in part, will be conducted in a classroom setting, with system and component documentation, and suitable classroom training aids.
2. Training will be conducted jointly by the Commissioning Agent, the Contractor, and the equipment vendors. The Test Engineer will be responsible for highlighting system peculiarities specific to this project.

Q. Systems Documentation
1. In addition to the requirements of Division 01, The Contractor shall update contract documents to incorporate field changes and revisions to system designs to account for actual constructed configurations. All drawings shall be red-lined on two sets. Divisions 21, 22, 23 and 26 as-built drawings shall

include architectural floor plans, elevations, and details, and the individual mechanical or electrical systems in relation to actual building layout.

2. Maintain as-built red-lines as required by Division 01. Given the size and complexity of this project, red-line drawings at completion of construction, based on memory of key personnel, is not satisfactory. Continuous and regular red-lining of drawings is considered essential and mandatory.

R. Miscellaneous Support

1. Divisions 21, 22, 23 and 26 shall remove and replace covers of mechanical equipment, open access panels, etc., to permit the Commissioning Agent, Architect and Owner's representative to observe equipment and controllers provided. Furnish ladders and flashlights as necessary.

S. Systems To Be Commissioned

1. HVAC
   a. Each exhaust fan.
   b. Each supply fan.
   c. Each return fan.
   d. Each supply air unit including verification of all air and water flows at each coil and filter.
   e. Each air flow station.
   f. Each Variable Frequency Drive.
   g. Cabinet and unit heaters.
   h. Each steam/water flow measuring station/flow meter.
   i. Each DDC terminal box and induction box.
   j. Each Circulating Pump.
   k. Air Cooled Chiller
   l. Steam heat exchangers.
   m. Snow melt system
   n. In floor radiant system
   o. Smoke exhaust system
   p. Tele/Data A.C.System.
   q. Verify the final accuracy of the air and water test and balancing report.
   r. Verify the air distribution of the operating rooms system for both summer and winter operations. (termperature, humidity and pressurization)
   s. BMS functional and operational control sequences.
   t. Moisture sensor system at drain pans.
   u. Each individual lighting control interface.
   v. Each kilowatt metering interface.
2. Plumbing/Fire Protection
   a. Domestic Water Heaters (Potable).
   b. Each alarm valve.
   c. Flow Restriction Devices
   d. Reduced Pressure Backflow Devices
3. Electrical
   a. Circuit breaker trip setting verification.
   b. Lighting controls.
   c. Fire alarm interface to HVAC/ATC.
   d. Security interface.
   e. Elevator fire alarm control system.
   f. Emergency Power

T. Post Occupancy Commissioning

1. This Contractor shall fully cooperate in all regards with this phase of commissioning.
2. The Commissioning Agent will prepare a complete building operations review within ten (10) months after substantial completion with the owners operating personnel and note in the report any outstanding construction and/or operational deficiencies that are identified during this post occupancy review. This report shall be provided to the owner, Construction Manager and A/E. This Post-Occupancy deficiency list shall be corrected by the Construction Manager under the one year guarantee/warranty period and shall be submitted as being completed by the Contractor and Equipment Suppliers. The Commissioning Agent shall also procure all equipment manufacturer test data verifying post-occupancy equipment efficiencies and compare all such data to the information published by the manufacturer. This data shall be used to verify overall equipment efficiency against the contract specifications.
3. Divisions 21, 22, 23 and 26 shall correct any and all system deficiencies noted by the Commissioning Agent during the first one year after substantial completion and as noted by the Commissioning Agent during the 10th month building operating review.

U. LEED Point Initiative
1. It is the intent of the Owner to install, test, commission and operate the building systems in accordance with USGBC LEED-NC for new construction. This contractor shall be responsible for all submittal data, testing, flush-out, reporting and verification necessary during the construction, close-out and post commissioning to comply with the following USGBC LEED credits for HVAC systems:
   a. Energy and Atmosphere Credit 3- Cooperation and Documentation for Enhanced Commissioning and Credit 5-Measurement and Verification Documentation.
   b. Indoor Environmental Quality Credits 1- Outdoor Air Delivery Monitoring,Credit 3.2- Construction IAQ Management Plan (Before Occupancy), Credit 4.1- Low-Emitting Materials (Adhesive and Sealants), Credit 5- Indoor Chemical and Pollutant Source Control and Credit 7.2- Thermal Comfort Verification.

PART 2 - PRODUCTS

2.1 BASE BID MANUFACTURERS

A. Base bid on materials or equipment are specified by name of manufacturer, brand or trade name and catalog reference.

B. The choice will be optional with bidder where two or more manufacturers are named.

C. The following are base bid manufacturers for items under this Section:
1. Access doors: Karp Associates, Inc., Higgins Mfg. Co., Milcor Steel Co., and Walsh-Spencer Co.
2. Inserts: F and S Mfg Co., Fee and Mason and Grinnell.
3. Hangers and supports: I.T.T. Grinnell, Carpenter and Patterson, Inc., and Fee & Mason.

4. Paint: Sherwin-Williams, Pittsburgh Paint Co., Pratt and Lambert, and Rust-Oleum.
5. Gratings: Irving Grating IKG Industries and Ryerson - Inland Steel Co.

2.2 INSERTS AND SUPPORTS

A. Support all HVAC work from building construction by providing inserts, beam clamps, steel fishplates (in concrete fill only), and acceptable brackets. Submit all methods for review.

B. Provide trapeze hangers of bolted angles or channels for grouped lines and services.

C. Provide additional framing where building construction is inadequate. Submit for review.

D. Inserts shall be steel, slotted type and factory-painted.
1. Single rod shall be similar to Grinnell Fig. 281.
2. Multi-rod shall be similar to Fee & Mason Series 9000 with end caps and closure strips.
3. Clip form nails flush with inserts.
4. Maximum loading including pipe, contents and covering shall not exceed 75 percent of rated insert capability.

E. Supports from steel decks:
1. Pipes:
   a. Sizes up to 3” diameter maximum hanger spacing: 10’ centers maximum.
   b. Beyond 3” diameter provide support steel, hanger spacing: 10’ centers.
2. Ductwork:
   a. Hangers spacing: maximum 10’ centers and/or every change in direction.

2.3 SUPPLEMENTARY STEEL, CHANNELS AND SUPPORTS:

A. Furnish supplementary steel, channels and supports required for proper installation, mounting and support of all HVAC work.

B. Connect supplementary steel and channels firmly to building construction in an acceptable manner.

C. Determine type and size of supporting channels and supplementary steel. Supplementary steel and channels shall be of sufficient strength and size to allow only a minimum deflection in conformance with manufacturer's requirements of loading.

D. Install supplementary steel and channels in a neat and workmanlike manner parallel to walls, floors, and ceiling construction.

E. All supplementary steel, channels, supports shall be submitted to Structural Engineer for review.

2.4 EXPANSION ANCHORS

A. Provide smooth wall, non-self-drilling internal plug expansion type anchors constructed of AISC 12L14 steel and zinc plated in accordance with Fed. Spec. QQ-A-325 Type 1, Class 3.

B. Do not exceed 1/4 of average valves for a specific anchor size using 2000 psig (13,800 kpa) concrete only, for maximum working load.

C. Provide spacing and install anchors in accordance with manufacturer's recommendations.

2.5 ACCESS DOORS

A. This contractor shall submit to the architect for approval a plan indicating the size (minimum 18" x 18") and location of all building construction access doors required for operation and maintenance of all concealed equipment, devices, valves, dampers and controls. Contractor shall arrange for furnishing of all access doors in finished construction and include costs in the bid.

B. Flush type access doors shall be similar to Karp Type DSC-211 with No. 13 USSG steel doors and trim and No. 16 USSG steel frame, metal wings for keying into construction, concealed hinges and screwdriver operated stainless steel cam lock. Provide lift off type access doors, similar to Karp Type DSC-212, where door cannot swing open.

C. In acoustic tile ceilings, factory finished white access doors shall be similar to Karp Type DSC-210, with No. 13 USSG steel frame, No. 16 USSG steel pan door suitable for receiving tile thickness and hinges that are not visible when door is closed. Access door shall have screwdriver operated stainless steel cam locks finishing flush with tile with a minimum of 2 per door.

D. In plaster ceilings recessed access doors shall be similar to Karp DSC-210-PL, with recess to receive plaster.

E. In fire rated construction provide fire rated access doors, similar to Karp KRP-150-FR, in accordance with applicable code requirements.

F. Access doors shall have one coat of shop-painted zinc chromate primer.

2.6 ACCESS TILE IDENTIFICATION:

A. In removable ceiling tiles, provide buttons, tabs, and markers to identify location of concealed work. Submit for review.

2.7 EQUIPMENT PLATFORMS

A. Equipment platforms will be provided under General Construction Work.

2.8 LADDERS

A. Ladders will be provided under General Construction Work except those inside air handling units which shall be provided as an integral part of the unit.

2.9 SHAFT GRATINGS

A. Shaft gratings will be provided under General Construction Work.

2.10 TAGS:

A. Provide 2 in. round valve tags on all valves and controls of No. 18 BS gauge aluminum with stamped numbers and letters filled in with black paint.

B. Indicate identifying number and system letter on tags, and fasten by heavy aluminum or brass "S" hooks or chains.

C. Tags shall be similar to Seton Name Plate Corporation.

2.11 CHARTS

A. Provide valve tag chart indicating valve number, system, type, size, location and function for all valves.

B. Mount in aluminum frame and glass.

C. Letter and number valves and controls to correspond with designations on metal tags.

D. Fasten charts permanently in locations, as directed, with four brass screws.

2.12 NAMEPLATES

A. Provide nameplates with inscriptions, subject to review, indicating building abbreviations, equipment number and capacity (CFM and/or GPM). Fasten with epoxy cement or chrome plated screws. Nameplate shall be black Lamicoid sheet with white lettering.

PART 3 - EXECUTION

3.1 MECHANICAL IDENTIFICATION

A. Refer to identification Section.

3.2 FOUNDATIONS

A. Foundations and concrete will be provided under General Construction Work.

B. Coordinate foundations for:
1. Pumps.
2. Fans.
3. Air handling units and floor mounted plenums.
4. Floor mounted control panels.
5. Motor controllers; VFD's, Disconnect Switches, etc.
6. Motors.
7. Air cooled chillers and/or compressor/condensers units.
8. Control Panels.
9. Vertical Stacks.

3.3 WATERPROOFING

A. Waterproofing will be provided under General Construction Work.

3.4 FIELD QUALITY CONTROL

A. Perform tests as noted, and in the presence of Architect and/or Construction Manager, Engineer and authorities having jurisdiction.

B. Provide required labor, material, equipment, and connections necessary for tests and submit results for review.

C. Repair or replace defective work and pay for restoring or replacing damaged work due to tests, as directed.

3.5 CLEANING

A. Brush and clean work prior to concealing, painting and acceptance. Perform in stages if directed.

B. Clean and repair painted exposed work, soiled or damaged, to match adjoining work before final acceptance.

C. Remove debris from inside and outside of material and equipment.

END OF SECTION

This page is intentionally left blank.

SECTION 23 00 01

SUPPLEMENTARY CONDITIONS FOR MECHANICAL, ELECTRICAL, PLUMBING AND FIRE PROTECTION WORK

PART 1 - GENERAL

1.1 The "GENERAL CONDITIONS OF THE CONTRACT FOR CONSTRUCTION", AIA Document A201-2007, is part of this Contract.

1.2 SUMMARY

A. Sustainable Building Requirements:

1. The Owner requires the Contractor to implement practices and procedures to meet the project's environmental performance goals, which include achieving LEED version 4 Certified level Certification. Specific project goals that may impact this area of work include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; construction waste recycling; and the implementation of a construction indoor air quality management plan. The Contractor shall ensure that the requirements related to these goals, as defined in the Articles below, are implemented to the fullest extent. Substitutions, or other changes to the work proposed by the Contractor or their Subcontractors, shall not be allowed if such changes compromise the aforementioned environmental goals and LEED certification.

1.3 SUPPLEMENTARY CONDITIONS

A. These SUPPLEMENTARY CONDITIONS amend or supplement the GENERAL CONDITIONS and other provisions of the Contract Documents as indicated below. All provisions which are not so amended or supplemented remain in full force and effect. AIA document A201-2007 Edition is referenced

1.4 GENERAL PROVISIONS

A. THE SPECIFICATIONS

B. For additional definitions, see "General Provisions" section of each trade.

1.5 CORRELATION AND INTENT OF CONTRACT DOCUMENTS

A. No reassignment of division of responsibility for work as specified for the respective trades shall be made without prior written acceptance by Engineer.

1.6 CONTRACTOR

A. SUPERINTENDENT

B. Contractor shall arrange for Subcontractors for Heating, Ventilation and Air Conditioning work, Electrical Work, Fire Protection Work, Plumbing Work, or any other division of work, to each supply services of a competent project manager who shall act as assistants to the Superintendent and who shall be in attendance at the Project site during the progress of the Work. Such project managers shall be satisfactory to the Engineer, and shall not be changed except with the consent of the Architect

1.7 DOCUMENTS AND SAMPLES AT THE SITE

A. Dimension underground utilities from permanent identifiable benchmarks on Record Drawings.

1.8 RECORD DRAWINGS

A. Before commencing work, procure complete reproducible set of Contract Drawings.

B. Conspicuously indicate major deviations in Mechanical Equipment Rooms by specific reference to shop drawings of these rooms and submit reproducibles of such shop drawings.

C. Submit up-to-date "in progress" prints, to Architect when requesting 25 percent, 50 percent, 75 percent and 95 percent payment of work installed.

D. Upon completion of work, submit signed certified reproducibles of Record and reference shop drawings, along with marked-up prints of in-progress drawing to Architect for acceptance. Also provide an electronic version of the as-built drawings using Auto CADD

1.9 SHOP DRAWINGS, PRODUCT DATA AND SAMPLES

A. Any Shop Drawing, Product Data or Sample submitted without Contractor's approval will not be processed for approval by the Architect, but will be returned to the Contractor for his compliance with the above procedures, in which event it will be deemed that the Contractor has not complied with the provisions herein specified and the Contractor shall bear risk of all delays as if no Shop Drawing, Product Data or Sample had been submitted

B. Shop Drawings, Product Data, and Samples shall include complete dimensional accuracy; the Contractor shall verify that he has checked to insure that work contiguous with and having bearing on the work shown on the Shop Drawings is accurately and clearly shown, that he has checked the Shop Drawings against the Composite Drawings prepared by the Contractor, and that the work has been coordinated and that the equipment will fit into the assigned spaces

C. Prior to shop drawings and sample submissions, and within 30 days after award of contract, submit lists of proposed manufacturers names, shop drawings and samples with proposed schedule of submission dates referenced by Specification Section, Article Numbers and Contract Drawing Number. Contractor shall be responsible for any delays resulting from failure to submit such lists

D. Submit shop drawings and samples for materials, equipment and systems as noted in each respective specification section for each trade

E. Any construction and/or design changes as a result of any approved substitution shall be made at no additional cost to the Owner

F. Composite Drawings:

G. In the interest of coordination and to expedite the work in critical areas, the Contractor shall prepare and submit, to the Architect for review, Composite Drawings incorporating the work of the various trades and/or subcontractor involved. After review, the Contractor shall distribute prints of reviewed Composite Drawings to affected trades and/or subcontractors. The Contractor shall require that the involved trades and/or subcontractors cooperate in preparation of the Composite Drawings to assure proper coordination between trades and/or subcontractors. The participating parties shall indicate their approval on these drawings, in addition to the Contractor

H. Provide composite shop drawings 3/8 inch per foot scale or as approved of areas where contractors proposed installation is at variance with the Contract Drawings or Specifications. Ductwork, piping layout and distribution drawings are required for all below listed specific areas

1. Equipment Rooms

2. Plenums

3. Shafts

4. Roof Level

5. All Floors

I. Indicate dimensioned layouts, elevations and sections of the following, on composite shop drawings

1. Piping and valves

2. Raceways

3. Pull boxes

4. Lighting

5. Equipment

6. Connections

7. Access for servicing

8. Building construction (floor, ceiling, beams and columns)

J. Plan work to allow sufficient time for coordination and for compliance with construction schedule

K. Catalog, model and serial numbers will be assumed to represent equipment complying with Contract Drawings and Specifications, unless otherwise noted

L. Submit additional shop drawings (other than noted) when directed, during progress of project

M. Shop drawing resubmissions are required within 30 days of receipt of review comments from Architect

N. Replace all material and equipment which was installed prior to shop drawing review when directed by Architect

O. Before submitting shop drawings and samples, check material and equipment against drawings for clearance, connections, accessibility, servicing and maintenance

P. Submit shop drawings with:

Q. Marked notation of any deviations from the Contract Documents and reasons for same. Indicate such deviations in a conspicuous manner including component, material and system variations, additions and deletions revised equipment locations, hung ceiling heights and headroom conditions

R. Manufacturer's specifications including: materials, type, performance characteristics, voltage, phase and capacity. Specifications for project shall be tailored to reflect the requirements of the contract documents

S. Certified dimensional drawings, indicating sizes, component parts and installation details

T. Wiring diagrams when applicable

1. Identify with:

a. Project name and number.

b. Names of Architect and Engineer.

c. Identification of applicable items on each submission.

d. Applicable Contract Specification Section and Article Numbers.

e. Applicable Contract Drawing Numbers.

U. Minimum copies of shop drawing submissions:

V. 8-1/2 inch by 14 inch and smaller: Eight (8) copies

W. Larger than 8-1/2 inch by 14 inch: 1 reproducible plus eight (8) print

X. All fire walls and smoke partitions must be highlighted on the sheet metal drawings for appropriate coordination

1.10 CLEANING UP

A. Remove broken or scratched glass and replace with new glass, remove paint drippings, spots, stains, and dirt from finished surfaces and clean fixtures, hardware, floors and equipment. Contractor shall keep interior of the building free of stored or unattended combustible material

1.11 INDEMNIFICATION

A. Relieve Owner of all claims in connection with use of facilities, conveniences or services supplied by other parties

1.12 ADMINISTRATION OF THE CONTRACT

A. ARCHITECT

1. Whenever the word "Architect" occurs, the word "Engineer" shall be also stipulated, and shall mean the firm of AKF Group, LLC or its authorized representative

B. PROTECTION OF PERSONS AND PROPERTY

C. SAFETY OF PERSONS AND PROPERTY

D. Close open ends of work with temporary covers or plugs during construction to prevent entry of obstructing materials

E. Storage areas will be designated by Architect or Building Owner

F. PARTIAL OCCUPANCY OR USE

G. No equipment intended for permanent installation shall be operated for temporary purposes without written permission of, and complete agreement with stipulation as set forth by, the Architect

H. DEVIATIONS

I. When deviations to Contract Documents are requested by the Contractor and accepted by the Architect, Contractor shall be responsible for all affected work and costs, including that of other contracts.

J. Interference with Owner's Operations

K. Contractors shall take whatever action is necessary to avoid interference with owner's use of the building or damage to existing facilities equipment

L. Except as otherwise specified herein, contractors may work during normal working hours. In the event that noisy work interferes with owner's operations, owner

may direct contractor to stop that work. If the workers involved cannot be used on other work, Contractor shall be paid for the lost time in accordance with a schedule of hourly rates to be included in the contract. Owner's representative will determine the duration of the stoppage and whether compensation therefor is warranted

M. Contractor shall include with his proposal a schedule of hourly rates and overtime premiums

N. Maintain all existing site utility and building services in operation

O. PROJECT CLOSEOUT PROCEDURES

P. The requirements of this section are in addition to and supplement the requirements outlined in Division 1

Q. It shall be each contractor's responsibility to personally hand-deliver all of the required project closeout checklist items and to obtain Owner's authorized representative(s) signed receipt on all items requiring Owner sign-off

R. Project Closeout Checklist

S. Review requirements of each section of the specifications and submit for approval to Architect the sign-off forms which shall become the project closeout checklist. These, at a minimum, shall include the following information shown in attached Project Closeout Checklist Example. The Architect and/or Owner may incorporate additional specific items to the following checklist which shall become part of the project requirements

T. Closeout Checklist Example:

PART 2 - PROJECT CLOSETOUT			
PART 3 - PROJECT:			
PART 4 - DIVISION NO.:			
PART 5 - CONTRACTOR:			
PART 6 - ITEM [1]	PART 7 - DATES		PART 8 - OWNER'S SIGN-OFF
	PART 9 - COMPLETED	PART 10 - RECEIVED BY OWNER	
PART 11 - Permits	PART 12 -	PART 13 -	PART 14 -
PART 15 - City and State Inspection	PART 16 -	PART 17 -	PART 18 -
PART 19 - Manufacturer's warranties	PART 20 -	PART 21 -	PART 22 -
PART 23 - Contractor's Warranties	PART 24 -	PART 25 -	PART 26 -
PART 27 - State Fire Rating Data	PART 28 -	PART 29 -	PART 30 -
PART 31 - Copy of Final Shop Drawings	PART 32 -	PART 33 -	PART 34 -
PART 35 - List and Possession of Spare Parts	PART 36 -	PART 37 -	PART 38 -

PART 2 - PROJECT CLOSETOUT			
PART 3 - PROJECT:			
PART 4 - DIVISION NO.:			
PART 5 - CONTRACTOR:			
PART 39 - Pressure Tests (Ductwork)	PART 40 -	PART 41 -	PART 42 -
PART 43 - Pressure Tests (Piping)	PART 44 -	PART 45 -	PART 46 -
PART 47 - Equipment Tests Required by Specs	PART 48 -	PART 49 -	PART 50 -
PART 51 - O & M Manuals	PART 52 -	PART 53 -	PART 54 -
PART 55 - Record Documents	PART 56 -	PART 57 -	PART 58 -
PART 59 - Coordination Drawings	PART 60 -	PART 61 -	PART 62 -
PART 63 - Sanitization Reports	PART 64 -	PART 65 -	PART 66 -
PART 67 - Commissioning and LEED® Reports/Letters/Forms	PART 68 -	PART 69 -	PART 70 -
PART 71 - On-Site Training Complete	PART 72 -	PART 73 -	PART 74 -
PART 75 - Protective Device Settings	PART 76 -	PART 77 -	PART 78 -
PART 79 - Valve Tags and Charts	PART 80 -	PART 81 -	PART 82 -
PART 83 - Final BMS Installation Drawings	PART 84 -	PART 85 -	PART 86 -
PART 87 - Insurance Underwriters Approvals	PART 88 -	PART 89 -	PART 90 -
PART 91 - Final Punch List (Initialed by contractor that items are complete)	PART 92 -	PART 93 -	PART 94 -
PART 95 - Building Certificate of Occupancy (C.O.)	PART 96 -	PART 97 -	PART 98 -
PART 99 - 24-Hour Phone No. for Service During Guarantee Period	PART 100 -	PART 101 -	PART 102 -

Part 2- PRODUCTS

(Not Applicable)

Part 3- EXECUTION

(Not Applicable)

END OF SECTION

SECTION 23 05 00

COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Section 01 81 13 "Sustainable Design Requirements – LEED v4 for Building Design & Construction – New Construction" for sustainable design requirements and detailed sustainable design submittal requirements.

C. Section 01 74 19 "Construction and Demolition Waste Management and Disposal" for disposal of construction, demolition and packaging waste disposal requirements.

1.2 SUMMARY

A. This Section includes the following:
1. Piping materials and installation instructions common to most piping systems.
2. Transition fittings.
3. Dielectric fittings.
4. Mechanical sleeve seals.
5. Sleeves.
6. Escutcheons.
7. Grout.
8. Equipment installation requirements common to equipment sections.
9. Painting and finishing.
10. Concrete bases.
11. Supports and anchorages.

B. Sustainable Building Requirements:
1. The Owner requires the Contractor to implement practices and procedures to meet the project's environmental performance goals, which include achieving LEED version 4 Certified level Certification. Specific project goals that may impact this area of work include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; construction waste recycling; and the implementation of a construction indoor air quality management plan. The Contractor shall ensure that the requirements related to these goals, as defined in the Articles below, are implemented to the fullest extent. Substitutions, or other changes to the work proposed by the Contractor or their Subcontractors, shall not be allowed if such changes compromise the aforementioned environmental goals and LEED certification.

1.3 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct chases, unheated spaces immediately below roof, spaces above ceilings, unexcavated spaces, crawlspaces, and tunnels.

B. Exposed, Interior Installations: Exposed to view indoors. Examples include finished occupied spaces and mechanical equipment rooms.

C. Exposed, Exterior Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions. Examples include rooftop locations.

D. Concealed, Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and chases.

E. Concealed, Exterior Installations: Concealed from view and protected from weather conditions and physical contact by building occupants but subject to outdoor ambient temperatures. Examples include installations within unheated shelters.

F. The following are industry abbreviations for plastic materials:
1. CPVC: Chlorinated polyvinyl chloride plastic.
2. PE: Polyethylene plastic.
3. PVC: Polyvinyl chloride plastic.

G. The following are industry abbreviations for rubber materials:
1. EPDM: Ethylene-propylene-diene terpolymer rubber.
2. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS

A. Product Data: For the following:
1. Transition fittings.
2. Dielectric fittings.
3. Mechanical sleeve seals.
4. Escutcheons.

B. Welding certificates

C. Welding: Before proceeding, submit the following for review and approval;
1. Proposed procedure conforming to latest revision of:
a. ANSI/ASME B31.1, Pressure Piping Chapter V.
b. ANSI/ASME B31.9, Building Services Piping
c. ANSI 249.1 Safety in Welding and Cutting
2. List of welders qualified per section IX of ASME. Boiler and Pressure Vessel Code including, but not limited to, the following information:
a. Welder's name
b. Welder's Social Security Number
c. Employer's name
d. Name of testing laboratory
e. Procedure tested for including, but not limited to, the following:
1) Date of test
2) Wall thickness
3) Base metal material
4) Electrode
5) Position
f. Procedure tested for including, but not limited to, the following:
1) Type of test performed

2) Result of test
3) Welder's identification symbol
4) Sample of each identification device
5) Certify that each welder has either worked in the procedure or successfully tested in the procedure within the past six month

D. Brazing: Before proceeding, submit the following for review and approval;
1. Proposal procedure conforming to latest revision of:
a. Section IX, ASME Boiler and Pressure Vessel Code, Welding and Brazing Qualifications.
b. ANSI/AWS B2.2 Standard for Brazing Procedure and Performance Qualification
2. List of brazers qualified per section IX of ASME. Boiler and Pressure Vessel Code including, but not limited to, the following information:
a. Brazer's name
b. Brazer's Social Security Number
c. Employer's name
d. Name of testing laboratory
e. Procedure tested for including, but not limited to, the following:
1) Date of test
2) Wall thickness
3) Base metal material
4) Brazing filler material
5) Position
6) Type of test performed
7) Result of test
8) Brazer's identification symbol
9) Sample of each identification device
10) Certify that each Brazer has either worked in the procedure or successfully tested in the procedure within the past six months

1.5 QUALITY ASSURANCE

A. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code--Steel."

B. Steel Pipe Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

C. Electrical Characteristics for HVAC Equipment: Equipment of higher electrical characteristics may be furnished provided such proposed equipment is approved in writing and connecting electrical services, circuit breakers, and conduit sizes are appropriately modified. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver pipes and tubes with factory-applied end caps. Maintain end caps through shipping, storage, and handling to prevent pipe end damage and to prevent entrance of dirt, debris, and moisture.

B. Store plastic pipes protected from direct sunlight. Support to prevent sagging and bending.

1.7 COORDINATION

A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for HVAC installations.

B. Coordinate installation of required supporting devices and set sleeves in poured-in-place concrete and other structural components as they are constructed.

C. Coordinate requirements for access panels and doors for HVAC items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 08 Section "Access Doors and Frames."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In other Part 2 articles where subparagraph titles below introduce lists, the following requirements apply for product selection:
   1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the manufacturers specified.
   2. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 23 Piping Sections for pipe, tube, and fitting materials and joining methods.

B. Pipe Threads: ASME B1.20.1 for factory-threaded pipe and pipe fittings.

2.3 JOINING MATERIALS

A. Refer to individual Division 23 Piping Sections for special joining materials not listed below.

B. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
   1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch (3.2-mm) maximum thickness unless thickness or specific material is indicated.
      a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
      b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
   2. AWWA C110, rubber, flat face, 1/8 inch (3.2 mm) thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

D. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, unless otherwise indicated.

E. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.

F. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for general-duty brazing, unless otherwise indicated; and AWS A5.8, BAg1, silver alloy for refrigerant piping, unless otherwise indicated.

G. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

2.4 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

B. Insulating Material: Suitable for system fluid, pressure, and temperature.

C. Dielectric Unions: In lieu of dielectric unions, use brass unions between different pipe materials.

2.5 MECHANICAL SLEEVE SEALS

A. Description: Modular sealing element unit, designed for field assembly, to fill annular space between pipe and sleeve.
   1. Manufacturers:
      a. Advance Products & Systems, Inc.
      b. Calpico, Inc.
      c. Metraflex Co.
      d. Pipeline Seal and Insulator, Inc.
      e. Thunderline Link-seal
   2. Sealing Elements: NBR interlocking links shaped to fit surface of pipe. Include type and number required for pipe material and size of pipe.
   3. Pressure Plates: Stainless steel. Include two for each sealing element.
   4. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.6 SLEEVES

A. Galvanized-Steel Sheet: 0.0239-inch minimum thickness; round tube closed with welded longitudinal joint.

B. Steel Pipe: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.
   1. Underdeck Clamp: Clamping ring with set screws.

2.7 ESCUTCHEONS

A. Description: Manufactured wall and ceiling escutcheons and floor plates, with an ID to closely fit around pipe, tube, and insulation of insulated piping and an OD that completely covers opening.

B. One-Piece, Deep-Pattern Type: Deep-drawn, box-shaped brass with polished chrome-plated finish.

C. One-Piece, Cast-Brass Type: With set screw.
   1. Finish: Polished chrome-plated.

D. Split-Casting, Cast-Brass Type: With concealed hinge and set screw.
   1. Finish: Polished chrome-plated.

E. One-Piece, Stamped-Steel Type: With spring clips and chrome-plated finish.

F. Split-Plate, Stamped-Steel Type: With concealed hinge, spring clips, and chrome-plated finish.

G. One-Piece, Floor-Plate Type: Cast-iron floor plate.

H. Split-Casting, Floor-Plate Type: Cast brass with concealed hinge and set screw.

2.8 GROUT

A. General Purpose Description: ASTM C 1107, Grade B, nonshrink and nonmetallic, dry hydraulic-cement grout.
   1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.
   2. Design Mix: 14000 / 19000-psi, 36 hours @70 degrees compressive strength.
   3. Packaging: factory packaged for field mixing.

B. Pump Mounting: High flow, high strength epoxy machine-based grout: ASTM C 881, CRD-C 590.
   1. Characteristics: Two to Three-component, highly flowable, epoxy-based grout that produces high performance strength plus chemical inertness and excellent bonding properties.
   2. Design Mix: ASTM-C 579, 14,000 / 19,000 psi , 36 hours @72 degree F compressive strength.
   3. Packaging: Factory packaged for field mixing.
   4. Products: Chocfast by ITW Philadelphia resins, ESCOWELD or approved equal.

PART 3 - EXECUTION

3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 23 Sections specifying piping systems.

B. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

C. Install piping in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

D. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install piping to permit valve servicing.

G. Install piping at indicated slopes.

H. Install piping free of sags and bends.

I. Install fittings for changes in direction and branch connections.

J. Install piping to allow application of insulation.

K. Select system components with pressure rating equal to or greater than system operating pressure.

L. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:
   1. New Piping:
      a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.
      b. Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.
      c. Insulated Piping: One-piece, stamped-steel type with spring clips.
      d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
      e. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, stamped-steel type.
      f. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.
      g. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, stamped-steel type and set screw.
      h. Bare Piping in Unfinished Service Spaces: One-piece, cast-brass type with polished chrome-plated finish.
      i. Bare Piping in Unfinished Service Spaces: One-piece, stamped-steel type with spring clips.
      j. Bare Piping in Equipment Rooms: One-piece, cast-brass type.
      k. Bare Piping in Equipment Rooms: One-piece, stamped-steel type with spring clips.
      l. Bare Piping at Floor Penetrations in Equipment Rooms: One-piece, floor-plate type.

M. Sleeves are not required for core-drilled holes except at all Penthouse and/or roof penetrations.

N. Permanent sleeves are not required for holes formed by removable PE sleeves except at all Penthouse and/or roof penetrations.

O. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.

P. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.
   1. Cut sleeves to length for mounting flush with both surfaces.
      a. Exception: Extend sleeves installed in floors of the Penthouse and/or mechanical equipment areas or other wet areas 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
   2. Install sleeves in new walls and slabs as new walls and slabs are constructed. Air seal all penetrations at all supply and return air plenums.

3. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:
   a. Steel Pipe Sleeves: For pipes smaller than NPS 6.
   b. Steel Sheet Sleeves: For pipes NPS 6 and larger, penetrating gypsum-board partitions 16 Gauge
      1) Seal space outside of sleeve fittings with grout.
4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.

Q. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
1. Install steel pipe for sleeves smaller than 6 inches in diameter.
2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.
3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

R. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.
1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

S. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section "Penetration Firestopping" for materials.

T. Verify final equipment locations for roughing-in.

U. Refer to equipment specifications in other Sections of these Specifications for roughing-in requirements.

3.2 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel or groove (on applicable systems) plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. 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.

E. 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.

F. 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.
   3. Threaded fittings not allowed in glycol system.

G. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

H. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

I. Grooved Joints: Install in accordance with the manufacturer's (Victaulic or Engineer Approved Equal) guidelines and recommendations. All grooved couplings, fittings, valves and specialties shall be supplied by a single manufacturer. Grooving tools shall be supplied by the same manufacturer as the grooved components. The gasket style and elastomeric material (grade) shall be verified as suitable for the intended service as specified. Gaskets shall be developed and supplied by the manufacturer. Grooved end shall be clean and free from indentations, projections and roll marks in the area from pipe end to groove. A Victaulic factory trained field representative shall provide on-site training to contractor's field personnel in the installation of grooved piping products. Factory trained representative shall periodically review the product installation. Contractor shall remove and replace any improperly installed products.
   1. Install the Victaulic AGS piping system in accordance with the latest Victaulic installation instructions. Use Victaulic grooving tools with AGS roll sets to groove the pipe. Follow Victaulic guidelines for tool selection and operation. Coupling installation shall be complete when visual metal-to-metal contact is reached. AGS products shall not be installed with standard grooved end pipe or components. Installing AGS products in combination with standard grooved end products could result in joint separation and/or leakage.
   2. Grooved joints not allowed on Hot Water system

3.3 PIPING CONNECTIONS

A. 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.
   2. Install flanges,or grooved joints, in piping NPS 2-1/2 and larger, adjacent to flanged or grooved end valves and at final connection to each piece of equipment.
   3. Dry Piping Systems: Install brass unions to connect piping materials of dissimilar metals.
   4. Wet Piping Systems: Install brass unions to connect piping materials of dissimilar metals.

3.4 DUCT SYSTEMS – COMMON REQUIREMENTS

A. Install ductwork according to the following requirements and Division 23 Sections specifying metal ducts, casings, duct accessories and related components.

B. Drawing plans, schematics and diagram indicate general location and arrangement of duct systems. Indicated locations and arrangements were used to size ducts and calculate friction loss, expansion, fan sizing and other design considerations. Install ductwork as indicated unless deviations to layout are approved on Coordination Drawings.

C. Install ductwork in concealed locations, unless otherwise indicated and except in equipment rooms and service areas.

D. Install ductwork indicated to be exposed and ductwork in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

E. Install ductwork above accessible ceilings to allow sufficient space for ceiling panel removal.

F. Install ductwork to permit servicing of C.V. boxes, VAV boxes, dampers, actuators, filters, valves, and as required.

G. Install with indicated horizontal and vertical offset.

H. Install ductwork free of sags and bends.

I. Install fittings for changes in direction and branch connections.

J. Install ductwork to allow application of insulation.

K. Select system components with pressure class equal to or greater than system operating pressure.

3.5 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

A. Install equipment to allow maximum possible headroom unless specific mounting heights are not indicated.

B. Install equipment level and plumb, parallel and perpendicular to other building systems and components in exposed interior spaces, unless otherwise indicated.

C. Install HVAC equipment to facilitate service, maintenance, and repair or replacement of components. Connect equipment for ease of disconnecting, with minimum interference to other installations. Extend grease fittings to accessible locations.

D. Install equipment to allow right of way for piping installed at required slope.

3.6 PAINTING

A. Painting of HVAC systems, equipment, and components is specified in Division 09 Sections "Interior Painting" and "Exterior Painting."

B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.7 CONCRETE BASES

A. Concrete Bases: Anchor equipment to concrete base according to equipment manufacturer's written instructions and according to seismic codes at Project.
   1. Construct concrete bases of dimensions indicated, but not less than 4 inches larger in both directions than supported unit.
   2. 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 the base.
   3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
   4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   5. Install anchor bolts to elevations required for proper attachment to supported equipment.
   6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.8 ERECTION OF METAL SUPPORTS AND ANCHORAGES

A. Refer to Division 05 Section "Metal Fabrications" for structural steel.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor HVAC materials and equipment.

C. Field Welding: Comply with AWS D1.1.

3.9 GROUTING

A. Mix and install grout for HVAC equipment base bearing surfaces, pump and other equipment base plates, and anchors.

B. Clean surfaces that will come into contact with grout.

C. Provide forms as required for placement of grout.

D. Avoid air entrapment during placement of grout.

E. Place grout, completely filling equipment bases.

F. Place grout on concrete bases and provide smooth bearing surface for equipment.

G. Place grout around anchors.

H. Cure placed grout.

END OF SECTION

This page is intentionally left blank.

SECTION 23 05 12

BEARING PROTECTION RING FOR MOTORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V.

B. The mechanical contractor is to provide motor protection ring. The mechanical contractor to install motor protection ring. Coordinate all requirements with electrical contractor.

1.3 COORDINATION

A. Coordinate features of bearing ring with the following:
   1. Motor controllers
   2. Variable frequency motor controllers.
   3. Torque, speed, and horsepower requirements of the load.
   4. Ambient and environmental conditions of installation location.

1.4 DESCRIPTION OF BEARING PROTECTION RING

A. VFD induced shaft voltages may also discharge through the bearing in attached equipment included gear boxes, pillow block bearings, break motor bearings, encoders, etc. Applying AEGIS SGR Bearing Protection Ring applied to the motor shaft will discharge induced electrical voltages to ground and prevent voltages from seeking a discharge path through the attached equipment.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS

A. Provide shaft grounding ring (AEGIA SGR on the AC motor to discharge shaft currents to the ground whenever variable frequency PWM drives are installed to control AC motors.

B. Bearing ring to be circumferential conductive micro-fiber and maintenance free

C. Provide vibration baseline readings before and after installation

D. Installation to be preformed by factory authorized personnel only.

E. For outdoor installations, a cover should be installed to prevent rust on the shaft. Use Ted Pella fast drying silver paint on motor shaft to help retard rust.

F. For wash down duty application, high pressure water should not be directed onto the conductive micro fibers. Install o-ring or slinger to AEGIS SGR.

G. For severe duty environments, install an o-ring or slinger against the AEGIS SGR to prevent ingress of excess grease or particles.

H. Verify RPM/ surface rates with AEGIS engineering.

I. Maximum temperature rating 300F/150C – Verify application specific temperatures with AEGIS engineering.

J. Minimum temperature rating -40 degrees F/C – Verify application specific temperatures with AEGIS engineering.

K. Humidity rating - 0-90% - Verify application specific acceptable humidity with AEGIS engineering

L. Shaft preparation - Motor shaft must be clean and bear metal to ensure electrical contact of motor shaft to conductive micro fibers.

M. Shaft - Shaft motor manufacturer standard shaft finish is suitable for AEGIS shaft grounding ring application. A nominal 130 micron finish or better.

N. Corrosion Protection - Apply a Fast Drying Silver paint such as Ted Pella #16040-30, on shaft surface to prevent corrosion.

O. Thread Locking Compound - Do not use Loctite or any other non-conductive material to secure the screws.

P. Excessive Vibration - Installation bolts should be tightened and lock washers used. In some critical applications it may also be desirable to use a thread locker. In this case you must use a conductive silver epoxy such as Chemtronics Conductive Silver Epoxy CW2400.

PART 3 - EXECUTION

(Not Applicable)

END OF SECTION

SECTION 23 05 13

COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Section 01 81 13 “Sustainable Design Requirements – LEED v4 for Building Design & Construction – New Constructions” for sustainable design requirements and detailed sustainable design submittal requirements.

C. Section 01 74 19 “Construction and Demolition Waste Management and Disposal” for disposal of construction, demolition and packaging waste disposal requirements.

1.2 SUMMARY

A. Section includes general requirements for single-phase and three-phase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

B. The mechanical contractor is to provide motor, motor controllers, fused disconnect switches and VFD’s. The mechanical contractor to install motor, motor controllers, disconnect switches and VFD’s. The Electrical contractor is to wire all motors, fused disconnect switches, motor controllers and VFD’s. Electrical contractor to furnish and install all fuses in disconnect switches.

C. Sustainable Building Requirements:

1. The Owner requires the Contractor to implement practices and procedures to meet the project’s environmental performance goals, which include achieving LEED version 4 Certified level Certification. Specific project goals that may impact this area of work include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; construction waste recycling; and the implementation of a construction indoor air quality management plan. The Contractor shall ensure that the requirements related to these goals, as defined in the Articles below, are implemented to the fullest extent. Substitutions, or other changes to the work proposed by the Contractor or their Subcontractors, shall not be allowed if such changes compromise the aforementioned environmental goals and LEED certification.

1.3 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:

1. Motor controllers and fused disconnect switches.
2. Variable frequency motor controllers.
3. Torque, speed, and horsepower requirements of the load.
4. Ratings and characteristics of supply circuit and required control sequence.
5. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.1 BASE BID MANUFACTURERS

A. Motors: Toshiba, ~~Reliance~~, WEG

B. Motor controllers and disconnect switches:
   1. Division 260000-"Enclosed Switches and Circuit Breakers" and "Enclosed Controllers".

2.2 MOTORS

A. Motors shall be in accordance with NEMA, IEEE, UL and ANSI C50 standards with minimum indicated horsepower and the ability to operate the drive device under all conditions without overload. Motors shall be of the same manufacturer, except those provided integrally with equipment.

B. Motors shall be designed for continuous load to operate in ambient temperature of 104 deg F and service factor of 1.15.

C. Efficiency of motor shall be IEEE standard 112, 1978 Test Method B. Unless noted otherwise motors shall be of premium efficiency, in order to qualify for the local utility company rebate program for New Construction, and shall meet ASHRAE 90.1-2013 as a minimum, unless the utility company rebate program for new construction is more stringent, then they shall meet the utility company requirements.

D. Except as noted, motors below ½ hp shall be 120 volts, 60 Hertz, single phase and motors ½ hp and larger shall be 460 volts, 60 hertz, 3 phase.

E. Except as noted, motors shall be squirrel-cage induction type, open dripproof, 1750 rpm Class B insulation. Motors mounted on equipment outdoors shall be totally enclosed fan cooled (TEFC), weatherproof, 1750 rpm, class F insulation.

F. Motor mounted outdoor and in areas where condensation can occur shall be with electrical heaters.

G. Provide, sealed, permanently lubricated bearings for motors, such as Perma Lube.

H. Except as noted, multispeed motors shall be variable torque type.

I. Coordinate all motor types and sizes with motor controller types and sizes. Coordinate size and location of terminal box with electrical work. Terminal box shall be clear of ventilation openings and shall be of size to receive electrical circuit wiring.

J. Provide foundation slide base and shaft for belt-connected motors as required for aligning pulleys.

K. Fractional horsepower motors shall be furnished with built in overload protection, where respective controllers are without overload protection.

2.3 MOTORS WITH ADDITIONAL REQUIREMENTS

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: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.
   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. Energy- and 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.

C. Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor.

2.4 SINGLE-PHASE MOTORS

A. Motors larger than 1/20 hp shall be electronically commutated (ECM).

B. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.

C. Motors 1/20 HP and Smaller: Shaded-pole type.

D. 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

3.1 FIELD QUALITY CONTROL

A. Test all motors for proper operation after installation and wiring.

END OF SECTION

This page is intentionally left blank.

SECTION 23 05 14

ENCLOSED CONTROLLERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes ac, enclosed controllers rated 600 V and less, of the following types:
   1. Across-the-line, manual and magnetic controllers.
   2. Reduced-voltage controllers.
   3. Multispeed controllers.
   4. All with fused disconnect switches.

1.3 WORK INCLUDED

A. The mechanical contractor is to provide motor, motor controllers and VFD's. The mechanical contractor to install motor, motor controllers and VFD's. The Electrical contractor is to wire all motors and motor controllers.

B. The mechanical contractor shall be responsible for coordinating all requirements of the motor and controller manufacturer.

C. If this contractor elects to substitute or increase motor horsepower over that specified, the cost of motor, motor controllers and electrical changes shall be borne by this contractor

D. Each motor except as noted, shall be provided with a combination fused disconnection means and across-the-line magnetic starter with push button stations mounted on cover or variable frequency drive. Coordinate requirements between trades (electrical and mechanical contractors).

E. For automatically or remotely controlled motors, furnish hand off auto (HOA) selector switches in place of the push buttons.

F. Provide manually operated motor starters of the proper size for all motors less than 1/2 hp which are not automatically controlled. Starters for motors 175 watts or less shall consist of a snap switch with thermal overload protection where such protection is not an integral part of the motor.

G. Combination magnetic starters for all motors shall have thermal overload, pilot light, low voltage protection in all three phases. Include a control transformer for each magnetic starter to provide 120 volt control power with 3 sets of spare normally closed or normally open contacts

H. Starters for motors 75 hp and above shall be solid state electronic soft start type starters.

I. All disconnect switches shall be provided by this contractor and shall be fused suitable for the motor or equipment served.

J. Provide enclosures for motor controllers suitable for operating environment.

K. Where a motor control center is indicated on plans, individually mounted motor controllers shall not be utilized. Please review electrical drawings for all motor control center starters, which will be provided by others.

1.4 RELATED SECTIONS INCLUDE THE FOLLOWING:

1. Division 26 Section "Electrical Power Monitoring and Control" for interfacing communication and metering requirements.
2. Division 23 Section 230515 "Variable-Frequency Motor Controllers" for general-purpose, ac, adjustable-frequency, pulse-width-modulated controllers for use on constant torque loads in ranges up to 200 hp.
3. All division 230000 sections.
4. Division 26 Section “Enclosed Controllers”.

1.5 SUBMITTALS

A. Product Data: For each type of enclosed controller. Include dimensions and manufacturer's technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each enclosed controller.

1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:
   a. Each installed unit's type and details.
   b. Nameplate legends.
   c. Short-circuit current rating of integrated unit.
   d. Listed and labeled for series rating of overcurrent protective devices in combination controllers by an NRTL acceptable to authorities having jurisdiction.
   e. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices in combination controllers.
2. Wiring Diagrams: Power, signal, and control wiring.

C. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout, required working clearances, and required area above and around enclosed controllers where pipe and ducts are prohibited. Show enclosed controller layout and relationships between electrical components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 100 miles of Project site, a service center capable of providing training, parts, and emergency maintenance and repairs.

B. Source Limitations: Obtain enclosed controllers of a single type through one source from a single manufacturer. Coordinate with the project electrical contractor so all equipment is compatiable.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. Comply with NFPA 70.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Store enclosed controllers indoors in clean, dry space with uniform temperature to prevent condensation. Protect enclosed controllers from exposure to dirt, fumes, water, corrosive substances, and physical damage.

B. If stored in areas subject to weather, cover enclosed controllers to protect them from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside controllers; install electric heating of sufficient wattage to prevent condensation.

1.8 PROJECT CONDITIONS

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 Construction Manager no fewer than two days in advance of proposed interruption of electrical service.
   2. Do not proceed with interruption of electrical service without Construction Manager's written permission.

1.9 COORDINATION

A. Coordinate layout and installation of enclosed controllers with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03 Section "Cast-in-Place Concrete."

C. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

D. Coordinate features of enclosed controllers and accessory devices with pilot devices and control circuits to which they connect.

E. Coordinate features, accessories, and functions of each enclosed controller with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of motor and load.

1.10 EXTRA MATERIALS

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

1. Spare Fuses: Furnish one spare for every five installed, but no fewer than one set of three of each type and rating.
2. Indicating Lights: Two of each type installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, and compatibility with the electrical system equipment being provided, provide products by one of the following:
1. ABB Power Distribution, Inc.; ABB Control, Inc. Subsidiary.
2. Danfoss Inc.; Danfoss Electronic Drives Div.
3. Eaton Corporation; Cutler-Hammer Products.
4. Rockwell Automation; Allen-Bradley Co.; Industrial Control Group.
5. Square D.

2.2 ACROSS-THE-LINE ENCLOSED CONTROLLERS

A. Manual Controller: NEMA ICS 2, general purpose, Class A, with "quick-make, quick-break" toggle or pushbutton action, and marked to show whether unit is "OFF," "ON," or "TRIPPED."
1. Overload Relay: Ambient-compensated type with inverse-time-current characteristics and NEMA ICS 2, Class 10 tripping characteristics. Relays shall have heaters and sensors in each phase, matched to nameplate, full-load current of specific motor to which they connect and shall have appropriate adjustment for duty cycle.

B. Magnetic Controller: NEMA ICS 2, Class A, full voltage, nonreversing, across the line, unless otherwise indicated.
1. Control Circuit: 120 V; obtained from integral control power transformer of sufficient capacity to operate connected pilot, indicating and control devices, plus 100 percent spare capacity.
2. Overload Relay: Ambient-compensated type with inverse-time-current characteristic and NEMA ICS 2, Class 10 tripping characteristic. Provide with heaters or sensors in each phase matched to nameplate full-load current of specific motor to which they connect and with appropriate adjustment for duty cycle.
3. Adjustable Overload Relay: Dip switch selectable for motor running overload protection with NEMA ICS 2, Class 10 tripping characteristic, and selected to protect motor against voltage and current unbalance and single phasing. Provide relay with Class II ground-fault protection, with start and run delays to prevent nuisance trip on starting.

C. Combination Magnetic Controller: Factory-assembled combination controller and fused disconnect switch.
1. Fusible Disconnecting Means: NEMA KS 1, heavy-duty, fusible switch with rejection-type fuse clips rated for fuses. Select and size fuses to provide Type 2 protection according to IEC 947-4-1, as certified by an NRTL.
2. Nonfusible Disconnecting Means: NEMA KS 1, heavy-duty, nonfusible switch.

3. Circuit-Breaker Disconnecting Means: NEMA AB 1, motor-circuit protector with field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.

2.3 REDUCED-VOLTAGE ENCLOSED CONTROLLERS

A. Star-Delta Controller: NEMA ICS 2, closed transition with adjustable time delay.

B. Part-Winding Controller: NEMA ICS 2, closed transition with separate overload relays for starting and running sequences.

C. Autotransformer Reduced-Voltage Controller: NEMA ICS 2, closed transition.

D. Solid-State, Reduced-Voltage Controller: NEMA ICS 2, suitable for use with NEMA MG 1, Design B, polyphase, medium induction motors.
   1. Adjustable acceleration rate control utilizing voltage or current ramp, and adjustable starting torque control with up to 500 percent current limitation for 20 seconds.
   2. Surge suppressor in solid-state power circuits providing 3-phase protection against damage from supply voltage surges 10 percent or more above nominal line voltage.
   3. LED indicators showing motor and control status, including the following conditions:
      a. Control power available.
      b. Controller on.
      c. Overload trip.
      d. Loss of phase.
      e. Shorted silicon-controlled rectifier.
   4. Motor running contactor operating automatically when full voltage is applied to motor.

2.4 ENCLOSURES

A. Description: Flush- or surface-mounting cabinets as indicated. NEMA 250, Type 1, unless otherwise indicated to comply with environmental conditions at installed location.
   1. Outdoor Locations: NEMA 250, Type 3R.
   2. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
   3. Hazardous Areas Indicated on Drawings: NEMA 250, Type 7C.

2.5 ACCESSORIES

A. Devices shall be factory installed in controller enclosure, unless otherwise indicated.

B. Push-Button Stations, Pilot Lights, and Selector Switches: NEMA ICS 2, heavy-duty type.

C. Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.

D. Control Relays: Auxiliary and adjustable time-delay relays.

E. Auxillary contacts (normally open/ normally closed) for Building Management System (BMS) interface and control.

2.6 FACTORY FINISHES

A. Finish: Manufacturer's standard paint applied to factory-assembled and -tested enclosed controllers before shipping.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and surfaces to receive enclosed controllers for compliance with requirements, installation tolerances, and other conditions affecting performance.
   1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 APPLICATIONS

A. Select features of each enclosed controller to coordinate with ratings and characteristics of supply circuit and motor; required control sequence; duty cycle of motor, controller, and load; and configuration of pilot device and control circuit affecting controller functions.

B. Select horsepower rating of controllers to suit motor controlled.

3.3 INSTALLATION

A. For control equipment at walls, bolt units to wall or mount on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide freestanding racks complying with Division 26 Section "Hangers and Supports for Electrical Systems."

B. Install freestanding equipment on concrete bases.

C. Comply with mounting and anchoring requirements specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

D. Enclosed Controller Fuses: Install fuses in each fusible switch. Comply with requirements in Division 26 Section "Fuses."

3.4 CONCRETE BASES

A. Coordinate size and location of concrete bases. Verify structural requirements with structural engineer.

B. Concrete base is specified in Division 26 Section "Hangers and Supports for Electrical Systems," and concrete materials and installation requirements are specified in Division 03.

3.5 IDENTIFICATION

A. Identify enclosed controller, components, and control wiring according to Division 26 Section "Identification for Electrical Systems."

3.6 CONTROL WIRING INSTALLATION

A. Install wiring between enclosed controllers according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

B. Bundle, train, and support wiring in enclosures.

C. Connect hand-off-automatic switch and other automatic-control devices where applicable.
   1. Connect selector switches to bypass only manual- and automatic-control devices that have no safety functions when switch is in hand position.
   2. Connect selector switches with enclosed controller circuit in both hand and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.7 CONNECTIONS

A. Conduit installation requirements are specified in other Division 26 Sections. Drawings indicate general arrangement of conduit, fittings, and specialties.

B. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

3.8 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:
   1. Test insulation resistance for each enclosed controller element, bus, component, connecting supply, feeder, and control circuit.
   2. Test continuity of each circuit.
   3. Perform test to demonstrate that controllers are operational and functioning in accordance with the manufacturer’s recommendations and the contract documents.

3.9 ADJUSTING

A. Set field-adjustable switches and circuit-breaker trip ranges.

END OF SECTION

This page is intentionally left blank.

SECTION 23 05 15

VARIABLE-FREQUENCY MOTOR CONTROLLERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes solid-state, PWM, VFDs for speed control of three-phase, squirrel-cage induction motors.

B. Related Sections include the following:

~~1. Division 26 Section "Electrical Power Monitoring and Control" for monitoring and control of motor circuits.~~

2. Division 26 Section "Transient-Voltage Suppression for Low-Voltage Electrical Power Circuits" for low-voltage power, control, and communication surge suppressors
3. All division 230000 sections.

1.3 WORK INCLUDED

1. The mechanical contractor is to provide motor, variable frequency controllers (VFD's). The mechanical contractor to install motor, motor controllers and VFD's. The Electrical contractor is to wire all motors and VFD's
2. The mechanical contractor shall be responsible for coordinating all requirements of the motor and VFD manufacturer.
3. If this contractor elects to substitute or increase motor horsepower over that specified, the cost of motor, motor controllers and electrical changes shall be borne by this contractor.
4. Each motor except as noted, shall be provided with a combination fused disconnecting means and across-the-line magnetic starter with push button stations mounted on cover or variable frequency drive. Coordinate requirements between trades (electrical and mechanical contractors.
5. For automatically or remotely controlled motors, furnish hand off auto (HOA) selector switches in place of the push buttons.
6. Combination magnetic starters for all motors shall have thermal overload, pilot light, low voltage protection in all three phases. Include a control transformer for each magnetic starter to provide 120 volt control power with 3 sets of spare normally closed or normally open contacts
7. Starters for motors 75 hp and above shall be solid state electronic soft start type starters.
8. Fused disconnect switches are to be provided by the electrical contractor if not integral with equipment.
9. Provide enclosures for VFD's suitable for operating environment.

1.4 DEFINITIONS

A. BMS: Building Management System.

B. IGBT: Integrated gate bipolar transistor.

C. LAN: Local area network.

D. PID: Control action, proportional plus integral plus derivative.

E. PWM: Pulse-width modulated.

F. VFD: Variable frequency motor controller.

G. VFD: Variable frequency drive same as variable frequency motor controller

1.5 SUBMITTALS

A. Product Data: For each type of VFD. Include dimensions, mounting arrangements, location for conduit entries, shipping and operating weights, and manufacturer's technical data on features, performance, electrical ratings, characteristics, and finishes.

B. Shop Drawings: For each VFD.
   1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings. Include the following:
      a. Each installed unit's type and details.
      b. Nameplate legends.
      c. Short-circuit current rating of integrated unit.
      d. Listed and labeled for series rating of overcurrent protective devices in combination controllers by an NRTL acceptable to authorities having jurisdiction.
      e. Features, characteristics, ratings, and factory settings of each motor-control center unit.
   2. Wiring Diagrams: Power, signal, and control wiring for VFDs. Provide schematic wiring diagram for each type of VFD.

C. Coordination Drawings: Floor plans, drawn to scale, showing dimensioned layout, required working clearances, and required area above and around VFDs where pipe and ducts are prohibited. Show VFD layout and relationships between electrical components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.

D. Qualification Data: For manufacturer.

E. Field quality-control test reports.

F. Operation and Maintenance Data: For VFDs, all installed devices, and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
   1. Routine maintenance requirements for VFDs and all installed components.
   2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.

G. Load-Current and Overload-Relay Heater List: Compile after motors have been installed and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.

H. Load-Current and List of Settings of Adjustable Overload Relays: Compile after motors have been installed and arrange to demonstrate that dip switch settings for motor running overload protection suit actual motor to be protected.

I. Compliance to IEEE 519
   1. Harmonic analysis for particular jobsite including total harmonic voltage distortion and total harmonic current distortion (TDD).
      a. The VFD manufacturer shall provide calculations, specific to this installation, showing total harmonics voltage distortion is less than 5%. Input line filters shall be sized and provided as required by the VFD manufacturer to ensure compliance with IEEE standard 519. All VFD's shall include a minimum of 5% impedance reactors, no exceptions.
      b. No VFD shall be reviewed unless all required calculations are submitted and reviewed as part of the shop drawing submission.

1.6 QUALITY ASSURANCE

A. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 100 miles (160 km) of Project site, a service center capable of providing training, parts, and emergency maintenance and repairs.

B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
   1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

C. Source Limitations: Obtain VFDs of a single type through one source from a single manufacturer.

D. 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.

E. Comply with NFPA 70.

F. All components and assembly shall be UL listed.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver VFDs in shipping splits of lengths that can be moved past obstructions in delivery path as indicated.

B. Store VFDs indoors in clean, dry space with uniform temperature to prevent condensation. Protect VFDs from exposure to dirt, fumes, water, corrosive substances, and physical damage.

C. If stored in areas subject to weather, cover VFDs to protect them from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside controllers; install electric heating of sufficient wattage to prevent condensation.

1.8 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation, capable of driving full load without derating, under the following conditions, unless otherwise indicated:
   1. Ambient Temperature: 0 to 40 deg C.
   2. Humidity: Less than 90 percent (noncondensing).
   3. Altitude: Not exceeding 3300 feet (1005 m).

B. 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 Construction Manager no fewer than two days in advance of proposed interruption of electrical service.
   2. Indicate method of providing temporary electrical service.
   3. Do not proceed with interruption of electrical service without Construction Manager's written permission.

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for VFDs, including clearances between VFDs, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

1.9 COORDINATION

A. Coordinate layout and installation of VFDs with other construction including conduit, piping, equipment, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03 Section "Cast-in-Place Concrete."

C. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

D. Coordinate features of VFDs, installed units, and accessory devices with pilot devices and control circuits to which they connect.

E. Coordinate features, accessories, and functions of each VFD and each installed unit with ratings and characteristics of supply circuit, motor, required control sequence, and duty cycle of motor and load.

1.10 EXTRA MATERIALS

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

1. Spare Fuses: Furnish one spare for every five installed, but no fewer than one set of three of each type and rating.
2. Indicating Lights: Two of each type installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. ABB Power Distribution, Inc.; ABB Control, Inc. Subsidiary.

2.2 VARIABLE FREQUENCY CONTROLLERS

A. Description: NEMA ICS 2, IGBT, PWM, VFD; listed and labeled as a complete unit and arranged to provide variable speed of an NEMA MG 1, Design B, 3-phase induction motor by adjusting output voltage and frequency.
   1. Provide unit suitable for operation of premium-efficiency motor as defined by NEMA MG 1.

B. Design and Rating: Match load type such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.

C. Output Rating: 3-phase; 6 to 60 Hz, with voltage proportional to frequency throughout voltage range .

D. Twelve (12) Pulse Input Configuration, 25HP to 200HP
   1. The VFD shall be configured with a 12-pulse converter section comprised of two full wave bridge rectifiers, and an integral three-phase-shifting transformers to reduce the harmonic current distortion. The VFD, phase-shifting transformer, and bypass contactors shall be provided in one enclosure. Each 12-pulse VFD shall be furnished with a 3% line reactor and 2.5% D.C. choke to avoid line interference and act as harmonic filters.

E. Unit Operating Requirements:
   1. Input ac voltage tolerance of 480 0 V, plus or minus 10 percent.
   2. Input frequency tolerance of 60 Hz, plus or minus 6 percent.
   3. Minimum Efficiency: 96 percent at 60 Hz, full load.
   4. Minimum Displacement Primary-Side Power Factor: 96 percent.
   5. Overload Capability: 1.1 times the base load current for 60 seconds; 1.5 times the base load current for 3 seconds.
   6. Starting Torque: 100 percent of rated torque or as indicated.
   7. Speed Regulation: Plus or minus 1 percent.

F. Isolated control interface to allow controller to follow control signal over an 11:1 speed range.
   1. Electrical Signal: 4 to 20 mA at 24 V.

G. Internal Adjustability Capabilities:
   1. Minimum Speed: 5 to 25 percent of maximum rpm.
   2. Maximum Speed: 80 to 100 percent of maximum rpm.
   3. Acceleration: 2 to a minimum of 22 seconds.

4. Deceleration: 2 to a minimum of 22 seconds.
5. Current Limit: 50 to a minimum of 110 percent of maximum rating.

H. Self-Protection and Reliability Features:
1. Input transient protection by means of surge suppressors.
2. Under- and overvoltage trips; inverter overtemperature, overload, and overcurrent trips.
3. Motor Overload Relay: Adjustable and capable of NEMA ICS 2, Class 10 performance.
4. Notch filter to prevent operation of the controller-motor-load combination at a natural frequency of the combination.
5. Instantaneous line-to-line and line-to-ground overcurrent trips.
6. Loss-of-phase protection.
7. Reverse-phase protection.
8. Short-circuit protection.
9. Motor over temperature fault.

I. Multiple-Motor Capability: Controller suitable for service to multiple motors and having a separate overload relay and protection for each controlled motor. Overload relay shall shut off controller and motors served by it when overload relay is tripped.

J. Automatic Reset/Restart: Attempts three restarts after controller fault or on return of power after an interruption and before shutting down for manual reset or fault correction. Bidirectional autospeed search shall be capable of starting into rotating loads spinning in either direction and returning motor to set speed in proper direction, without damage to controller, motor, or load.

K. Power-Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped.

L. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.

M. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.

N. Input Line Conditioning: Integral input 5% impedance line reactors .

O. Status Lights: Door-mounted LED indicators shall indicate the following conditions:
1. Power on.
2. Run.
3. Overvoltage.
4. Line fault.
5. Overcurrent.
6. External fault.

P. Panel-Mounted Operator Station: Start-stop and auto-manual selector switches with manual speed control potentiometer and elapsed time meter.

Q. Indicating Devices: Meters or digital readout devices and selector switch, mounted flush in controller door and connected to indicate the following controller parameters:
1. Output frequency (Hz).

2. Motor speed (rpm).
3. Motor status (running, stop, fault).
4. Motor current (amperes).
5. Motor torque (percent).
6. Fault or alarming status (code).
7. PID feedback signal (percent).
8. DC-link voltage (VDC).
9. Set-point frequency (Hz).
10. Motor output voltage (V).

R. Control Signal Interface:
1. Electric Input Signal Interface: A minimum of 2 analog inputs (0 to 10 V or 0/4-20 mA) and 6 programmable digital inputs.
2. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the BMS or other control systems:
   a. 0 to 10-V dc.
   b. 0-20 or 4-20 mA.
   c. Potentiometer using up/down digital inputs.
   d. Fixed frequencies using digital inputs.
   e. RS485.
   f. Keypad display for local hand operation.
3. Output Signal Interface:
   a. A minimum of 1 analog output signal (0/4-20 mA), which can be programmed to any of the following:
      1) Output frequency (Hz).
      2) Output current (load).
      3) DC-link voltage (VDC).
      4) Motor torque (percent).
      5) Motor speed (rpm).
      6) Set-point frequency (Hz).
4. Remote Indication Interface: A minimum of 2 dry circuit relay outputs (120-V ac, 1 A) for remote indication of the following:
   a. Motor running.
   b. Set-point speed reached.
   c. Fault and warning indication (overtemperature or overcurrent).
   d. PID high- or low-speed limits reached.

S. Communications: Provide an RS485 interface allowing VFD to be used with an external system within a multidrop LAN configuration. Interface shall allow all parameter settings of VFD to be programmed via BMS control. Provide capability for VFD to retain these settings within the nonvolatile memory.

T. Manual Bypass: Magnetic contactor arranged to safely transfer motor between controller output and bypass controller circuit when motor is at zero speed. Controller-off-bypass selector switch sets mode, and indicator lights give indication of mode selected. Unit shall be capable of stable operation (starting, stopping, and running), with motor completely disconnected from controller (no load)

U. Bypass Controller: NEMA ICS 2, full-voltage, nonreversing enclosed controller with across-the-line starting capability in manual-bypass mode for motors less than 75 horsepower. Provide motor overload protection under both modes of operation with control logic that allows common start-stop capability in either mode

1. Provide Solid-State, Reduced-Voltage Controller: NEMA ICS 2, suitable for use with NEMA MG 1, Design B, polyphase, medium induction motors for motors 75 horsepower and greater..

V. Integral Disconnecting Means: NEMA AB 1, fusible disconnect switch with lockable handle rated minimum 65 K.A.I.C..

W. Remote Indicating Circuit Terminals: Mode selection, controller status, and controller fault

X. Provide eight adjustable set points to lock out operation at frequencies that may provide mechanical resonance.

2.3 ENCLOSURES

A. NEMA 1 ventilated freestanding enclosure for motor horsepower listed on the design drawings. Coordinate final motor hp with fan/pump/equipment manufacturer.

2.4 ACCESSORIES

A. Devices shall be factory installed in controller enclosure, unless otherwise indicated.

B. Push-Button Stations, Pilot Lights, and Selector Switches: NEMA ICS 2, heavy-duty type.

C. Stop and Lockout Push-Button Station: Momentary-break, push-button station with a factory-applied hasp arranged so padlock can be used to lock push button in depressed position with control circuit open.

D. Control Relays: Auxiliary and adjustable time-delay relays.

E. Standard Displays:
1. Output frequency (Hz).
2. Set-point frequency (Hz).
3. Motor current (amperes).
4. DC-link voltage (VDC).
5. Motor torque (percent).
6. Motor speed (rpm).
7. Motor output voltage (V).

F. Interlock terminal strip
1. Provide a separate terminal strip for connection of freeze, fire, smoke and all dampers contacts and external start command. All external safety interlocks shall remain fully functional whether the system is in hand, auto, or bypass modes. The remote start / stop contact shall operate in auto and bypass modes.

G. Historical Logging Information and Displays:
1. Real-time clock with current time and date.
2. Running log of total power versus time.
3. Total run time.
4. Fault log, maintaining last four faults with time and date stamp for each.

H. Line Reactors and D.C. Chokes

2.5 FACTORY FINISHES

A. Finish: Manufacturer's standard paint applied to factory-assembled and -tested VFDs before shipping.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, surfaces, and substrates to receive VFDs for compliance with requirements, installation tolerances, and other conditions affecting performance.

B. Examine roughing-in for conduit systems to verify actual locations of conduit connections before VFD installation.

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

3.2 APPLICATIONS

A. Select features of each VFD to coordinate with ratings and characteristics of supply circuit and motor; required control sequence; and duty cycle of motor, controller, and load.

B. Select horsepower rating of controllers to suit motor controlled.

3.3 INSTALLATION

A. Anchor each VFD assembly to steel-channel sills arranged and sized according to manufacturer's written instructions. Attach by bolting. Level and grout sills flush with mounting surface.

B. Install VFDs on concrete bases.

C. Comply with mounting and anchoring requirements specified in Division 26 Section "Hangers and Supports for Electrical Systems."

D. Controller Fuses: Install fuses in each fusible switch. Comply with requirements in Division 26 Section "Fuses."

3.4 CONCRETE BASES

A. Coordinate size and location of concrete bases. Verify structural requirements with structural engineer.

B. Concrete base is specified in Division 26 Section "Common Work Results for Electrical," and concrete materials and installation requirements are specified in Division 03.

3.5 IDENTIFICATION

A. Identify VFDs, components, and control wiring according to Division 26 Section "Identification for Electrical Systems."

B. Operating Instructions: Frame printed operating instructions for VFDs, including control sequences and emergency procedures. Fabricate frame of finished metal, and cover instructions with clear acrylic plastic. Mount on front of VFD units.

3.6 CONTROL WIRING INSTALLATION

A. Install wiring between VFDs and remote devices according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

B. Bundle, train, and support wiring in enclosures.

C. Connect hand-off-automatic switch and other automatic-control devices where applicable.
   1. Connect selector switches to bypass only manual- and automatic-control devices that have no safety functions when switch is in hand position.
   2. Connect selector switches with control circuit in both hand and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.7 CONNECTIONS

A. Conduit installation requirements are specified in other Division 26 Sections. Drawings indicate general arrangement of conduit, fittings, and specialties.

B. Ground equipment according to Division 26 "Grounding and Bonding for Electrical Systems."

3.8 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:
   1. Test insulation resistance for each enclosed controller element, bus, component, connecting supply, feeder, and control circuit.
   2. Test continuity of each circuit.

B. Setup drive set points to lock out operation at frequencies that may provide mechanical resonance

C. Manufacturer's Field Service: Engage a factory-authorized service representative to perform the following:
   1. Inspect controllers, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
   2. Assist in field testing of equipment including pretesting and adjusting of solid-state controllers.
   3. Report results in writing.
   4. Service station shall be located within 100 miles of job site and shall be available upon a 24-hour basis.

D. Testing Agency: Owner will engage a qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.

E. Testing Agency: Engage a qualified testing and inspecting agency to perform the following field tests and inspections and prepare test reports:

F. Perform the following field tests and inspections and prepare test reports:

1. Perform each electrical test and visual and mechanical inspection, except optional tests, stated in NETA ATS. 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

3.9 ADJUSTING

A. Set field-adjustable switches and circuit-breaker trip ranges.

3.10 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain variable frequency controllers. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION

This page is intentionally left blank.

SECTION 23 05 16

EXPANSION FITTINGS AND LOOPS FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
1. Metal-bellows expansion joints.
2. Expansion compensators.
3. Flexible-hose expansion joints.
4. Packed slip expansion joints.
5. Flexible ball joints.
6. Pipe bends and loops.
7. Alignment guides and anchors.

1.3 DEFINITIONS

A. BR: Butyl rubber.

B. Buna-N: Nitrile rubber.

C. CR: Chlorosulfonated polyethylene synthetic rubber.

D. CSM: Chlorosulfonyl-polyethylene rubber.

E. EPDM: Ethylene-propylene-diene terpolymer rubber.

F. NR: Natural rubber.

G. PTFE: Polytetrafluoroethylene plastic.

1.4 PERFORMANCE REQUIREMENTS

A. Compatibility: Products shall be suitable for piping system fluids, materials, working pressures, and temperatures.

B. Capability: Products shall absorb 200 percent of maximum axial movement between anchors.

1.5 SUBMITTALS

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

B. Delegated-Design Submittal: For each anchor and alignment guide 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. Design Calculations: Calculate requirements for thermal expansion of piping systems and for selecting and designing expansion joints, loops, and bends.
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
5. Coordination:
   a. Coordinate the location of all anchors, guides and expansion devices with the structural engineer.
   b. Submit details for attachment to the building structure to the structural engineer including all loads and supplemental steel.
   c. Coordinate the location of items in this section with access requirements for equipment, valves, dampers, as required for work in other sections, and as indicated on the drawings.

C. Welding certificates.

D. Product Certificates: For each type of pipe expansion joint, signed by product manufacturer.

E. Maintenance Data: For pipe expansion joints to include in maintenance manuals.

F. Grooved joint couplings and fittings shall be shown on drawings and product submittals, and be specifically identified with the applicable Victaulic style or series number.

1.6 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to the following:
   1. Steel Shapes and Plates: AWS D1.1, "Structural Welding Code - Steel."
   2. Welding to Piping: ASME Boiler and Pressure Vessel Code: Section IX.

B. Engineering Responsibility: Design and preparation of Shop Drawings and calculations for expansion fittings and loops by a qualified professional engineer
   1. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of expansion fittings and loops that are similar to those indicated for this Project in material, design, and extent.

C. To assure uniformity and compatibility of piping components in grooved piping systems, all grooved products utilized shall be supplied by a single manufacturer. Grooving tools shall be supplied by the same manufacturer as the grooved components.

PART 2 - PRODUCTS

2.1 EXPANSION JOINTS

A. Metal-Bellows Expansion Joints: ASTM F 1120, circular-corrugated-bellows type with external tie rods.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Adsco Manufacturing, LLC.
      b. Badger Industries.
      c. Hyspan Precision Products, Inc.
      d. Metraflex, Inc.
   2. Metal-Bellows Expansion Joints for Copper Piping: Single- or multiple-ply phosphor-bronze bellows, copper pipe end connections, and brass shrouds.
   3. Metal-Bellows Expansion Joints for Stainless-Steel Waterway: Single-ply stainless-steel bellows, stainless-steel-pipe end connections, and steel shroud.
   4. Metal-Bellows Expansion Joints for Steel Piping: Single- or multiple-ply stainless-steel bellows, steel pipe end connections, and carbon-steel shroud.
   5. Minimum Pressure Rating: 150 psig unless otherwise indicated.
   6. Configuration: Single- or double bellows type with base, unless otherwise indicated.
   7. End Connections: Flanged welded or Brazed.

B. Expansion Compensators: Double-ply corrugated steel, stainless-steel, or copper-alloy bellows in a housing with internal guides, antitorque device, and removable end clip for positioning.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Adsco Manufacturing, LLC.
      b. Hyspan Precision Products, Inc.
      c. Metraflex, Inc.
   2. Minimum Pressure Rating: 150 psig unless otherwise indicated.
   3. Configuration for Copper Piping: Two-ply phosphor-bronze or stainless-steel bellows and bronze or stainless-steel shroud.
   4. Configuration for Steel Piping: Two-ply stainless-steel bellows and carbon-steel shroud.
   5. End Connections for Copper Tubing NPS 2 and Smaller: Solder joint or threaded.
   6. End Connections for Copper Tubing NPS 2-1/2 to NPS 4: Solder joint .
   7. End Connections for Steel Pipe NPS 2 and Smaller: Threaded.
   8. End Connections for Steel Pipe NPS 2-1/2 to NPS 4: Flanged, threaded or Welded.

C. Flexible-Hose Expansion Joints: Manufactured assembly with two flexible-metal-hose legs joined by long-radius, 180-degree return bend or center section of flexible hose; with inlet and outlet elbow fittings, corrugated-metal inner hoses, and braided outer sheaths.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Flexicraft Industries.
      b. Metraflex, Inc.

2. Flexible-Hose Expansion Joints for Copper Piping: Copper-alloy fittings with solder- joint end connections.
   a. NPS 2 and Smaller: Bronze hoses and single-braid bronze sheaths with 450 psig at 70 deg F and 340 psig at 450 deg F ratings.
   b. NPS 2-1/2 to NPS 4: Stainless-steel hoses and single-braid, stainless-steel sheaths with 300 psig at 70 deg F and 225 psig at 450 deg F ratings.
3. Flexible-Hose Expansion Joints for Copper Piping: Copper-alloy fittings with solder- joint end connections.
   a. NPS 2 and Smaller: Bronze hoses and double-braid bronze sheaths with 700 psig at 70 deg F and 500 psig at 450 deg F ratings.
   b. NPS 2-1/2 to NPS 4: Stainless-steel hoses and double-braid, stainless-steel sheaths with 420 psig at 70 deg F and 315 psig at 450 deg F ratings.
4. Flexible-Hose Expansion Joints for Steel Piping: Carbon-steel fittings with threaded end connections for NPS 2 and smaller and flanged or weld end connections for NPS 2-1/2 and larger.
   a. NPS 2 and Smaller: Stainless-steel hoses and single-braid, stainless-steel sheaths with 450 psig at 70 deg F and 325 psig at 600 deg F ratings.
   b. NPS 2-1/2 to NPS 6: Stainless-steel hoses and single-braid, stainless-steel sheaths with 200 psig at 70 deg F and 145 psig at 600 deg F ratings.
   c. NPS 8 to NPS 12: Stainless-steel hoses and single-braid, stainless-steel sheaths with 125 psig at 70 deg F and 90 psig at 600 deg F ratings.
5. Flexible-Hose Expansion Joints for Steel Piping: Carbon-steel fittings with threaded end connections for NPS 2 and smaller and flanged or weld end connections for NPS 2-1/2 and larger.
   a. NPS 2 and Smaller: Stainless-steel hoses and double-braid, stainless-steel sheaths with 700 psig at 70 deg F and 515 psig at 600 deg F ratings.
   b. NPS 2-1/2 to NPS : Stainless-steel hoses and double-braid, stainless-steel sheaths with 275 psig at 70 deg F and 200 psig at 600 deg F ratings.
   c. NPS 8 and Larger: Stainless-steel hoses and double-braid, stainless-steel sheaths with 165 psig at 70 deg F and 120 psig at 600 deg F ratings.

D. Packed Slip Expansion Joints: ASTM F 1007, carbon-steel, packing type designed for repacking under pressure and pressure rated for 250 psig at 400 deg F minimum. Include asbestos-free PTFE packing, compound limit stops, and drip connection if used for steam piping.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Adsco Manufacturing, LLC. Type RJ
      b. Advanced Thermal Systems, Inc. Thermal Pak-Type TP2
      c. Hyspan Precision Products, Inc.
   2. Configuration: Single- and double joint class with base, unless otherwise indicated.
   3. End Connections: Flanged or weld ends to match piping system.

E. Packed type: Provide single or double slip, with anchor base except as noted. Provide internal and external guides integral with stuffing box; wrought steel with

chromium plating applied directly to polished steel surface. Provide butt weld ends, except as noted.

1. Provide limit stops, capable of holding against full internal thrust.
2. Packing: Provide self-lubricating asbestos-free polytetrafluoroethylene or asbestos-free reinforced teflon type, which can be injected under full line pressure, contained by minimum of 3 teflon non-asbestos rings at each side.
3. Provide joints body of weldable quality carbon steel, ASTM 53 grade B seamless pipe with drip connection if used for steam service.
4. Slip requirements: Provide ASTM A 53 grade B seamless pipe up to and including 12 inch: Schedule 80 and 16 inch through 24 inch: Schedule 60.
   a. Provide wall thickness after machining not reduced more than 1/8 inch.
   b. Provide double layer of chrome plating with minimum thickness 0.001 inch each after buffing. First layer: crack-free hard chrome; second layer: standard hard chrome.
5. Provide welded steel packing cylinder with internal acme thread and male threaded plunger with cylinder welded directly to stuffing box. Minimum number of packing cylinders as follows:

Expansion Joint Size	Number of Packing Cylinders
1-1/2 inch thru 4 inch	1
5 inch and 6 inch	3
8 inch and 10 inch	4
12 inch and 14 inch	5
16 inch and 18 inch	6
20 inch and 24 inch	8

6. Pressure ratings:
   a. All piping: 150 lb.
7. Provide all welding in accordance with Section IX of ASME Boiler and Pressure Vessel Code.

F. Flexible Ball Joints: Carbon-steel assembly with asbestos-free composition packing, designed for 360-degree rotation and angular deflection, and 250 psig at 400 deg F minimum pressure rating; complying with ASME Boiler and Pressure Vessel Code: Section II, "Materials," and with ASME B31.9, "Building Services Piping," for materials and design of pressure-containing parts and bolting.
   1. Angular Deflection for NPS 6 and Smaller: 30-degree minimum.
   2. Angular Deflection for NPS 8 and Larger: 15-degree minimum.
   3. End Connections for NPS 2 and Smaller: Threaded.
   4. End Connections for NPS 2-1/2 and Larger: Flanged.
   5. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Advanced Thermal Systems, Inc.
      b. Hyspan Precision Products, Inc.

G. Grooved End Expansion Joints for Steel Piping: Use in water piping systems 2-1/2” and larger that are installed within enclosures where a pipe bend or loop cannot be applied. Grooved joints not to be used on hot water systems.
   1. Manufacturers: Subject to compliance with requirements provide products by one of the following:
      a. Victaulic Company
   2. 2” Through 6”: Packless, gasketed, slip-type expansion joint with grooved end telescoping body for installation with Victaulic Style 07 rigid couplings.

Provides axial end movement to 3", designed for water services up to 230°F and working pressure to 350 psi. Victaulic Style 150 Mover®.

3. 2" Through 24: Combination of short nipples and Victaulic Style 75 or 77 flexible couplings joined in tandem for increased expansion. Joint movement and expansion capabilities dependent on number of couplings/nipples used in the joint. Pressure rating dependent on size and style of flexible couplings used. Victaulic Style 155.

2.2 ALIGNMENT GUIDES

A. Description: Steel, factory fabricated, with bolted two-section outer cylinder and base for alignment of piping and two-section guiding spider for bolting to pipe.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Adsco Manufacturing, LLC.
      b. Advanced Thermal Systems, Inc.
      c. B-Line systems, Inc.
      d. Grinnell Corp.

2.3 MATERIALS FOR ANCHORS

A. Steel Shapes and Plates: ASTM A 36/A 36M.

B. Bolts and Nuts: ASME B18.10 or ASTM A 183, steel, hex head.

C. Washers: ASTM F 844, steel, plain, flat washers.

D. Mechanical Fasteners: Insert-wedge-type stud with expansion plug anchor for use in hardened portland cement concrete, and tension and shear capacities appropriate for application.
   1. Stud: Threaded, zinc-coated carbon steel.
   2. Expansion Plug: Zinc-coated steel.
   3. Washer and Nut: Zinc-coated steel.

E. Chemical Fasteners: Insert-type-stud bonding system anchor for use with hardened portland cement concrete, and tension and shear capacities appropriate for application.
   1. Bonding Material: ASTM C 881, Type IV, Grade 3, 2-component epoxy resin suitable for surface temperature of hardened concrete where fastener is to be installed.
   2. Stud: ASTM A 307, zinc-coated carbon steel with continuous thread on stud, unless otherwise indicated.
   3. Washer and Nut: Zinc-coated steel.

F. Concrete: Portland cement mix, 3000 psi minimum. Comply with requirements in Division 03 Section "Cast-in-Place Concrete" for formwork, reinforcement, and concrete.

G. Grout: ASTM C 1107, factory-mixed and -packaged, dry, hydraulic-cement, nonshrink, 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 EXPANSION-JOINT INSTALLATION

A. Install manufactured, nonmetallic expansion joints according to FSA's "Technical Handbook: Non-Metallic Expansion Joints and Flexible Pipe Connectors."

B. Install expansion joints of sizes matching size of piping in which they are installed.

C. Install alignment guides to allow expansion and to avoid end-loading and torsional stress.

D. Grooved joint piping systems shall be installed in accordance with the manufacturer's guidelines and recommendations. All grooved couplings, fittings, valves and specialties shall be supplied by a single manufacturer. Grooving tools shall be supplied by the same manufacturer as the grooved components. The gasket style and elastomeric material (grade) shall be verified as suitable for the intended service as specified. Gaskets shall be developed and supplied by the manufacturer. Grooved end shall be clean and free from indentations, projections and roll marks in the area from pipe end to groove. A factory trained field representative shall provide on-site training to contractor's field personnel in the installation of grooved piping products. Factory trained representative shall periodically review the product installation. Contractor shall remove and replace any improperly installed products.

3.2 PIPE BEND AND LOOP INSTALLATION

A. Install pipe bends and loops cold-sprung in tension or compression as required to partly absorb tension or compression produced during anticipated change in temperature.

B. Expansion: Install piping to permit free expansion and contraction without damaging piping or construction.
   1. Provide offsets, expansion loops, anchors, guides and supports to permit expansion, with stress limits of ASME Code for Pressure Piping for temperature range of 40 deg F to minimum of 20 deg F above maximum system temperature.

C. Attach pipe bends and loops to anchors.
   1. Steel Anchors: Attach by welding. Comply with ASME B31.9 and ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."
   2. Concrete Anchors: Attach by fasteners. Follow fastener manufacturer's written instructions.

3.3 SWING CONNECTIONS

A. Connect risers and branch connections to mains with at least five pipe fittings, including tee in main.

B. Connect risers and branch connections to terminal units with at least four pipe fittings, including tee in riser.

C. Connect mains and branch connections to terminal units with at least four pipe fittings, including tee in main.

3.4 ALIGNMENT-GUIDE INSTALLATION

A. Install guides on piping adjoining pipe expansion fittings and loops.

B. Attach guides to pipe and secure to building structure.

3.5 ANCHOR INSTALLATION

A. 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.

B. Fabricate and install steel anchors by welding steel shapes, plates, and bars to piping and to structure. Comply with ASME B31.9 and AWS D1.1.

C. Construct concrete anchors of poured-in-place concrete of dimensions indicated and include embedded fasteners.

D. Install pipe anchors according to expansion-joint manufacturer's written instructions if expansion joints or compensators are indicated.

E. Use grout to form flat bearing surfaces for expansion fittings, guides, and anchors installed on or in concrete.

3.6 PAINTING

A. Touching Up: 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. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION

SECTION 23 05 19

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 and Division 01 Specification Sections, apply to this Section.

B. Section 01 81 13 “Sustainable Design Requirements – LEED v4 for Building Design & Construction – New Construction” for sustainable design requirements and detailed sustainable design submittal requirements.

C. Section 01 74 19 “Construction and Demolition Waste Management and Disposal” for disposal of construction, demolition and packaging waste disposal requirements.

D. Section 23 09 00” HVAC Instrumentation and Controls” for metering requirements

1.2 SUMMARY

A. Section Includes:
1. Thermometers.
2. Thermometer wells.
3. Gages.
4. Test plugs.

B. This Contractor shall provide all devices, piping, valving, relays, end switches, control components, power wiring, control wiring and interlock wiring as required to accomplish the sequence of operations for the specified meters and instrumentation and thereby provide a fully operational system

C. Sustainable Building Requirements:
1. The Owner requires the Contractor to implement practices and procedures to meet the project’s environmental performance goals, which include achieving LEED version 4 Certified level Certification. Specific project goals that may impact this area of work include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; construction waste recycling; and the implementation of a construction indoor air quality management plan. The Contractor shall ensure that the requirements related to these goals, as defined in the Articles below, are implemented to the fullest extent. Substitutions, or other changes to the work proposed by the Contractor or their Subcontractors, shall not be allowed if such changes compromise the aforementioned environmental goals and LEED certification.

1.3 DEFINITIONS

A. CR: Chlorosulfonated polyethylene synthetic rubber.

B. EPDM: Ethylene-propylene-diene terpolymer rubber.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated; include performance curves.

B. Shop Drawings: Schedule for thermometers, gages and flowmeters indicating manufacturer's number, scale range, and location for each.

C. Product Certificates: For each type of thermometer, gage and flowmeter, signed by product manufacturer.

D. Operation and Maintenance Data: For flowmeters to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Product options: Drawings indicate size, profiles and connections for instrumentation and are based on the specific types and models indicated.

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.

C. Standards: If any item in this specification as furnished by the contractor is manufactured in a location which does not certify ASME/ANSI standards, the contractor is to pay the owner for all expenses incurred by the owner for an outside testing company to confirm such compliances.

D. Pressure and temperature rating:
1. Each meter and gauge shall be rated and suitable for the piping system that it is being installed in.
2. Refer to applicable piping section for service temperature and pressure rating of systems that meters and gauges are to be installed in.
3. Minimum upstream and downstream straight pipe diameters for meters shall be provided as per manufacturer’s published recommendations.

1.6 COORDINATION

A. Coordinate the location and installation of all items furnished under this specification with and including but not limited to the following:
1. Equipment installation details.
2. Purchased equipment.
3. Piping shop drawings.
4. Field conditions.

PART 2 - PRODUCTS

2.1 METAL-CASE, LIQUID-IN-GLASS THERMOMETERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Trerice, H. O. Co.
2. Weiss Instruments, Inc.
3. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.
4. Miljoco Corporation

B. Case: Die-cast aluminum 9 inches long.

C. Tube: Red or blue reading, organic-liquid filled, with magnifying lens, silicone shock mounted.

D. Tube Background: Satin-faced, nonreflective aluminum with permanently etched scale markings.

E. Window: Plastic.

F. Connector: Adjustable type, 180 degrees in vertical plane.

G. Stem: Copper-plated steel, aluminum, or brass for thermowell installation and of length to suit installation.

H. Accuracy: Plus or minus 1 percent of range or plus or minus 1 scale division to maximum of 1.5 percent of range.

2.2 DIRECT-MOUNTING, VAPOR-ACTUATED DIAL THERMOMETERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Ashcroft Commercial Instrument Operations; Dresser Industries; Instrument Div.
   2. KOBOLD Instruments, Inc.
   3. Trerice, H. O. Co.
   4. Weiss Instruments, Inc.
   5. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div
   6. Miljoco Corporation

B. Case: Dry type, stainless steel , 4-1/2-inch diameter.

C. Element: Bourdon tube or other type of pressure element.

D. Movement: Mechanical, connecting element and pointer.

E. Dial: Satin-faced, nonreflective aluminum with permanently etched scale markings.

F. Pointer: Red metal.

G. Window: Plastic.

H. Ring: Stainless steel .

I. Connector: Adjustable type, 180 degrees in vertical plane, 360 degrees in horizontal plane, with locking device.

J. Thermal System: Liquid- filled bulb in copper-plated steel, aluminum, or brass stem for thermowell installation and of length to suit installation.

K. Accuracy: Plus or minus 1 percent of range or plus or minus 1 scale division to maximum of 1.5 percent of range.

2.3 REMOTE-MOUNTING, VAPOR-ACTUATED DIAL THERMOMETERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. AMETEK, Inc.; U.S. Gauge Div.
   2. Ashcroft Commercial Instrument Operations; Dresser Industries; Instrument Div.

3. Miljoco Corp.
4. Trerice, H. O. Co.
5. Weiss Instruments, Inc.
6. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.

B. Case: Dry type, stainless steel, 4-1/2-inch diameter with holes for panel mounting.

C. Element: Bourdon tube or other type of pressure element.

D. Movement: Mechanical, connecting element and pointer.

E. Dial: Satin-faced, nonreflective aluminum with permanently etched scale markings.

F. Pointer: Red metal.

G. Window: Plastic.

H. Ring: Stainless steel.

I. Connector: Back union type.

J. Thermal System: Liquid-filled bulb in copper-plated steel, aluminum, or brass stem for thermowell installation and of length to suit installation.

K. Accuracy: Plus or minus 1 percent of range or plus or minus 1 scale division to maximum of 1.5 percent of range.

2.4 BIMETALLIC-ACTUATED DIAL THERMOMETERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Ashcroft Commercial Instrument Operations; Dresser Industries; Instrument Div.
2. Miljoco Corp.
3. Trerice, H. O. Co.
4. Weiss Instruments, Inc.
5. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.
6. WIKA Instrument Corporation.

B. Description: Direct-mounting, bimetallic-actuated dial thermometers complying with ASME B40.3.

C. Case: Liquid-filled type, stainless steel with 5-inch (127-mm) diameter.

D. Element: Bimetal coil.

E. Dial: Satin-faced, nonreflective aluminum with permanently etched scale markings.

F. Pointer: Red metal.

G. Window: Plastic.

H. Ring: Stainless steel.

I. Connector: Adjustable angle type.

J. Stem: Metal, for thermowell installation and of length to suit installation.

K. Accuracy: Plus or minus 1 percent of range or plus or minus 1 scale division to maximum of 1.5 percent of range.

2.5 THERMOWELLS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Miljoco Corp.
   2. Trerice, H. O. Co.
   3. Weiss Instruments, Inc.
   4. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.
   5. WIKA Instrument Corporation.

B. Manufacturers: Same as manufacturer of thermometer being used.

C. Description: Pressure-tight, socket-type metal fitting made for insertion into piping and of type, diameter, and length required to hold thermometer.

2.6 PRESSURE GAGES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Miljoco Corp.
   2. Trerice, H. O. Co.
   3. Weiss Instruments, Inc.
   4. Weksler Instruments Operating Unit; Dresser Industries; Instrument Div.

B. Dry type for steam only, liquid-filled case type for all other services.

C. Direct-Mounting, Dial-Type Pressure Gages: Indicating-dial type complying with ASME B40.100.
   1. Case: Liquid-filled type, cast aluminum , 4-1/2-inch diameter.
   2. Pressure-Element Assembly: Bourdon tube, unless otherwise indicated.
   3. Pressure Connection: Brass, NPS 1/4, bottom-outlet type unless back-outlet type is indicated.
   4. Movement: Mechanical, with link to pressure element and connection to pointer.
   5. Dial: Satin-faced, nonreflective aluminum with permanently etched scale markings.
   6. Pointer: Red metal.
   7. Window: Plastic.
   8. Ring: Aluminum .
   9. Accuracy: Grade A, plus or minus 1 percent of middle half scale.
   10. Vacuum-Pressure Range: 30-in. Hg of vacuum to 15 psig of pressure.
   11. Range for Fluids under Pressure: Two times operating pressure.

D. Remote-Mounting, Dial-Type Pressure Gages: ASME B40.100, indicating-dial type.
   1. Case: Dry type, cast aluminum, 4-1/2-inch diameter with holes for panel mounting.
   2. Pressure-Element Assembly: Bourdon tube, unless otherwise indicated.
   3. Pressure Connection: Brass, NPS 1/4, bottom-outlet type unless back-outlet type is indicated.
   4. Movement: Mechanical, with link to pressure element and connection to pointer.
   5. Dial: Satin-faced, nonreflective aluminum with permanently etched scale markings.
   6. Pointer: Red metal.
   7. Window: Plastic.

8. Ring: Aluminum.
9. Accuracy: Grade A, plus or minus 1 percent of middle half scale.
10. Vacuum-Pressure Range: 30-in. Hg of vacuum to 15 psig of pressure.
11. Range for Fluids under Pressure: Two times operating pressure.

E. Provide single gauge for pump installations mounted to a 4-port trumpet valve

F. Pressure-Gage Fittings:
1. Valves: NPS 1/4 brass or stainless-steel needle type.
2. Syphons: NPS 1/4 coil of brass tubing with threaded ends.
3. Snubbers: ASME B40.5, NPS 1/4 brass bushing with corrosion-resistant, porous-metal disc of material suitable for system fluid and working pressure.

2.7 TEST PLUGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Trerice, H. O. Co.
2. Watts Industries, Inc.; Water Products Div.

B. Description: Corrosion-resistant brass or stainless-steel body with core inserts and gasketed and threaded cap, with extended stem for units to be installed in insulated piping.

C. Minimum Pressure and Temperature Rating: 500 psig at 200 deg F.

D. Core Inserts: One or two self-sealing rubber valves.
1. Insert material for air, water, oil, or gas service at 20 to 200 deg F shall be CR.
2. Insert material for air or water service at minus 30 to plus 275 deg F shall be EPDM.

E. Test Kit: Furnish one test kit containing one pressure gage and adaptor, two thermometer(s), and carrying case. Pressure gage, adapter probes, and thermometer sensing elements shall be of diameter to fit test plugs and of length to project into piping.
1. Pressure Gage: Small bourdon-tube insertion type with 2- to 3-inch-diameter dial and probe. Dial range shall be 0 to 200 psig.
2. Low-Range Thermometer: Small bimetallic insertion type with 1- to 2-inch-diameter dial and tapered-end sensing element. Dial ranges shall be 25 to 125 deg F.
3. High-Range Thermometer: Small bimetallic insertion type with 1- to 2-inch-diameter dial and tapered-end sensing element. Dial ranges shall be 0 to 220 deg F.
4. Carrying case shall have formed instrument padding.

PART 3 - EXECUTION

3.1 THERMOMETER APPLICATIONS

A. Install liquid-in-glass thermometers in the following locations:
1. Inlet and outlet of each hydronic zone.
2. Inlet and outlet of each boiler and air cooled chiller.

3. Inlet and outlet of each hydronic coil in air-handling units and built-up central systems.
4. Inlet and outlet of each mixing valve.

B. Install direct-mounting, vapor-actuated dial thermometers in locations where temperature sensing bulb is more than 5 feet from viewing position.

C. Install remote-mounting, vapor-actuated dial thermometers in cabinets and panels.

D. Install liquid-filled-case-type, bimetallic-actuated dial thermometers at suction and discharge of each pump.

E. Provide the following temperature ranges for thermometers:
1. Heating Hot Water: 30 to 240 deg F, with 2-degree scale divisions.
2. Chilled Water: 0 to 100 deg F, with 2-degree scale divisions.

3.2 GAGE APPLICATIONS

A. Install liquid-filled-type pressure gauges at suction and discharge of each pump and all other services.

3.3 INSTALLATIONS

A. Install direct-mounting thermometers and adjust vertical and tilted positions.

B. Install remote-mounting dial thermometers on panel, with tubing connecting panel and thermometer bulb supported to prevent kinks. Use minimum tubing length.

C. Install thermowells with socket extending a minimum of 2 inches into fluid and in vertical position in piping tees where thermometers are indicated.

D. Install direct-mounting pressure gages in piping tees with pressure gage located on pipe at most readable position.

E. Install remote-mounting pressure gages on panel.

F. Install needle-valve and snubber fitting in piping for each pressure gage for fluids (except steam).

G. Install needle-valve and syphon fitting in piping for each pressure gage for steam.

H. Install test plugs in tees in piping.

I. Install flow indicators, in accessible positions for easy viewing, in piping systems.

J. Assemble and install connections, tubing, and accessories between flow-measuring elements and flowmeters as prescribed by manufacturer's written instructions.

K. Install flowmeter elements in accessible positions in building chilled water piping systems.

L. Install differential-pressure-type flowmeter elements with at least minimum straight lengths of pipe upstream and downstream from element as prescribed by manufacturer's written instructions.

3.4 CONNECTIONS

A. Install meters and gages adjacent to machines and equipment to allow service and maintenance for meters, gages, machines, and equipment.

3.5 ADJUSTING

A. Calibrate meters according to manufacturer's written instructions, after installation.

B. Adjust faces of thermometers and gages to proper angle for best visibility.

END OF SECTION

SECTION 23 05 23

GENERAL-DUTY VALVES FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Section 01 81 13 "Sustainable Design Requirements – LEED v4 for Building Design & Construction – New Construction" for sustainable design requirements and detailed sustainable design submittal requirements.

C. Section 01 74 19 "Construction and Demolition Waste Management and Disposal" for disposal of construction, demolition and packaging waste disposal requirements.

1.2 SUMMARY

A. Section Includes:
1. Bronze gate valves.
2. Bronze globe valves.
3. Bronze swing check valves.
4. Bronze needle valves.
5. Iron gate valves.
6. Iron globe valves.
7. Iron swing check valves.
8. **Steel gate valves**
9. **Steel globe valves**
10. **Steel Check valves**
11. Iron grooved-end check valves.
12. Bronze ball valves.
13. Steel ball valves.
14. Cast iron plug valves.
15. Calibrated balancing valves.
16. Electric valve actuators.

B. Related Sections:
1. Division 23 HVAC piping Sections for specialty valves applicable to those Sections only.
2. Division 23 Section "Identification for HVAC Piping and Equipment" for valve tags and schedules.

C. Sustainable Building Requirements:
1. The Owner requires the Contractor to implement practices and procedures to meet the project's environmental performance goals, which include achieving LEED version 4 **Certified** level Certification. Specific project goals that may impact this area of work include: use of recycled-content materials; use of

locally-manufactured materials; use of low-emitting materials; construction waste recycling; and the implementation of a construction indoor air quality management plan. The Contractor shall ensure that the requirements related to these goals, as defined in the Articles below, are implemented to the fullest extent. Substitutions, or other changes to the work proposed by the Contractor or their Subcontractors, shall not be allowed if such changes compromise the aforementioned environmental goals and LEED certification.

1.3 DEFINITIONS

A. CWP: Cold working pressure.

B. EPDM: Ethylene propylene copolymer rubber.

C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.

D. NRS: Nonrising stem.

E. OS&Y: Outside screw and yoke.

F. RS: Rising stem.

G. SWP: Steam working pressure.

H. PTFE: Polytetrafluoroethylene plastic.

I. WOG: Water, oil, or gas.

J. TFE: Tetrafluoroethylene plastic

1.4 SUBMITTALS

A. Product Data:
1. For each type of valve indicated. Include body, seating, and trim materials; valve design; pressure and temperature classifications; end connections; arrangement; dimensions; and required clearances. Include list indicating valve and its application. Include rated capacities; shipping, installed, and operating weights; furnished specialties; and accessories.
2. For each type of special duty valve indicated include flow and pressure drop curves based on manufacturer’s testing for diverting fittings, calibrated balancing valves and automatic flow control valves.

B. Maintenance Data.
1. Furnish maintenance manuals as specified in Division 1.

1.5 QUALITY ASSURANCE

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

B. ASME Compliance:
1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
2. ASME B31.1 for power piping valves.
3. ASME B31.9 for building services piping valves.

C. Standards: If any item in this specification, as furnished by the contractor is manufactured in a location which does not certify ASME / ANSI standards, the contractor is to pay the owner for all expenses incurred by the owner for an outside testing company to confirm such compliances.

D. To assure uniformity and compatibility, all grooved end valves and adjoining couplings and fittings shall be supplied by Victaulic.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:
   1. Protect internal parts against rust and corrosion.
   2. Protect threads, flange faces, grooves, and weld ends. with wooden flange covers or with screwed plugs / caps as required.
   3. Set gate, and globe valves closed to prevent rattling.
   4. Set ball and plug valves open to minimize exposure of functional surfaces.
   5. Set butterfly valves closed or slightly open.
   6. Block check valves in either closed or open position.
   7. Protect instrumentation from damage.
   8. Clean flanges and exposed metal surfaces and treat with anti-corrosive compound before assembly and testing.

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

1.7 WARRANTY

A. General warranty: Special warranty specified in this article shall not deprive the owner of the other rights Owner may have under other provisions of the Contract Documents and shall be in addition to and run concurrent with other warranties made by Contractor under requirements of the Contract Documents.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

A. Refer to HVAC valve schedule articles for applications of valves (Part 3 "Valve Applications Schedule".

B. Valve Pressure and Temperature Ratings: Not less than indicated and as required for system pressures and temperatures.

C. Valve Sizes: Same as upstream piping unless otherwise indicated.

D. Valve Actuator Types:
   1. Gear Actuator: For quarter-turn valves NPS 8 (DN 200) and larger.
   2. Handwheel: For valves other than quarter-turn types.

3. Handlever: For quarter-turn valves NPS 6 (DN 150) and smaller except plug valves.
4. Wrench: For plug valves with square heads. Furnish Owner with 1 wrench for every 10 plug valves, for each size square plug-valve head.
5. Chainwheel: Device for attachment to valve handwheel, stem, or other actuator; of size and with chain for mounting height, as indicated in the "Valve Installation" Article.
6. Electric motor: As indicated on the drawings.

E. Valves in Insulated Piping: With 2-inch (50-mm) stem extensions and the following features:
1. Gate Valves: With rising stem.
2. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.

F. Valve-End Connections:
1. Flanged: With flanges according to ASME B16.1 for iron valves
2. Flanged: With flanges according to ASME B16.24 for bronze valves.
3. Grooved: With grooves according to AWWA C606.
4. Solder Joint: With sockets according to ASME B16.18.
5. Threaded: With threads according to ASME B1.20.1.

G. Valve Bypass and Drain Connections: MSS SP-45.

2.2 VALVE DESCRIPTIONS

A. BRONZE GATE VALVES, 2 INCHES AND SMALLER, MSS SP-80 TYPE 1
1. Manufacturers -Bronze gate valves
   a. Crane Co.; Crane Valve Group; Jenkins Valves
   b. Crane Co; Crane Valve Group; Crane Valves
   c. Crane Co; Crane Valve Group; Stockham Division.
   d. Grinnell Corporation
   e. Walworth Company
   f. NIBCO Inc.
2. Class 150 psi steam, 300 psi cold working pressure (CWP)
   a. ASTM B 62 cast-bronze body and bonnet (unless used for steam service, then use cast iron body)
   b. Union bonnet
   c. Solid-bronze wedge
   d. Copper-silicon alloy rising stem
   e. Teflon-impregnated packing with bronze packing nut
   f. Threaded (steel piping) end connection –SCHEDULE VALVE NO. 0101
   g. Soldered (copper piping) end connection – SCHEDULE VALVE NO. 0102
   h. Aluminum or malleable-iron handwheel

B. BRONZE GLOBE VALVES, 2 INCHES AND SMALLER, MSS SP-80 TYPE 3
1. Manufactures-Bronze globe valves
   a. Crane Co; Crane Valve Group; Jenkins Valves
   b. Crane Co; Crane Valve Group; Crane Valves
   c. Crane Co; Crane Valve Group; Stockham Division.
   d. Grinnell Corporation
   e. Walworth Company

f. NIBCO Inc.
2. Class 150 psi steam, 300 psi cold working pressure (CWP)
a. ASTM B 62 cast-bronze body and bonnet (unless used for steam service, then use cast iron body)
b. Union bonnet
c. Stainless steel disc
d. Stainless steel seat
e. Copper-silicon alloy rising stem
f. Teflon-impregnated packing with bronze packing nut
g. Threaded end connection
h. Aluminum or malleable-iron handwheel
i. SCHEDULE VALVE NO. 0201

C. BRONZE SWING CHECK VALVES, 2 INCHES AND SMALLER, MSS SP-80
1. Manufacturers - Bronze check valves, Horizontal and Vertical
a. Horizontal
1) Crane Co.; Crane Valve Group; Jenkins Valves
2) Crane Co.; Crane Valve Group; Crane Valves
3) Crane Co.; Crane Valve Group; Stockham Division
4) Grinnell Corporation
5) Walworth Company
6) NIBCO Inc.
b. Vertical
1) Crane Co.; Crane Valve Group; Jenkins Valves
2) Crane Co.; Crane Valve Group; Crane Valves
3) Cincinnati Valve Co
2. Class 150 pi steam, 300 psi cold working pressure (CWP)
a. ASTM B 62 cast-bronze body and cap
b. "Y" pattern
c. Stainless steel free floating hinge pin
d. Threaded cap
e. Regrinding seat
f. Bronze disc
g. Threaded (steel piping) end connection – SCHEDULE VALVE NO. 0301
h. Soldered (copper piping) end connection – SCHEDULE VALVE NO. 0302

D. Bronze needle valves, 1/8 inch to 3/4 inch, MSS SP-80
1. Manufacturers - Bronze Needle Valves
a. Crane Co.; Crane Valve Group; Jenkins Valves
b. Crane Co.; Crane Valve Group; Stockham Division.
2. Class 200 psi steam, 400 psi cold working pressure (CWP)
a. ASTM B 62 cast-bronze body and bonnet
b. Screwed bonnet
c. Bronze ASTM B 150 rising stem & needle
d. Integral bronze seat
e. Graphite packing with bronze packing nut
f. Threaded end connection
g. Globe or angle pattern
h. Aluminum or malleable-iron handwheel
i. SCHEDULE VALVE NO. 0501

E. IRON GATE VALVES
1. Manufacturers - Iron gate valves

a. Crane Co.; Crane Valve Group; Jenkins Valves
b. Crane Co.; Crane Valve Group; Crane Valves
c. Crane Co.; Crane Valve Group; Stockham Division
d. Grinnell Corporation
e. Cincinnati Valve Co.
f. NIBCO Inc.

2. 2 inch and smaller, MSS SP 25, MSS SP-70 type 1
   a. Class 125 psi steam, 200 psi cold working pressure (CWP)
      1) ASTM A 126 class B cast-iron body and bonnet
      2) Bolted bonnet
      3) Outside screw & yoke
      4) Rising stem
      5) Solid bronze disc
      6) Bronze stem
      7) Renewable bronze seat rings
      8) Threaded end connection
      9) Non-asbestos packing and gaskets
      10) Aluminum or malleable-iron handwheel
      11) SCHEDULE VALVE NO. 0601
   b. Class 250 psi steam, 500 psi cold working pressure (CWP)
      1) ASTM A 126 class B cast-iron body and bonnet
      2) Bolted bonnet
      3) Outside screw & yoke
      4) Rising stem
      5) Solid bronze disc
      6) Steel stem
      7) Renewable bronze seat rings
      8) ANSI 250 flat face flanged ends
      9) Non-asbestos packing and gaskets
      10) Aluminum or malleable-iron handwheel
      11) SCHEDULE VALVE NO. 0602
3. 2 1/2 inch to 12 inch, MSS SP 25, MSS SP-70 type 1
   a. Class 125 psi steam, 200 psi cold working pressure (CWP)
      1) ASTM A 126 class B cast-iron body and bonnet
      2) Bolted bonnet
      3) Outside screw & yoke
      4) Rising stem
      5) Solid bronze disc
      6) Steel stem
      7) Renewable bronze seat rings
      8) ANSI 125 flat face flanged ends
      9) Non-asbestos packing and gaskets
      10) Aluminum or malleable-iron handwheel
      11) SCHEDULE VALVE NO. 0611
   b. Class 250 psi steam, 500 psi cold working pressure (CWP)
      1) ASTM A 126 class B cast-iron body and bonnet
      2) Bolted bonnet
      3) Outside screw & yoke
      4) Rising stem
      5) Solid bronze disc
      6) Steel stem

7) Renewable bronze seat rings
8) ANSI 250 flat face flanged ends
9) Non-asbestos packing and gaskets
10) Aluminum or malleable-iron handwheel
11) SCHEDULE VALVE NO. 0612

F. IRON GLOBE VALVES
1. Manufacturers - Iron globe valves
a. Crane Co.; Crane Valve Group; Jenkins Valves
b. Crane Co.; Crane Valve Group; Crane Valves
c. Crane Co.; Crane Valve Group; Stockham Division
d. Grinnell Corporation
e. Cincinnati Valve Co.
f. NIBCO Inc.
2. 3 inches to 10 inches, MSS SP-85
a. Class 125 psi steam, 200 psi cold working pressure (CWP)
1) ASTM A 126 class B cast-iron body and bonnet
2) Bolted bonnet
3) Outside screw & yoke
4) Rising stem
5) 6 inch and smaller: solid bronze disc
6) 8 inch and larger: cast iron disc with bronze facing
7) Bottom guided disc
8) Brass alloy stem
9) Renewable bronze seat
10) ANSI 125 flat face flanged ends
11) Non-asbestos packing and gaskets
12) Aluminum, steel, or cast iron handwheel
13) SCHEDULE VALVE NO. 0701
b. Class 250 psi steam, 500 psi cold working pressure (CWP)
1) ASTM A 126 class B cast-iron body and bonnet
2) Bolted bonnet
3) Outside screw & yoke
4) Rising stem
5) 3 inch and smaller: solid bronze disc
6) 6 inch and larger: cast iron disc with bronze facing
7) Bottom guided disc
8) Brass alloy stem
9) Renewable bronze seat
10) ANSI 250 flat face flanged ends
11) Non-asbestos packing and gaskets
12) Aluminum, steel, or cast iron handwheel
13) SCHEDULE VALVE NO. 0702

G. IRON SWING CHECK VALVES
1. Manufacturers:
a. Crane Co.; Crane Valve Group; Jenkins Valves
b. Crane Co.; Crane Valve Group; Crane Valves
c. Crane Co.; Crane Valve Group; Stockham Division
d. Grinnell Corporation
e. Cincinnati Valve Co.
f. NIBCO Inc.

2. 2½ inch to 12 inch, ASME B16.10
   a. Class 125 psi steam, 200 psi cold working pressure (CWP)
      1) Cast iron body and cap
      2) Replaceable bronze seat ring
      3) 6 inch and smaller: solid bronze disc
      4) 8 inch and larger: cast iron disc with bronze facing
      5) Replaceable brass hinge pin
      6) Flanged ends
      7) SCHEDULE VALVE NO. 0811
   b. Class 250 psi steam, 500 psi cold working pressure (CWP)
      1) Cast iron body and cap, ASTM A126 class B
      2) Screwed in bronze body seat ring
      3) 3 inch and smaller: solid bronze disc
      4) 4 inch and larger: cast iron disc with bronze facing
      5) Stainless steel hinge pin
      6) Flanged ends
      7) SCHEDULE VALVE NO. 0812

H. IRON, GROOVED-END SWING CHECK VALVES
1. Manufacturers: Subject to compliance with requirements, [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:
   a. Victaulic Company.
2. Description:
   a. CWP Rating: NPS 2 through NPS 12: 300 psig (2070 kPa).
   b. Body Material: ASTM A 536, ductile iron.
   c. Seal: EPDM.
   d. Disc: Spring operated, ductile iron or stainless steel.
   e. Victaulic Styles 716H, 716, 779

I. BRONZE BALL VALVES, 3 INCHES AND SMALLER
1. Manufacturers - Bronze ball valves
   a. Conbraco Industries Inc.; Apollo Division
   b. Crane Co.; Crane Valve Group; Jenkins Valves
   c. Crane Co.; Crane Valve Group; Stockham Division
   d. Jamesbury Inc.
   e. Milwaukee Valve Company
2. 2 piece, class 150 psi steam, 600 psi cold working pressure (CWP), standard port
   a. ASTM B584 cast bronze body
   b. Stainless steel ball and stem
   c. Chrome plated brass ball with brass stem
   d. Blow out proof stem design
   e. PTFE seats
   f. PTFE stem packing
   g. Zinc plated steel lever with vinyl covered grip
   h. Threaded ends – SCHEDULE VALVE NO. 1811
   i. Solder ends – SCHEDULE VALVE NO. 1812
3. 3 piece, class 150 psi steam, 600 psi cold working pressure (CWP), full port
   a. ASTM B584 cast bronze body
   b. Stainless steel ball and stem
   c. Chrome plated brass ball with brass stem

d. Blow out proof stem design
e. PTFE seats
f. PTFE stem packing
g. Zinc plated steel lever with vinyl covered grip
h. Threaded ends
i. SCHEDULE VALVE NO. 1821

J. CARBON STEEL BALL VALVES
1. Manufacturers - Steel ball valves
a. Conbraco Industries Inc.; Apollo Division
b. Crane Co.; Crane Valve Group; Stockham Division
c. Jamesbury Inc.
d. Cooper Cameron Corp.; Cooper Cameron Valves Div.
e. Milwaukee Valve Company
2. 2 piece, class 150 psi steam, 3000 psi cold working pressure (CWP), full port, 2_inches and smaller
a. ASTM A108 carbon steel body

b. Stainless steel ball and stem
c. ASTM A108 chrome plated ball and stem
d. Blow out proof stem design
e. PTFE seats
f. PTFE stem packing
g. Zinc plated steel lever with vinyl covered grip
h. Threaded ends
i. SCHEDULE VALVE NO. 1901
3. 3 piece, class 150 psi steam, 1000 psi cold working pressure (CWP), full port, 2_inches and smaller
a. ASTM A108 carbon steel body
b. Stainless steel ball and stem
c. ASTM A108 chrome plated ball and stem
d. Blow out proof stem design
e. PTFE seats
f. PTFE stem packing
g. Zinc plated steel lever with vinyl covered grip
h. Threaded ends – SCHEDULE VALVE NO. 1911
i. Socket weld ends – SCHEDULE VALVE NO. 1912
4. ANSI flanged, class 150 psi steam, 285 psi cold working pressure (CWP), reduced port, 2½ inches to 10 inches
a. ASTM A216 WCB cast carbon steel body
b. ASTM A216 WCB chrome plated ball
c. ASTM A108 carbon steel stem
d. Blow out proof stem design
e. PTFE seats
f. Graphite stem packing
g. Galvanized pipe lever
h. Raised face flange ends
i. SCHEDULE VALVE NO. 1921
5. ANSI flanged, class 300 psi steam, 740 psi cold working pressure (CWP), reduced port, 3 inches to 10 inches
a. ASTM A216 WCB cast carbon steel body
b. ASTM A216 WCB chrome plated ball

c. ASTM A108 carbon steel stem
d. Blow out proof stem design
e. PTFE seats
f. Graphite stem packing
g. Galvanized pipe lever
h. Raised face flange ends
i. SCHEDULE VALVE NO. 1941

K. CAST IRON PLUG VALVES
1. Manufacturers - Cast iron plug valves
a. Nordstrom Valve Inc.
b. Walworth Company
c. R&M Energy systems (Tomball Tx)
d. Olson Technologies; Homestead Div.
2. 2 inch and smaller, MSS SP 25, MSS SP-78
a. 200 psi cold working pressure (CWP)
1) ASTM A 126 gray iron body
2) Regular pattern
3) Screwed gland
4) Buna-N gland and stem seals
5) Gray iron lubricated tapered plug
6) Carbon steel sealant fitting
7) 1 year supply lubricant per valve
8) 1 lubricating gun with 15,000 psi gauge and 12 inch connection hose per 10 valves
9) 1 wrench operator per 10 valves
10) Threaded end connection
11) SCHEDULE VALVE NO. 2001
b. 400 psi cold working pressure (CWP)
1) ASTM A 126 gray iron body
2) Short pattern
3) Screwed gland
4) Buna-N gland and stem seals
5) Gray iron lubricated tapered plug
6) Carbon steel sealant fitting
7) 1 year supply lubricant per valve
8) 1 lubricating gun with 15,000 psi gauge and 12 inch connection hose per 10 valves
9) 1 wrench operator per 10 valves
10) Threaded end connection
11) SCHEDULE VALVE NO. 2002
3. 2 1/2 inch to 4 inch, MSS SP 25, MSS SP-78
a. 200 psi cold working pressure (CWP)
1) ASTM A 126 gray iron body
2) Regular pattern
3) Screwed gland
4) Buna-N gland and stem seals
5) Gray iron lubricated tapered plug
6) Carbon steel sealant fitting
7) 1 year supply lubricant per valve
8) 1 lubricating gun with 15,000 psi gauge and 12 inch connection hose per 10 valves

9) 1 wrench operator per 10 valves
10) ANSI 125 flanged ends
11) SCHEDULE VALVE NO. 2011

b. 400 psi cold working pressure (CWP)
1) ASTM A 126 gray iron body
2) Short pattern
3) Screwed gland
4) Buna-N gland and stem seals
5) Gray iron lubricated tapered plug
6) Carbon steel sealant fitting
7) 1 year supply lubricant per valve
8) 1 lubricating gun with 15,000 psi gauge and 12 inch connection hose per 10 valves
9) 1 wrench operator per 10 valves
10) ANSI 250 flanged ends
11) SCHEDULE VALVE NO. 2012

4. 5 and 6 inch, MSS SP 25, MSS SP-78
a. 200 psi cold working pressure (CWP)
1) ASTM A 126 gray iron body
2) Short pattern
3) Bolted gland
4) Buna-N gland and stem seals
5) Gray iron lubricated tapered plug
6) Carbon steel sealant fitting
7) 1 year supply lubricant per valve
8) 1 lubricating gun with 15,000 psi gauge and 12 inch connection hose per 10 valves
9) 1 wrench operator per 10 valves
10) ANSI 125 flanged ends
11) SCHEDULE VALVE NO. 2021
b. 400 psi cold working pressure (CWP)
1) ASTM A 126 gray iron body
2) Regular pattern
3) Bolted gland
4) Buna-N gland and stem seals
5) Gray iron lubricated tapered plug
6) Carbon steel sealant fitting
7) 1 year supply lubricant per valve
8) 1 lubricating gun with 15,000 psi gauge and 12 inch connection hose per 10 valves
9) 1 wrench operator per 10 valves
10) ANSI 250 flanged end
11) SCHEDULE VALVE NO. 2022

L. IRON BUTTERFLY VALVES-Not Used

M. FORGED STEEL GATE VALVES, 2 INCHES AND SMALLER, MSS SP-84

1. Manufacturers - Forged steel gate valves

a. **Velan**

b. **Powell**

2. **Class 800 psi steam, 1975 psi cold working pressure (CWP), conventional port**

a. **ASTM A105 forged steel body and bonnet**

b. **Bolted bonnet**

c. **Outside screw and yoke**

d. **Bolted gland**

e. **Solid stainless steel, ASTM A276 wedge**

f. **Stellite faced seats**

g. **Steel / chrome alloy rising stem**

h. **Flexible graphite packing**

i. **Threaded end connection – SCHEDULE VALVE NO. 1101**

j. **Socket weld end connection – SCHEDULE VALVE NO. 1102**

k. **Malleable-iron handwheel**

3. **Class 800 psi steam, 1975 psi cold working pressure (CWP), full port**

a. **ASTM A105 forged steel body and bonnet**

b. **Bolted bonnet**

c. **Outside screw and yoke**

d. **Bolted gland**

e. **Solid stainless steel, ASTM A276 wedge**

f. **Stellite faced seats**

g. **Steel / chrome alloy rising stem**

h. **Flexible graphite packing**

i. **Threaded end connection – SCHEDULE VALVE NO. 1111**

j. **Socket weld end connection – SCHEDULE VALVE NO. 1112**

k. **Malleable-iron handwheel**

N. **FORGED STEEL GLOBE VALVES, 2 INCHES AND SMALLER, MSS SP-84**

1. **Manufacturers -Forged steel globe valves**

a. **Velan.**

b. **Powell**

2. **Class 800 psi steam, 1975 psi cold working pressure (CWP), conventional port**

a. **ASTM A105 forged steel body and bonnet**

b. **Bolted bonnet**

c. **Outside screw and yoke**

d. **Bolted gland**

e. **Loose disc, steel / chrome alloy**

f. **Renewable satellite faced seat**

g. **Steel / chrome alloy rising stem**

h. **Flexible graphite packing**

i. **Threaded end connection – SCHEDULE VALVE NO. 1201**

j. **Socket weld end connection – SCHEDULE VALVE NO. 1202**

k. **Malleable-iron handwheel**

O. **FORGED STEEL CHECK VALVES, 2 INCHES AND SMALLER, MSS SP-84**

1. **Manufacturers - Forged steel check valves**

a. **Velan**

b. **Powell**

2. **Class 800 psi steam, 1975 psi cold working pressure (CWP), conventional port, horizontal piston check**

a. **ASTM A105 forged steel body and cover**

b. **Bolted cover**

c. **Fully guided disc steel / chrome alloy**

d. Renewable satellite faced seat

e. Stainless steel / graphite gasket

f. Threaded end connection – SCHEDULE VALVE NO. 1301

g. Socket weld end connection – SCHEDULE VALVE NO. 1302

P. FORGED STEEL CHECK VALVES, 2 INCHES AND SMALLER, MSS SP-84

1. Manufacturers - Forged steel check valves

a. Velan

b. Powell

2. Class 800 psi steam, 1975 psi cold working pressure (CWP), conventional port, horizontal piston check

a. ASTM A105 forged steel body and cover

b. Bolted cover

c. Fully guided disc steel / chrome alloy

d. Renewable satellite faced seat

e. Stainless steel / graphite gasket

f. Threaded end connection – SCHEDULE VALVE NO. 1301

g. Socket weld end connection – SCHEDULE VALVE NO. 1302

Q. CAST STEEL GATE VALVES, 2INCHES TO 24 INCHES

1. Manufacturers - Cast steel gate valves

a. Velan
b. Powell

2. Class 150 psi steam, 290 psi cold working pressure (CWP)

a. ASTM A216 grade WCB cast steel body and bonnet

b. Bolted bonnet

c. Outside screw and yoke

d. Rising stem

e. Bolted gland

f. **Solid steel, 13% chromium overlay wedge**

g. **Stellite faced seats**

h. **Stainless steel stem**

i. **Flexible graphite packing**

j. **Raised face flange ends – SCHEDULE VALVE NO. 1401**

k. **Buttwelding ends – SCHEDULE VALVE NO. 1402**

l. **Malleable-iron or steel handwheel**

3. **Class 300 psi steam, 750 psi cold working pressure (CWP)**

a. **ASTM A216 grade WCB cast steel body and bonnet**

b. **Bolted bonnet**

c. **Outside screw and yoke**

d. **Rising stem**

e. **Bolted gland**

f. **Solid steel, 13% chromium overlay wedge**

g. **Stellite faced seats**

h. **Stainless steel stem**

i. **Flexible graphite packing**

j. **Raised face flange ends – SCHEDULE VALVE NO. 1411**

k. **Buttwelding ends – SCHEDULE VALVE NO. 1412**

l. **Malleable-iron or steel handwheel**

R. **CAST STEEL GLOBE VALVES, 2 INCHES TO 12 INCHES**

1. **Manufacturers - Cast steel globe valves**

a. **Velan**
b. **Powell**

2. **Class 150 psi steam, 290 psi cold working pressure (CWP)**

a. **ASTM A216 grade WCB cast steel body and bonnet**

b. **Bolted bonnet**

c. **Outside screw and yoke**

d. **Rising stem and handwheel**

e. **Bolted gland**

f. **Steel with 13% chromium overlay disc**

g. **Stellite faced seat ring**

h. **Stainless steel stem**

i. **Flexible graphite packing**

j. **Raised face flange ends – SCHEDULE VALVE NO. 1501**

k. **Buttwelding ends – SCHEDULE VALVE NO. 1502**

l. **Malleable-iron or steel handwheel**

3. **Class 300 psi steam, 750 psi cold working pressure (CWP)**

a. **ASTM A216 grade WCB cast steel body and bonnet**

b. **Bolted bonnet**

c. **Outside screw and yoke**

d. **Rising stem and handwheel**

e. **Bolted gland**

f. **Steel with 13% chromium overlay disc**

g. **Stellite faced seat ring**

h. **Stainless steel stem**

i. **Flexible graphite packing**

j. **Raised face flange ends – SCHEDULE VALVE NO. 1511**

k. **Buttwelding ends – SCHEDULE VALVE NO. 1512**

l. **Malleable-iron or steel handwheel**

S. **CAST STEEL SWING CHECK VALVES, 2 INCHES TO 24 INCHES**

1. **Manufacturers - Cast steel swing check valves**

a. Velan
b. Powell

2. Class 150 psi steam, 290 psi cold working pressure (CWP)

a. ASTM A216 grade WCB cast steel body and cover

b. Bolted cover

c. Steel with 13% chromium overlay disc

d. Stellite faced seat ring

e. Steel hinge, stainless steel hinge pin

f. Stainless steel / graphite gasket

g. Raised face flange ends – SCHEDULE VALVE NO. 1601

h. Buttwelding ends – SCHEDULE VALVE NO. 1602

3. Class 300 psi steam, 750 psi cold working pressure (CWP)

a. ASTM A216 grade WCB cast steel body and cover

b. Bolted cover

c. Steel with 13% chromium overlay disc

d. Stellite faced seat ring

e. Steel hinge, stainless steel hinge pin

f. Stainless steel / graphite gasket

g. Raised face flange ends – SCHEDULE VALVE NO. 1611

h. Buttwelding ends – SCHEDULE VALVE NO. 1612

T. SPRING LOADED LIFT DISC CHECK VALVES
1. Manufacturers - Spring loaded lift disc check valves.
   a. Mueller Steam Specialty Co.
   b. Milwaukee Valve Co.
   c. Titan Flow Control, Inc.
2. 2 inch and smaller
   a. 200 psi cold working pressure (CWP) up to 150ºF
      1) Cast iron body and cap
      2) Screwed cap
      3) EPDM seal
      4) Stainless steel stem
      5) Stainless steel spring

6) Brass disc
7) Threaded ends
8) SCHEDULE VALVE NO. 2401

b. 400 psi cold working pressure (CWP) up to 150ºF
1) Bronze body and cap
2) Screwed cap
3) EPDM seal
4) Stainless steel stem
5) Stainless steel spring
6) Brass disc
7) Threaded ends
8) SCHEDULE VALVE NO. 2402

3. 2½ inch to 12 inch
a. 200 psi cold working pressure (CWP) up to 150ºF
1) ASTM A126 grade B cast iron, globe style, body
2) ASTM B62 bronze disc and seat
3) Stainless steel spring
4) Silicon bronze guide pins and bushings
5) ANSI class 125 flanged end connections
6) SCHEDULE VALVE NO. 2411

b. 500 psi cold working pressure (CWP) up to 150ºF
1) ASTM A126 grade B cast iron, globe style, body
2) ASTM B62 bronze disc and seat
3) Stainless steel spring
4) Silicon bronze guide pins and bushings
5) ANSI class 250 flanged end connections
6) SCHEDULE VALVE NO. 2413

U. CIRCUIT BALANCING VALVES
1. Manufacturers: Taco fixed port venturi style balancing valves:
a. 2” and Smaller Sizes: 300 psi (2065 kPa), threaded or soldered non-ferrous bronze body, with dual Schrader style pressure ports. All wetted parts shall be of brass construction. Valves shall have built in drain ports. Internal seats shall be Teflon. Valves shall have memory stop and shall be Taco Accu-Flo.
b. 2-1/2” and Larger Sizes: 125 psi ,flanged ends, Cast iron body, all other metal parts of brass, EPDM O-ring seals, dual Schrader style pressure ports. Valves shall have memory stop and shall be Taco Accu-Flo.

2.3 Electric MOTOR ACTUATORS
1. Manufacturers - Electric valve actuators
a. Limitorque Corporation
b. Rotork Controls, Inc.
c. Belimo Air Controls, Inc.
d. EIM Company, Inc.

B. Motor valve operators.

C. Provide as follows:
1. Mount operators on side or top of valve at factory or at site under manufacturer's supervision. Provide gear operated single or double

reduction. For 90 deg (1/4 turn) application, adjustable mechanical stops shall prevent travel of more than 90 deg

2. Grease or oil lubricated.
3. 120 Volt, 1 phase, 60 hertz
4. Control circuit: 24 volt, transformer as required.
5. Assembly:
   a. Motor shall be high speed, high torque, totally enclosed non-ventilated, Class B or F insulation and operational at up to 10 percent above or below nominal voltage. Motor shall be prelubricated, anti-friction bearing type with thermal overload protection.
   b. Limit switches shall be integral to the unit. Gearing shall be bronze or stainless steel. Steel switches shall be fully adjustable and shall trip anywhere between full open and full close, as required. Switches shall be heavy duty, open contact type with rotary wiping action. Provide minimum spare contacts 2 normally open, 2 normally closed.
   c. Torque switch shall have torque protection either direction, fully adjustable and shall shut off actuator motor when a predetermined amount of torque is reached.
   d. Stem nut shall be high tensile bronze or material compatible to the valve stem and shall be constructed for easy removal without disassembling gear case.
   e. Handwheel for manual operation: Handwheel shall declutch automatically when motor is energized. Rimpull shall not exceed a maximum of 80 lb. Handwheel shall be similar to Limitorque SMB and SMC.
6. For open/closed operation: All valves shall have integral control package including control transformer with fused secondary, motor reversing contactor (mechanically interlocked), limit switch compartment heater and terminal strip.
   a. Indicating lights shall be:
      1) Red light glows when valve closed.
      2) Green light glows when valve open.
      3) Intermediate position indication.
   b. Pushbutton station: Provide selector switch if required and momentary or maintained contacts as required.
7. For modulating service shall be controlled by analog signal 4-20 ma DC with momentary pushbuttons.
   a. Controls shall be mounted inside the actuator.
   b. Provide single phase power supply:
      1) Comparator circuit module.
      2) Mechanical dial position indicator with 1,000 ohm potentiometer feedback.
      3) 2 position (auto/manual) selector switch.
      4) Limit switch compartment heater.
      5) Motor: 2100 rpm D.C. in lieu of A.C.; class F insulation; 20 percent run valve duty.
      6) Mounted and wired, similar to Limitorque Modutronic 10A and 10B.
8. Closing time:
   a. Gate shall be 12 inches per minute, minimum 1 minute.
   b. Globe shall be 4 inches per minute, minimum 1 minute.

9. Provide remote open-close buttons and open-close indicating lights for installation on control board in Division 15 Section "Automatic Controls System".
10. Final field adjustment of valve operation shall be made by manufacturer's representative.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine piping system for compliance with requirements for installation tolerances and other conditions affecting performance.
   1. Proceed with installation only after unsatisfactory conditions have been corrected.

B. 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.

C. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

D. Examine threads on valve and mating pipe for form and cleanliness.

E. 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.

F. Do not attempt to repair defective valves; replace with new valves.

G. Examine grooved ends for conditions that might cause leakage. Ends should be free from indentations or projections in the area from valve end to groove

3.2 VALVE INSTALLATION

A. Install valves with unions flanges, or Victaulic couplings (on authorized systems) 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. Center-Guided and Plate-Type Check Valves: In horizontal or vertical position, between flanges.
   3. Lift Check Valves: With stem upright and plumb.

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. General-Duty Valve Applications: Unless otherwise indicated, use the following valve types:
   1. Shutoff Service except Steam: Ball, or gate valves.
   2. Shutoff service, Steam: **Steel** gate valves.
   3. Throttling Service except Steam: Ball, or plug valves.
   4. Throttling Service, Steam: **Steel** Globe valves.

B. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.

C. Install shutoff duty valves at each branch connection to supply mains, at supply connection to each piece of equipment, unless only one piece of equipment is connected in the branch line. Install throttling duty valves at each branch connection to return mains, at return connections to each piece of equipment, and elsewhere as indicated.

D. Install Y-pattern multi-turn globe style balancing valves in the return water line of each heating or cooling element and elsewhere as required to facilitate system balancing.

E. Install spring loaded check valves at each pump discharge and elsewhere as required to control flow direction.

3.5 VALVE SCHEDULE

A. The valve numbers listed in the tables below correspond to the valve numbers listed in the products section for each valve type.

B. Table abbreviations
   1. CHW – Chilled water
   2. HW – hot water
   3. LPS – low pressure steam
   4. MPS – medium pressure steam, classified as high pressure steam, however the requirements may vary
   5. HPS – high pressure steam
   6. The pressures are listed next to the service (i.e. <125 psig is less than 125 psig:, 126-250 is between 126 and 250 psig, >251 is greater than 251 psig)..

C. Gate valves

Service pressure	< 2”thread	< 2”solder	< 2”flange	> 2”flange	< 2”weld	> 2”weld
CHW< 125	0101 0601	0102	na	0611	na	na
HW < 125	0101 0601	0102	na	0611	na	na
LPS < 15	0101	na	na	0611	na	na

	0601					
MPS 16-125	0101 0601	na	na	0611	**1102**	**1412**
HPS 126-250	0111	na	na	1411	1102	1412
LPR	0101 0601	na	na	0611	na	na
HPR	0111	na	na	1411	1102	1412
MU	0101 0601	0102	na	0611	na	na

D. Globe valves

Service pressure	< 2"thread	< 2"solder	< 2"flange	> 2"flange	< 2"weld	> 2"weld
CHW< 125	0201	na	na	0701	na	na
HW < 125	0201	na	na	0701	na	na
LPS < 15	0201	na	na	0701	na	na
MPS 16-125	0201	na	na	1501	**1202**	**1512**
HPS 126-250	0211 1201	na	na	1511	1202	1512
LPR	0201	na	na	0701	na	na
HPR	0211	na	na	1511	1202	1512
MU	0201	na	na	0701	na	na

E. Check valves

Service pressure	< 2" thread	< 2" solder	< 2" flange	> 2" flange	< 2" weld	> 2" weld	>2" grooved
CHW< 125	0301	0302	na	0811	na	na	716/779/W715
HW < 125	0301	0302	na	0811	na	na	
LPS < 15	0301	na	na	0811	na	na	
MPS 16-125	0301	na	na	1601	**1302**	**1612**	
HPS 126-250	0311 0801	na	na	1611	1302	1612	
LPR	0301	na	na	0811	na	na	
HPR	0311	na	na	1611	1302	1612	
MU	0301	0302	na	0811	na	na	

F. Angle valves

Service pressure	< 2"thread	< 2"solder	< 2"flange	> 2"flange		
CHW< 125	0401	na	na	0901		
HW < 125	0401	na	na	0901		
LPS < 15	0401	na	na	0901		
MPS 16-125	na	na	na	0901		
HPS 126-	na	na	na	na		

300						
LPR	0401	na	na	0901		
HPR	na	na	na	na		
MU	0401	na	na	0901		

G. Needle valves

Service pressure	< ¾ ”thread					
CHW	0501					
HW	0501					
MU	0501					

H. Stop check valves

Service pressure				> 2”flange		> 2”weld
LPS < 15				1001		1702
MPS 16-125				1701		1702
HPS 126-300				1701		1702

I. Ball valves

Service pressure	< 3”thread	< 3”solder		> 2”flange	< 2” weld	
CHW< 125	1811 1821 1901	1812		1921	1912	
HW < 125	1811 1821 1901	1812		1921	1912	
LPS < 15	1811 1821 1901	na		1921	1912	
LPR	1811 1821 1901	1812		1921	1912	
MU	1811 1821 1901	1812		1921	na	

J. Plug valves

Service pressure	< 2”thread	2½” – 4”	5” – 6”	8” – 12”	8” – 24”	
CHW < 200	2001	2011	2021	2031	na	
HW < 125	2001	2011	2021	2031	na	

K. Butterfly valves-Not Used

L. High performance butterfly valves-Not Used

M. Spring loaded lift disc check valves

Service pressure	< 2″	2 ½ ″ – 12″	12″ – 24″			
CHW < 200	2401	2411	2422			
HW < 125	2401	2411	2422			

N. Safety valves

Service pressure	Shut Off	Relief				
LPS < 15	2701	2711				
MPS 16-125	2701	2711				
HPS 126-300	2701	2711				

O. Automatic flow control valves

Service pressure	< 2″ thread	2 ½″ – 3″	3″ – 14″	16″ – 24″		
CHW < 200	na	na	2821	2831		
HW < 200	na	na	2821	2831		

P. Solenoid valves

Service pressure	< 2″ thread					
CHW < 125	2901 2902					
HW < 125	2901 2902					
MU	2901 2902					

END OF SECTION

SECTION 23 05 29

HANGERS AND SUPPORTS 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 and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes the following hangers and supports for HVAC system piping and equipment:
   1. Steel pipe hangers and supports.
   2. Trapeze pipe hangers.
   3. Metal framing systems.
   4. Thermal-hanger shield inserts.
   5. Fastener systems.
   6. Equipment supports.

B. Related Sections include the following:
   1. Division 23 Section " Expansion Fittings and Loops for HVAC Piping" for pipe guides and anchors.
   2. Division 23 Section " Vibration and Seismic Controls for HVAC Piping and Equipment" for vibration isolation devices.
   3. Division 23 Section(s) "Metal Ducts" for duct hangers and supports.

1.3 DEFINITIONS

A. MSS: Manufacturers Standardization Society for The Valve and Fittings Industry Inc.

B. Terminology: As defined in MSS SP-90, "Guidelines on Terminology for Pipe Hangers and Supports."

1.4 PERFORMANCE REQUIREMENTS

A. Design supports for multiple pipes, including pipe stands, capable of supporting combined weight of supported systems, system contents, and test water.

B. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

C. Design seismic-restraint hangers and supports for piping and equipment.

1.5 SUPPLEMENTARY STEEL

A. Furnish supplementary steel as required for proper installation, mounting and support of HVAC work.

B. Connect supplementary steel firmly to building construction in an acceptable manner.

C. Determine type and size of supplementary steel. Supplementary steel shall be of sufficient strength and size to allow a minimum deflection of 1/360 of the span and in conformance with manufacturer's requirements of loading.

D. Install supplementary steel in a neat and workmanlike manner parallel to walls, floors and ceiling construction.

E. All supplementary steel and channel supports shall be submitted to the structural engineer for review

1.6 EXPANSION ANCHORS

A. Provide smooth wall, non-self-drilling internal plug expansion type anchors constructed of AISC 12L14 steel and zinc plated in accordance with Fed. Spec. QQ-A-325 Type 1, Class 3.

B. Do no exceed 1/4 of average values for a specific anchor size using 2,000 psig (13,800 kpa) concrete only for maximum working load.

C. Provide spacing and install anchors in accordance with manufacturer's recommendations.

1.7 SUBMITTALS

A. Product Data: For the following:
1. Steel pipe hangers and supports.
2. Thermal-hanger shield inserts.
3. Powder-actuated fastener systems.

B. Shop Drawings: Show fabrication and installation details and include calculations for the following:
1. Trapeze pipe hangers. Include Product Data for components.
2. Metal framing systems. Include Product Data for components.
3. Equipment supports.

C. Submit to the structural engineer:
1. Details of all proposed methods of attachment to the building structure for all hangers and supports.
2. All forces and weights that will be imposed on the building structure by the hangers and supports.

D. Welding certificates.

1.8 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code--Steel."

B. Welding: Qualify procedures and personnel according to the following:
1. AWS D1.1, "Structural Welding Code--Steel."

C. Engineering Responsibility: Design and preparation of Shop Drawings and calculations for each multiple pipe support, trapeze, and seismic restraint by a qualified professional engineer.

1. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of hangers and supports that are similar to those indicated for this Project in material, design, and extent

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

2.2 STEEL PIPE HANGERS AND SUPPORTS

A. Description: MSS SP-58, Types 1 through 58, factory-fabricated components. Refer to Part 3 "Hanger and Support Applications" Article for where to use specific hanger and support types.

B. Manufacturers:
   1. AAA Technology & Specialties Co., Inc.
   2. B-Line Systems, Inc.; a division of Cooper Industries.
   3. Carpenter & Paterson, Inc.
   4. Empire Industries, Inc.
   5. Globe Pipe Hanger Products, Inc.
   6. Grinnell Corp.
   7. GS Metals Corp.
   8. National Pipe Hanger Corporation.
   9. PHD Manufacturing, Inc.
   10. Piping Technology & Products, Inc.
   11. Tolco Inc.

C. Galvanized, Metallic Coatings: Pregalvanized or hot dipped.

D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

E. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion for support of bearing surface of piping.

2.3 TRAPEZE PIPE HANGERS

A. Description: MSS SP-69, Type 59, shop- or field-fabricated pipe-support assembly made from structural-steel shapes with MSS SP-58 hanger rods, nuts, saddles, and U-bolts.

2.4 METAL FRAMING SYSTEMS

A. Description: MFMA-3, shop- or field-fabricated pipe-support assembly made of steel channels and other components.

B. Manufacturers:
   1. B-Line Systems, Inc.; a division of Cooper Industries.
   2. ERICO/Michigan Hanger Co.; ERISTRUT Div.
   3. GS Metals Corp.
   4. Power-Strut Div.; Tyco International, Ltd.
   5. Thomas & Betts Corporation.
   6. Tolco Inc.
   7. Unistrut Corp.; Tyco International, Ltd.

C. Coatings: Manufacturer's standard finish, unless bare metal surfaces are indicated.

D. Nonmetallic Coatings: Plastic coating, jacket, or liner.

2.5 THERMAL-HANGER SHIELD INSERTS

A. Description: 100-psig- (690-kPa-) minimum, compressive-strength insulation insert encased in sheet metal shield.

B. Manufacturers:
   1. Carpenter & Paterson, Inc.
   2. ERICO/Michigan Hanger Co.
   3. PHS Industries, Inc.
   4. Pipe Shields, Inc.
   5. Rilco Manufacturing Company, Inc.
   6. Value Engineered Products, Inc.

C. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with vapor barrier.

D. Insulation-Insert Material for Hot Piping: ASTM C 552, Type II cellular glass.

E. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

F. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

G. Insert Length: Extend 2 inches (50 mm) beyond sheet metal shield for piping operating below ambient air temperature.

2.6 FASTENER SYSTEMS

A. 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.
   1. Manufacturers:
      a. Hilti, Inc.
      b. ITW Ramset/Red Head.
      c. Masterset Fastening Systems, Inc.
      d. MKT Fastening, LLC.
      e. Powers Fasteners.

B. Mechanical-Expansion Anchors: Insert-wedge-type zinc-coated steel, for use in hardened portland cement concrete with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.
   1. Manufacturers:
      a. B-Line Systems, Inc.; a division of Cooper Industries.

b. Empire Industries, Inc.
c. Hilti, Inc.
d. ITW Ramset/Red Head.
e. MKT Fastening, LLC.
f. Powers Fasteners.

2.7 EQUIPMENT SUPPORTS

A. Description: Welded, shop- or field-fabricated equipment support made from structural-steel shapes.

2.8 MISCELLANEOUS MATERIALS

A. Structural Steel: ASTM A 36/A 36M, 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 (34.5-MPa), 28-day compressive strength.

PART 3 - EXECUTION

3.1 HANGER AND SUPPORT APPLICATIONS

A. Specific hanger and support requirements are specified in Sections specifying piping systems and equipment.

B. Comply with MSS SP-69 for pipe hanger selections and applications that are not specified in piping system Sections.

C. Use hangers and supports with galvanized, metallic coatings for piping and equipment that will not have field-applied finish.

D. Use nonmetallic coatings on attachments for electrolytic protection where attachments are in direct contact with copper tubing.

E. Use padded hangers for piping that is subject to scratching.

F. Horizontal-Piping Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
   1. Adjustable, Steel Clevis Hangers (MSS Type 1): For suspension of noninsulated or insulated stationary pipes, NPS 1/2 to NPS 30 (DN 15 to DN 750).
   2. Yoke-Type Pipe Clamps (MSS Type 2): For suspension of 120 to 450 deg F (49 to 232 deg C) pipes, NPS 4 to NPS 16 (DN 100 to DN 400), requiring up to 4 inches (100 mm) of insulation.
   3. Carbon- or Alloy-Steel, Double-Bolt Pipe Clamps (MSS Type 3): For suspension of pipes, NPS 3/4 to NPS 24 (DN 20 to DN 600), requiring clamp flexibility and up to 4 inches (100 mm) of insulation.
   4. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes, NPS 1/2 to NPS 24 (DN 15 to DN 600), if little or no insulation is required.

5. Pipe Hangers (MSS Type 5): For suspension of pipes, NPS 1/2 to NPS 4 (DN 15 to DN 100), to allow off-center closure for hanger installation before pipe erection.
6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated stationary pipes, NPS 3/4 to NPS 8 (DN 20 to DN 200).
7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8 (DN 15 to DN 200).
8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 8 (DN 15 to DN 200).
9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated stationary pipes, NPS 1/2 to NPS 2 (DN 15 to DN 50).
10. Split Pipe-Ring with or without Turnbuckle-Adjustment Hangers (MSS Type 11): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 8 (DN 10 to DN 200).
11. Extension Hinged or 2-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated stationary pipes, NPS 3/8 to NPS 3 (DN 10 to DN 80).
12. U-Bolts (MSS Type 24): For support of heavy pipes, NPS 1/2 to NPS 30 (DN 15 to DN 750).
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 (DN 100 to DN 900), with steel pipe base stanchion support and cast-iron floor flange.
15. Pipe Stanchion Saddles (MSS Type 37): For support of pipes, NPS 4 to NPS 36 (DN 100 to DN 900), with steel pipe base stanchion support and cast-iron floor flange 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 (DN 65 to DN 900), 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 (DN 25 to DN 750), from 2 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 20 (DN 65 to DN 500), from single rod if horizontal movement caused by expansion and contraction might occur.
19. Complete Pipe Rolls (MSS Type 44): For support of pipes, NPS 2 to NPS 42 (DN 50 to DN 1050), if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes, NPS 2 to NPS 24 (DN 50 to DN 600), if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes, NPS 2 to NPS 30 (DN 50 to DN 750), if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

G. Vertical-Piping Clamps: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers, NPS 3/4 to NPS 20 (DN 20 to DN 500).
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers, NPS 3/4 to NPS 20 (DN 20 to DN 500), if longer ends are required for riser clamps.

H. 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 (150 mm) for heavy loads.
   2. Steel Clevises (MSS Type 14): For 120 to 450 deg F (49 to 232 deg C) 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 (49 to 232 deg C) piping installations.

I. 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 (340 kg).
      b. Medium (MSS Type 32): 1500 lb (680 kg).
      c. Heavy (MSS Type 33): 3000 lb (1360 kg).
   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.

J. 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.

K. 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 (32 mm).
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 absorb 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 absorb 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 absorb 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.

L. Comply with MSS SP-69 for trapeze pipe hanger selections and applications that are not specified in piping system Sections.

M. Comply with MFMA-102 for metal framing system selections and applications that are not specified in piping system Sections.

N. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

3.2 HANGER AND SUPPORT INSTALLATION

A. Steel Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from building structure.

B. Trapeze Pipe Hanger Installation: Comply with MSS SP-69 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping and support together on field-fabricated trapeze pipe hangers.
1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified above for individual pipe hangers.
2. Field fabricate from ASTM A 36/A 36M, steel shapes selected for loads being supported. Weld steel according to AWS D1.1.

C. Metal Framing System Installation: Arrange for grouping of parallel runs of piping and support together on field-assembled metal framing systems.

D. Thermal-Hanger Shield Installation: Install in pipe hanger or shield for insulated piping.

E. Fastener System Installation:
   1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches (100 mm) 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 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 (DN 65) 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 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 so maximum pipe deflections allowed by ASME B31.1 (for power piping) and ASME B31.9 (for building services piping) are not exceeded.

M. Insulated Piping: Comply with the following:
   1. Attach clamps and spacers to piping.
      a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
      b. 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 according to ASME B31.1 for power piping and 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 (DN 100) 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 (DN 100) 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 (DN 8 to DN 90): 12 inches (305 mm) long and 0.048 inch (1.22 mm) thick.
   b. NPS 4 (DN 100): 12 inches (305 mm) long and 0.06 inch (1.52 mm) thick.
   c. NPS 5 and NPS 6 (DN 125 and DN 150): 18 inches (457 mm) long and 0.06 inch (1.52 mm) thick.
   d. NPS 8 to NPS 14 (DN 200 to DN 350): 24 inches (610 mm) long and 0.075 inch (1.91 mm) thick.
   e. NPS 16 to NPS 24 (DN 400 to DN 600): 24 inches (610 mm) long and 0.105 inch (2.67 mm) thick.
5. Pipes NPS 8 (DN 200) and Larger: Include wood inserts.
6. Insert Material: Length at least as long as protective shield.
7. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.3 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 smooth bearing surface.

C. Provide lateral bracing, to prevent swaying, for equipment supports.

3.4 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 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 contours of welded surfaces match adjacent contours.

3.5 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 (40 mm).

3.6 PAINTING

A. Touch Up: Cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal are specified in Division 09 painting Sections.

B. Galvanized Surfaces: Clean welds, bolted connections, and abraded areas and apply galvanizing-repair paint to comply with ASTM A 780.

END OF SECTION

This page is intentionally left blank.

SECTION 23 05 33

HEAT TRACING FOR HVAC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes heat tracing with the following electric heating cables:
   1. Plastic insulated, series resistance.
   2. Self-regulating, parallel resistance.

1.3 SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for each type of product indicated.
   1. Schedule heating capacity, length of cable, spacing, and electrical power requirement for each electric heating cable required.

B. Shop Drawings: For electric heating cable. Include plans, sections, details, and attachments to other work.
   1. Wiring Diagrams: Power, signal, and control wiring.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For electric heating cables to include in operation and maintenance manuals.

E. Warranty: Special warranty specified in this Section.

1.4 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.

1.5 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace electric heating cable that fails in materials or workmanship within specified warranty period.
   1. Warranty Period: 15 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SELF-REGULATING, PARALLEL-RESISTANCE HEATING CABLES

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Raychem; a division of Tyco Thermal Controls.

C. Heating Element: Pair of parallel No. 16 AWG, nickel-coated stranded copper bus wires embedded in crosslinked conductive polymer core, which varies heat output in response to temperature along its length. Terminate with waterproof, factory-assembled nonheating leads with connectors at one end, and seal the opposite end watertight. Cable shall be capable of crossing over itself once without overheating.

D. Electrical Insulating Jacket: Flame-retardant polyolefin.

E. Cable Cover: Tinned-copper braid, and polyolefin outer jacket with UV inhibitor.

F. Maximum Operating Temperature (Power On): 150 deg F (65 deg C).

G. Maximum Exposure Temperature (Power Off): 150 deg F (65 deg C).

H. Maximum Operating Temperature: 300 deg F (150 deg C).

I. Capacities and Characteristics:
   1. Maximum Heat Output: 5 W/ft. (16.4 W/m).
   2. Piping Diameter: SEE PLANS.
   3. Number of Parallel Cables: 2.
   4. Volts: 120 V.
   5. Phase: 1.
   6. Hertz: 60.

2.2 CONTROLS

A. Remote bulb unit with adjustable temperature range from 30 to 50 deg F (minus 1 to plus 10 deg C).

B. Snap action; open-on-rise, single-pole switch with minimum current rating adequate for connected cable.

C. Remote bulb on capillary, resistance temperature device, or thermistor for directly sensing pipe-wall temperature.

D. Corrosion-resistant, waterproof control enclosure.

2.3 ACCESSORIES

A. Cable Installation Accessories: Fiberglass tape, heat-conductive putty, cable ties, silicone end seals and splice kits, and installation clips all furnished by manufacturer, or as recommended in writing by manufacturer.

B. Warning Labels: Refer to Division 23 Section "Identification for HVAC Piping and Equipment."

C. Warning Tape: Continuously printed "Electrical Tracing"; vinyl, at least 3 mils (0.08 mm) thick, and with pressure-sensitive, permanent, waterproof, self-adhesive back.
   1. Width for Markers on Pipes with OD, Including Insulation, Less Than 6 Inches (150 mm): 3/4 inch (19 mm) minimum.
   2. Width for Markers on Pipes with OD, Including Insulation, 6 Inches (150 mm) or Larger: 1-1/2 inches (38 mm) minimum.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces and substrates to receive electric heating cables for compliance with requirements for installation tolerances and other conditions affecting performance.
   1. Ensure surfaces and pipes in contact with electric heating cables are free of burrs and sharp protrusions.
   2. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install electric heating cable across expansion joints according to manufacturer's written recommendations using slack cable to allow movement without damage to cable.

B. Install electric heating cables after piping has been tested and before insulation is installed.

C. Install electric heating cables according to IEEE 515.1.

D. Install insulation over piping with electric cables according to Division 23 Section "HVAC Insulation."

E. Install warning tape on piping insulation where piping is equipped with electric heating cables.

F. Set field-adjustable switches and circuit-breaker trip ranges.

G. Protect installed heating cables, including nonheating leads, from damage.

3.3 CONNECTIONS

A. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Testing: Perform tests after cable installation but before application of coverings such as insulation, wall or ceiling construction, or concrete.
   1. Test cables for electrical continuity and insulation integrity before energizing.
   2. Test cables to verify rating and power input. Energize and measure voltage and current simultaneously.

B. Repeat tests for continuity, insulation resistance, and input power after applying thermal insulation on pipe-mounting cables.

C. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION

SECTION 23 05 48

MECHANICAL VIBRATION ISOLATION AND SEISMIC RESTRAINT SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. It is the objective of this Specification to provide the necessary design requirements for the control of excessive noise and vibration in the buildings due to the operation of machinery or equipment, and/or due to interconnected piping, ductwork or conduit. It is also the objective of this specification to provide the design criteria for seismic restraints for all isolated and non-isolated equipment.

B. Work in this section includes the providing of labor, materials, equipment and services necessary for a complete and safe installation in of vibration isolation systems and seismic restraints for every mechanical system including piping and ductwork within and on the roof of the building, complete, as shown and specified per the contract documents and all applicable codes and authorities having jurisdiction.

C. The work of this section includes, but is not limited to the following:
   1. Vibration isolation elements for piping and equipment.
   2. Equipment isolation bases.
   3. Piping flexible connections.
   4. Seismic restraints for isolated and non-isolated piping, tanks, stacks, ductwork, VAV boxes, and equipment.

D. Related Sections:
   1. All Division 23000 Sections as issued for this project.

E. Seismic restraints:
   1. All equipment, piping and ductwork shall be adequately restrained to resist seismic forces. This specification is in addition to the specified vibration isolation for this project. Restraint devices shall be designed and selected to meet seismic requirements as defined in the latest issue of the state and local codes and other authorities having jurisdiction.
   2. Anchor bolt calculations, signed and stamped by a registered Professional Engineer, shall be submitted showing adequacy of the bolt sizing and type. Calculations shall include anchor embedment, minimum edge distance and minimum center distance. The design lateral forces shall be distributed in proportion to the mass distribution of the equipment. Calculations shall be furnished for anchors on restraint devices, cables, isolators and on rigid mounted equipment. The seismic designer must perform final jobsite inspection to verify anchor installation.

3. Contractor shall supply all supplemental steel required for all equipment, ductwork and piping including roof mounted equipment.
4. All isolators and equipment shall meet OSHPD requirements and contain approval from OSHPD.

F. This specification shall be supplemented by all local codes and ordinance which shall take precedence in the event of the existence of any conflict between same and this specification. Where methods or materials specified are equivalent to the code requirements specified, comply with the specified requirements.

G. Seismic-Restraint Loading:
1. Site Class as Defined in the IBC: D
2. Assigned Seismic Use Group or Building Design Category as Defined in the IBC: C
   a. Component Importance Factor: 1.50
   b. Component Response Modification Factor: 6.0
   c. Component Amplification Factor: 2.5
3. Design Spectral Response Acceleration at Short Periods (0.123 Second): 0.327
4. Design Spectral Response Acceleration at 1-Second Period: 0.077

1.3 SUBMITTALS

A. In addition to the requirements of the section on Mechanical General Provisions, the submittal material shall include descriptive data for all products and materials including, but not limited to, the following:
1. Descriptive Data:
   a. Catalog cuts and data sheets on specific vibration isolators and seismic restraints to be utilized showing compliance with the specifications.
   b. An itemized list showing the items of equipment or piping to be isolated, the isolator type and model number selected, isolator loading and deflection, and reference to specific drawings showing seismic restraints, base and construction where applicable.
   c. An itemized list of non-isolated equipment, piping, and ductwork to be seismically restrained.
   d. Seismic restraint calculations.
   e. 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 has been examined for excessive stress and that none will exist.
   f. Structural or civil engineer's stamp verifying design and calculations for seismic restraining systems used.
2. Shop Drawings:
   a. Drawings showing equipment base constructions for each machine, including dimensions, structural member sizes and support point locations.
   b. Drawings showing methods of suspension, support guides for piping and ductwork.
   c. Drawings showing methods for isolation of pipes and ductwork piercing walls and slabs.
   d. Concrete and steel details for bases, including anchor bolt locations.
   e. Number and location of seismic restraints and anchors for each piece of equipment and of ductwork and piping.

f. Specific details of restraints, including anchor bolts for mounting and maximum loading at each location for each piece of equipment and lengths of ductwork and piping.

1.4 CODE AND REFERENCE STANDARD REQUIREMENTS

A. All equipment supplied under this specification shall conform in all respects to the rules and regulations of:
   1. SMACNA "Guidelines for Seismic Restraints of Mechanical Systems and Plumbing Piping Systems." 1982
   2. 2003 ASHRAE GUIDE, Chapter 47, and Chapter 54
   3. All applicable state and local codes and authorities having jurisdiction.
   4. American Society for Testing and Materials:
      a. ASTM A 36/a 36M-96: Specification for Carbon Structural Steel.
      b. ASTM E 488-96: Test Methods for Strength of Anchors in Concrete and Masonry Elements.
   5. American Welding Society:
      a. ASW D1.1-98: Structural Welding Code – Steel.

1.5 QUALITY ASSURANCE

A. All vibration isolation and seismic restraint devices shall be the product of a single manufacturer. Products of other manufacturer's are acceptable provided that their systems comply with the design intent for system performance, static deflection and structural design of the base manufacturer.

B. Vibration isolation firms having a minimum ten years experience designing and supervising the installation of vibration isolation and seismic restraint systems shall be qualified to provide the materials and installation required by this section. Project listings shall be provided including geographical location and a reference contact.

C. The installation of all vibration isolation units, and associated seismic restraints, hangers and bases, shall be under the direct supervision of the vibration isolation manufacturer's representative.The isolation manufacturer is to send a letter stating that they have inspected all of the vibration isolation units installed and they are installed properly and operating.

D. Substitution of internally isolated mechanical equipment in lieu of the specified isolation of this Section must be approved for individual equipment units and is acceptable only if above acceleration loads are certified in writing by the equipment manufacturer and stamped and sealed by a licensed civil or structural engineer.

E. Purchased and/or fabricated equipment must be designed to safely accept external forces of 1.0 g load in any direction for all rigidly and resiliently supported equipment, piping and ductwork without failure and permanent displacement of the equipment. Life safety equipment such as fire pumps, smoke exhaust fans, emergency generators and other life safety designated equipment must be capable of accepting external forces of up to 1.5 g in any direction without permanent displacement or failure of the equipment.

F. Standards: If any item in this specification as furnished by the contractor is manufactured in a location which does not certify the referenced standards as defined in paragraph 1.4 of this specification, the contractor is to pay the owner for

all expenses incurred by the owner for an outside testing company top confirm such compliances.

G. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code--Steel."

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver each item as a factory-assembled unit with protective crating and covering.

B. Store in a dry location.

C. Provide disassembly and re-assembly as required to accommodate rigging and shipping.

D. Comply with the manufacturer's written rigging and installation instructions for unloading, transporting and setting in final location.

E. All equipment with shaft bearings (pump, fans, etc..) must have the shaft rotated every 2 weeks and the equipment must be stored inside.

1.7 SUBSTITUTIONS

A. Any proposed substitution must be submitted at the time the bid is submitted. No substitute material or manufacturer of equipment shall be permitted without a formal written submittal to the engineer which includes all dimensional, performance and material specifications and is approved in writing by the engineer. Any changes in layout or design brought about by the use of a substitution shall be submitted to the engineer fully designed for review in conjunction with the submittal of the alternate. Any substitutions must be submitted with an explanation why a substitution is being proposed. If the substitute is being proposed for financial reasons the associated credit must be simultaneously submitted.

B. Final acceptance or rejection of any substitution is subject to the Owner’s review.

1.8 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into base. Coordinate with the architect and structural engineer for concrete, reinforcement, and formwork requirements.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 7 Section "Roof Accessories."

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. The following are approved manufacturers, provided their systems strictly comply with the design intent for performance, deflection and structural capacity of this specification.
   1. Mason Industries, Inc., Hauppauge, NY
   2. Vibration Mountings & Controls, Inc., Bloomingdale, NJ
   3. Kinetics Noise Control, Dublin, OH

4. Vibration Eliminator Co., Inc., Capiague, NY
5. Amber Booth, Houston, TX

2.2 DESCRIPTION

A. All vibration isolators shall have either known undeflected heights or calibration markings so that, after adjustment, when carrying their load, the deflection under load can be verified, thus determining that the load is within the proper range of the device and that the correct degree of vibration isolation is being provided according to the design.

B. All isolators shall operate in the linear portion of their load versus deflection curve. Load versus deflection curves shall be furnished by the manufacturer, and must be linear over a deflection range of not less than 50% above the design deflection.

C. Where spring isolation systems are described in the following specifications, the mounting assemblies shall utilize bare springs with the spring diameter not less than 0.8 of the loaded operating height of the spring. Each spring isolator shall be designed and installed so that the ends of the springs remain parallel. The minimum deflection from loaded operating height to spring solid height shall be 50% of the rated static deflection of the spring.

D. Where neoprene-in-shear isolation systems are described in the following specifications, the mounting assemblies shall utilize bare neoprene elements with unit type design molded in oil resistant neoprene. The neoprene shall be compounded to meet the following:
   1. Shore hardness of 35 to 65 $\pm$5, after minimum aging of 20 days or corresponding oven-aging.
   2. Minimum tensile strength of 2000 PSI.
   3. Minimum elongation of 300 %.
   4. Maximum compression at 25 % of original deflection.

E. The isolator ratio of lateral to vertical stiffness shall not be less than 0.9 nor more than 1.5.

F. The theoretical vertical natural frequency for each support point, based upon load per isolator and isolator stiffness, shall not differ from the design objectives for the equipment as a whole by more than $\pm$10%.

G. All mounting systems, including seismic restraints, exposed to weather and other corrosive environments shall be protected with factory corrosion resistance. All metal parts of mountings (except springs and hardware) to be hot dip galvanized. Springs shall be powder coated and neoprene coated. Nuts and bolts shall be cadmium plated.

H. All roof-mounted isolators shall be bolted or welded to building steel and anchored to the structure to resist 110 mph wind loads.

2.3 MANUFACTURER RESPONSIBILITIES

A. Manufacturer of vibration isolation and seismic restraint equipment shall have the following responsibilities:
   1. Determine vibration isolation and seismic restraint sizes and locations.
   2. Provide piping and equipment isolation systems and seismic restraints as scheduled or specified.

3. Guarantee specified isolation system deflection.
4. Provide installation instructions, drawings and field supervision to assure proper installation and performance.

2.4 VIBRATION ISOLATORS

A. Type A: Bare spring isolators shall incorporate the following:
1. Minimum 1/4" (6 mm) thick neoprene acoustical base pad on underside, unless designated otherwise.
2. Non-resonant with equipment forcing frequencies or support structure natural frequencies.
3. Requires seismic restraint type II
4. Spring isolators to be Mason Type SLF, or as approved.

B. Type B: Spring isolators shall be same as Type A, except:
1. Provide built-in vertical limit stops with minimum 1/4" clearance under normal operation.
2. Tapped holes in top plate for bolting to equipment. All hot dipped galvanized for outdoor installation such as at the air cooled chiller and centrifugal exhaust fans.
3. Capable of supporting equipment at a fixed elevation during equipment erection. Installed and operating heights shall be identical.
4. Shall incorporate snubbing restraint in all directions. Cast or aluminum housings are unacceptable. System to be field bolted or welded to deck with ability to resist forces of 1.5 g acceleration.
5. Mason Type SLR, or as approved.

C. Type C: Spring hanger rod isolators shall incorporate the following:
1. Spring element seated on a steel washer within a neoprene cup incorporating a rod isolation bushing.
2. Steel retainer box encasing the spring and neoprene cup.
3. Provide sufficient clearance between retainer box and spring hanger rod to permit minimum 15 degree allowable rod misalignment in any direction, total 30 degrees.
4. Requires seismic restraint type III
5. Mason Type TPC-30N, or as approved.
6. Where operating weight differs from installed weight, provide built-in adjustable limit stops to prevent equipment rising when weight is removed. Stops shall not be in contact during normal operation.

D. Type D: Elastomer Mounting Types/Elastomer Isolators, shall incorporate the following:
1. Bolt holes for bolting to equipment base.
2. Bottom steel plates for bolting or welding to sub-base as required.
3. Unit type design molded in oil-resistant neoprene.
4. Encased in ductile steel or iron casing and capable of withstanding external forces of up to 1.5 g. System to be field bolted or welded to deck with ability to resist forces of 1.5 g.
5. Mason Type ND isolation BR, RBA or as approved.

E. Type E: Elastomer hanger rod isolators shall incorporate the following:
1. Molded unit type neoprene element with projecting bushing lining rod clearance hole.
2. Neoprene element to be minimum 1 3/4" thick.

3. Steel retainer box encasing neoprene mounting.
4. Clearance between mounting hanger rod and neoprene bushing shall be minimum 1/8".
5. Requires seismic restraint type III.
6. Mason Type HD, or as approved.

F. Type F: Combination spring/elastomer hanger rod isolators to incorporate the following:
1. Spring and neoprene isolator elements in a steel box retainer.
2. Other characteristics of steel box retainer and hanger rod swing as described for Type C isolators.
3. Requires seismic restraint type III
4. Mason Type TPC-30N, or as approved.

G. Type G: Pad type elastomer mountings to incorporate the following:
1. 0.750" minimum thickness.
2. 50 psi maximum loading.
3. Ribbed or waffled design.
4. 0.10" deflection per pad thickness.
5. 1/16" galvanized steel plate between multiple layers of pad thickness.
6. Suitable bearing plate to distribute load.
7. Requires seismic restraint type II or III as installation requires.
8. Mason Type Super W, or as approved.

H. Type H: Pad type elastomer mountings to incorporate the following:
1. Laminated canvas duck and neoprene.
2. Maximum loading 1000 psi.
3. Suitable bearing plate to distribute load.
4. Minimum thickness, 2".
5. Requires seismic restraint type II or III as installation requires.
6. Mason Type HL, or as approved.

2.5 EQUIPMENT BASES

A. Integral Structural Steel Base, Type B-1
1. Reinforced, as required, to prevent base flexure at start-up and misalignment of drive and driven units. Centrifugal fan bases complete with motor slide base with double adjustment bolts.. Drilled for drive and driven unit mounting template.
2. Mason Type M, WF, or as approved.

B. Concrete Inertia Base, Type B-2
1. Concrete inertia bases shall be formed in a structural steel perimeter base, reinforced as required to prevent flexure, misalignment of drive and driven unit or stress transfer into equipment. The base shall be complete with motor slide base with double adjustment bolts , pump base elbow supports, and complete with height saving brackets, reinforcing, equipment bolting provisions and isolators.
2. Minimum thickness of the inertia base shall be according to the following tabulation:

Motor Size		Minimum Thickness	
(hp)	(kw)	(in.)	(mm)

5-15	(4-11)	6	(150)
20-50	(15-37)	8	(200)
60-75	(45-55)	10	(250)
100-250	(75-190)	12	(300)
300-500	(220-375)	18	(350)

3. Mason Type K, BMK, or as approved.

C. Curb Mounted Base, Type B-3
1. Rooftop equipment, such as the air cooled chiller, shall be mounted on steel dunnage that is part of the structure and roof construction and are flashed and incorporated into roof's membrane waterproofing system.
2. All spring isolators shall have Type G continuous Super W elastomer mounting pads between the equipment and the isolator plate and bolted through.
3. Curb and equipment shall be capable of withstanding 110mph wind and 1.5 g seismic loads.

D. Type B-4 (Flashable Roof Rail System)
1. Rooftop fans, condensing units, air handlers, etc. shall be mounted on continuous support piers that combines equipment support and isolation into (1) assembly.
2. Rails shall incorporate Type A isolators which are adjustable, removable and interchangeable after equipment has been installed.
3. The system shall maintain the same installed and operating height with or without the equipment load.
4. The system shall have full plywood nailers on all (4) sides, designed to accept membrane waterproofing and shall be dry galvanized or plastic coated.
5. Unit to be supplied with flashing.
6. Roof rail shall be similar to Mason Industries Type R-7000 having a minimum 3” rated static deflection.

E. Type B-6 (Non-Isolated Roof Curb)
1. Non-isolated, curb mounted rooftop equipment shall be mounted on structural curbs that meet the acceleration criteria hereinbefore defined.
2. Curbs shall accept standard 2” roof insulation furnished and installed by the roofing contractor.
3. Non-isolated curbs shall be similar to Mason Industries Type B-6000.

2.6 FLEXIBLE CONNECTORS

A. Elastomer Type FC-1
1. Manufactured of nylon tire cord and EPDM, both molded and cured with hydraulic presses.
2. Straight connectors to have two spheres reinforced with a molded-in external ductile iron ring between spheres.
3. Elbow shall be long radius reducing type.
4. Rated 250 psi. at 170°F. Dropping in a straight line to 170 psi. at 250°F for sizes 1-1/2" to 12", elbows. Elbows shall be rated no less than 90% of straight connections.
5. Sizes 10" and 12" to employ control cables with neoprene end fittings isolated from anchor plates by means of 2" bridge bearing neoprene bushings.
6. Minimum safety factor of 4 to 1 at maximum pressure ratings.
7. Submittals to include test reports, projected life, replacement interval, compression and elongation limits.

8. Mason Types SuperFlex MFNEC, MFLRR, MFTFU, MFTNC, MFTCR, or as approved.

B. Flexible Stainless Hose, Type FC-2
1. Braided flexible metal hose.
2. 2" pipe size and smaller with male nipple fittings.
3. 2-1/2" and larger pipe size with fixed steel flanges.
4. Suitable for operating pressure with 4 to 1 minimum safety factor.
5. Length as shown on drawings.
6. Mason Type BSS, or as approved.

C. Unbraided Exhaust Hose, Type FC-3
1. Low pressure stainless steel angularly corrugated.
2. Fitted with flanged ends.
3. Maximum temperature 1500°F.
4. Mason Type SDL-RF, or as approved.

2.7 SEISMIC RESTRAINTS

A. All seismic restraints for mechanical equipment shall be capable of safely accepting 1.0 g (1.5 g for designated life safety equipment) external forces without failure, and shall maintain equipment, piping, duct and pressure reducing boxes in a captive position. Seismic restraints shall not short circuit isolation systems or transmit objectionable vibration or noise, and shall be Provided on all equipment as scheduled on drawings.

B. Submit calculations by a licensed Structural or Civil Engineer substantiating that all equipment mountings and foundations and their seismic restraints can safely accept external forces of 1.0 g load for all rigidly and resiliently supported equipment, piping, and ductwork (1.5 g load for all life safety equipment) without failure and permanent displacement. Restrain all resiliently mounted piping and ductwork with cable sway bracing by Mason Industries, or approved equal.

C. Seismic Restraint Types
1. Seismic Restraint, Type I
   a. Shall comply with general characteristics of spring isolators.
   b. Shall have vertical restraints and are capable of supporting equipment at fixed elevation during equipment erection.
   c. Shall incorporate seismic snubbing restraint in all directions at specified acceleration loadings.
   d. System to be field bolted to structure with minimum capability to withstand external forces of 1.5 g.
   e. Mason Type SSLR, or as approved.
2. Seismic Restraint, Type II
   a. Each corner or side seismic restraint shall incorporate minimum 5/8" thick pad limit stops. Restraints shall be made of plate, structural members or square metal tubing in a welded assembly, incorporating resilient pads. Angle bumpers are not acceptable. System to be field bolted to deck with 1.5 g acceleration capacity.
   b. Seismic spring mountings as described above are an acceptable alternative providing all seismic loading requirements are met.
   c. Mason Industries Type Z-1011, Type Z-1225, or as approved.
3. Seismic Restraint, Type III

a. Galvanized steel aircraft cables with end connections made of steel assemblies that swivel to final installation angle and utilize two clamping bolts for cable fastening to equipment and structure. System to be field bolted to deck or overhead structural members or deck with aircraft cable and clamps as per SMACNA guidelines.

PART 3 - EXECUTION

3.1 GENERAL VIBRATION ISOLATION REQUIREMENTS

A. Install in accordance with manufacturer's written instructions. Vibration isolators must not cause any change of position of equipment or piping resulting in piping stresses or misalignment.

B. Mechanical equipment shall be isolated from the building structure by means of noise and vibration isolators as scheduled on the drawings or within these specifications.

C. No rigid connections between equipment and building structure shall be made that degrades the noise and vibration isolation systems herein specified.

D. Electrical circuit connections to isolated equipment shall be looped to allow free motion of isolated equipment.

E. The contractor shall not install any equipment, piping or conduit which makes rigid contact with the "building" unless permitted in this Specification. Building includes, but is not limited to, slabs, beams, columns, studs and walls.

F. Isolation mounting deflection shall be (minimum) as specified or scheduled on drawings.

G. Coordinate work with other trades to avoid rigid contact with the building. Inform other trades following work, such as plastering or electrical, to avoid any contact which would reduce the vibration isolation.

H. Bring to the Architect's attention, prior to installation, any conflicts with other trades which will result in unavoidable rigid contact with equipment or piping as described herein, due to inadequate space or other unforeseen conditions. Corrective work necessitated by conflicts after installation shall be at the responsible contractor's expense.

I. Bring to the Architect's attention any discrepancies between the specifications and field conditions or changes required due to specific equipment selection, prior to installation. Corrective work necessitated by discrepancies after installation shall be at the contractor's expense.

J. Obtain inspection and approval of any installation to be covered or enclosed, prior to such closure.

K. Correct, at no additional cost, all installations which are deemed defective in workmanship or materials.

3.2 EQUIPMENT ISOLATION

A. Mount floor mounted equipment on 4" high concrete housekeeping pads over complete floor area of equipment. Mount vibration isolating devices and related inertia blocks on concrete pad. Key housekeeping pads with hair pins, as required,

to be integral with structural slab. Provide approved seismic restraint anchor plates flush with top of housekeeping pad. Concrete work specified in Division 3.

3.3 EQUIPMENT BASES

A. Fill concrete inertia bases, after installing base frame, with concrete; trowel to a smooth finish.

B. Concrete Bases: Anchor equipment to concrete base according to supported equipment manufacturer's written instructions for seismic codes at Project site.
   1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch(450-mm) centers around the full perimeter of the base.
   2. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base and anchor into structural concrete floor.
   3. Place and secure anchorage devices. Use Setting Drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   4. Install anchor bolts to elevations required for proper attachment to supported equipment.
   5. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
   6. Cast-in-place concrete materials and placement requirements are specified in Division 3.

C. Each fan and motor assembly shall be supported on a single structural steel frame. Flexible duct connections shall be provided at inlet and discharge of fan.

D. The machine to be isolated shall be supported by a structural steel frame or concrete inertia base.

E. Brackets shall be provided to accommodate the isolator. The vertical position and size of the bracket shall be specified by the isolator manufacturer.

F. The minimum operating clearance between the equipment frame or rigid steel base frame and the housekeeping pad or floor shall be 1". Minimum operating clearance between concrete inertia and base and housekeeping pad or floor shall be 2".

G. The equipment structural steel or concrete inertia base shall be placed in position and supported temporarily by blocks or shims, as appropriate, prior to the installation of the machine or isolators.

H. The isolators shall be installed without raising the machine and frame assembly.

I. After the entire installation is complete and under full operational load, the isolators shall be adjusted so that the load is transferred from the blocks to the isolators. When all isolators are properly adjusted, the blocks or shims shall be barely free and shall be removed.

J. Prior to start-up, clean out all foreign matter between bases and equipment. Verify that there are no isolation short circuits in the base, isolators or seismic restraints.

K. Verify that all installed isolator and mounting systems permit equipment motion in all directions. Adjust or provide additional resilient restraints to flexibly limit start-up equipment lateral motion to 1/4".

L. Provide flexible connections between all fans and ductwork. Refer to duct accessories section.

M. When operating weight differs from installed weight, provide built-in limit stops to prevent equipment from rising when weight is removed. Stops shall not be in contact during normal operation.

N. Additional Requirements
1. Diagonal thrust restraint shall be as described for Type C hanger with the same deflection as specified for the spring mountings. The spring element shall be designed so it can be pre-set for thrust and adjusted to allow for a maximum of 1/4" movement at start and stop. Thrust restraints shall be attached at the centerline of thrust. Restraint shall be Mason Type WB, or as approved.
2. All piping and ductwork to be isolated shall freely pass through walls and floors without rigid connections. Penetration points shall be sleeved or otherwise formed to allow passage of piping or ductwork, and maintain 3/4" to 1 1/4" clearance around the outside surfaces. This clearance space shall be tightly packed with fiberglass (except in cases of fire smoke dampers in ducts), and caulked airtight after installation of piping or ductwork.
3. HVAC piping vertical risers larger than 2" in diameter shall be isolated from the building structure by means of noise and vibration isolation guides and supports.
4. Isolators shall be installed with the isolator hanger box attached to, or hung as close as possible to, the structure. Hanger rods shall be aligned to clear the hanger box.
5. Isolators shall be suspended from substantial structural members, not from slab diaphragm unless specifically permitted.
6. Structural steel for cooling tower or other equipment must support the equipment without excessive deflection of the steel. The structural steel support shall not be resonant with the isolation system resonant frequencies or the driving frequencies of the supported equipment.

3.4 PIPING AND BOILER BREECHING ISOLATORS

A. All piping and boiler breeching, except fire standpipe systems, are included under this Section.

B. Installation:
1. Isolate piping, generator stacks/breeching, muffler, domestic hot water breeching and boiler breeching outside of shafts as follows:
   a. All water, steam and glycol piping and breeching in the boiler room and machine rooms.
   b. Piping where exposed on roof.
   c. Water piping, stacks, all mufflers and all boiler breeching within 50 ft, or 100 diameters, which ever is greater, from connected equipment.
   d. All other piping shall be rigidly supported and provided with approved seismic restraints to maintain the piping in a captive position without excessive motion.
   e. Do not use neoprene components on emergency generator exhaust.
   f. All emergency generator fuel oil piping and pumps.
2. All piping 2" and over located in mechanical equipment rooms, and for a minimum of fifty (50) feet or 100 pipe diameters, whichever is greater, from connection to vibrating mechanical or electrical equipment, shall be isolated from the building structure by means of noise and vibration isolation hangers, Type F.

3. Horizontal suspended pipe 2" and smaller and all steam piping shall be suspended by Type E isolator with a minimum 3/8" deflection. Water pipe larger than 2" shall be supported by Type F isolator with a minimum 1", or same static deflection as isolated equipment to which pipe connects, whichever is greater.
4. Horizontal pipe floor supported at slab shall be supported via Type B, with a minimum static deflection of 1" or same deflection as isolated equipment to which pipe connects, whichever is the greater.
5. Vertical riser pipe supports shall utilize Type H.
6. Vertical riser guides, if required, shall avoid direct contact of piping with building.
7. Pipe anchors, where required, shall utilize resilient pipe anchors, Mason Industries Type ADA, or equivalent, to avoid direct contact of piping with building.
8. Pipe sway braces, where required, shall utilize two (2) neoprene elements (Type G or H to accommodate tension and compression forces).
9. Pipe extension and alignment connectors: Provide connectors at riser takeoffs, cooling and heating coils, and elsewhere as required, to accommodate thermal expansion and misalignment.
10. Adjust, as required, all isolators to eliminate all contact of the isolated rod with the hanger rod box retainer or short circuiting of the spring.

C. Domestic Water System Isolation :
1. Support all domestic water piping in horizontal and vertical runs with a resilient wrapping or clamp system employing a resilient element of wool, felt, neoprene, or other suitable material; "Trisolators" by Semco or P.R. Isolators by Potter-Roemer, or as approved.
2. All domestic water piping, size 2" and larger within the building shall be isolated as follows:
   a. Provide Type F hanger rod isolators with a minimum static deflection of 1" (25 mm) or as scheduled.
   b. Provide Type B isolators with 1" static deflection, or as scheduled.
   c. Support water piping in shafts and floor supports` entering shaft with Type G isolators or Type H pad to prevent direct contact of piping with building structure.
   d. Guide and anchor piping in shafts, as required, with approved mounting designs incorporating Type H pad to prevent direct contact of pipe with building structure.

D. Isolator Position:
1. Close to building structure.
2. Between building structure and supplementary steel if required.
3. Suspend isolators from rigid and massive support points.
4. All supplementary steel to be sized for a maximum deflection of 0.08 inches (2 mm) at center span.

3.5 GENERAL SEISMIC RESTRAINT REQUIREMENT

A. All equipment whether isolated or not shall be bolted to structure to allow for minimum 1.0 g of acceleration (1.5 g for life safety equipment). Bolt points and diameter of inserts shall be submitted and verified as part of the contractor's submission for each piece of equipment and stamped and sealed by a civil or structural engineer.

B. Position all corner or side seismic restraints with equipment at operating weight for proper operation clearance and weld or bolt seismic restraint to seismic anchor plates in housekeeping pad. Install equipment with flexibility in wiring connection. Verify all installed isolators and mounting systems permit equipment motion in all directions. Adjust or provide additional resilient restraints to flexibly limit startup equipment lateral motion to 1/4 inch. Prior to startup, clean out all foreign matter between bases and equipment. Verify that there are no isolation short circuits in the base, isolators or seismic restraints.

C. All suspended equipment, whether isolated or not, shall be seismically restrained at four points with Type III cable restraints.

D. Install seismic restraining system Type III taut for overhead suspended unisolated equipment, piping or ductwork, and slack with 2" cable deflection for isolated systems.

E. Seismically restrain all piping and ductwork with center bracing or Type III restraining system in accordance with SMACNA guidelines to comply as outlined below:
   1. All schedule 10, 20, or 40 piping shall be welded or laterally braced at 40 foot intervals and at turns of more than 4 feet. Longitudinally bracing shall be supplied at 80 foot intervals. No-hub piping shall be braced at 10 foot intervals or at 40 foot intervals if 1.5 g rated couplings are used.
   2. Ductwork to be braced every 30 feet and at every turn and duct run ends. Longitudinal bracing to be provided at 60 foot intervals.

F. Seismic restraints are not required for the following:
   1. Gas piping less than 1" internal diameter.
   2. Piping in boiler and MER room that is less than 1 1/4" internal diameter. Less than 1 inch for fuel oil piping.
   3. All other piping and electrical conduit less than 2" internal diameter.
   4. All rectangular ducts less than 6 sq. ft. (0.56 m^2) in cross sectional area.
   5. All round ducts less than 28" in diameter.
   6. All piping suspended by individual hangers 12" in length or less from the top of the pipe to the bottom of the support for the hanger.
   7. All ducts suspended by hangers 12" (305 mm) or less in length from the point of the attachment to the duct to the bottom of the support for the hanger.

G. Chimneys, breeching and stacks passing through floors are to be bolted at each floor level or secured above and below each floor with riser clamps or approved vibration isolation systems with seismic restraints.

H. Chimneys and stacks running horizontally to be braced every 30 ft with Type III restraining system.

I. Where base anchoring is insufficient to resist seismic forces, supplementary restraining such as seismic restraint system Type III shall be used above system's center of gravity to suitably resist "g" force levels. Vertically mounted tanks may require this additional restraint.

J. For overhead supported equipment, overstress of the building structure must not occur. Bracing may occur from:
   1. upper flanges of structural beams;
   2. upper truss chords in bar joist construction at the panel points;
   3. cast-in-place inserts or drilled and shielded inserts in concrete structures suitably located away from edges.

K. Each seismic restraint and snubbing device shall be installed after equipment is installed and fully operational. Each isolation mounting incorporating seismic restraint shall be adjusted to provide the minimum operating clearance in all directions to permit the operation of the equipment without objectionable noise or vibration to any part of the building structure. The operating clearance for equipment seismic restraints shall not be greater than 1/4" (6 mm). Seismic restraints must not result in short-circuiting of isolated equipment.

L. Pipe risers through cored holes in structure require no additional seismic bracing. (Cored hole diameter to be a maximum of 2 inches larger than pipe outer diameter).

3.6 INSPECTION

A. On completion of installation of all vibration isolation and seismic restraint devices herein specified, the local representative of the isolation materials manufacturer shall inspect the completed system and report in writing any installation errors, improperly selected isolation or restraint devices, or other faults that could affect the performance of the system. Contractor shall submit a report to the Architect, including the manufacturer's representatives final report, indicating all isolation reported as properly installed or requiring correction, and include a report by the Contractor on steps taken to properly complete the isolation work.

3.7 VIBRATION TESTING

A. Owner reserves the right to require vibration testing for all new rotating pieces of equipment installed under this contract including pumps and fans. Vibration testing will be performed after the equipment is installed, aligned, dynamically balanced and commissioned. The mechanical contractor shall correct any deficiencies found with the new equipment as identified in the vibration analysis report. The vibration testing shall be as follows:

1. Equipment Vibration testing shall be performed by a certified vibration consultant. A report shall be provided indicating all of the pieces of equipment tested, the results of the tests and any deficiencies found.
2. Vibration allowances shall be as per the latest ASHRAE standard for rotating equipment (ASHRAE 2000 Systems and Equipment), as defined here:
3. Vibration shall not exceed 0.20 inches per second (0.20 in/sec), peak value throughout the operating range of the piece of rotating equipment. (If connected to a VFD.)
4. Measurements for all equipment, at each point shall be taken at each axis (3 axis) throughout the entire operating range of the equipment. (If connected to a VFD.)
5. The test for equipment connected and driven by a Variable Frequency Drive shall include natural (critical) speed testing. Measurements shall be taken throughout the operating range of the equipment starting from a complete stop, ramping slowly up to maximum speed, and pausing briefly at the natural frequencies of the equipment/VFD (15, 30, 45 and 60 Hz) during the test.
6. Tests for any piece of equipment not driven by a VFD shall be at their normal operating speed, under normal operating conditions.

3.8 CLEANING

A. After completing equipment installation, inspect vibration isolation and seismic-control devices. Remove paint splatters and other spots, dirt, and debris.

3.9 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain air-mounting systems. Refer to Division 23 Section HVAC General Provisions or to Division 1 Section "Closeout Procedures and Demonstration and Training."

3.10 VIBRATION ISOLATION SCHEDULE

Equipment Type	Horsepower and Other	RPM	Base Type	Isolator Type	Min. Defl., in.
Chillers			–	B	
Rotary, screw	All	All	–	B	1.50
Air Compressors and vacuum pumping					
Tank-mounted horizontal	Up to 10	All	–	A or C	1.50
	15 & up	All	B-2	A or C	1.50
Tank-mounted vertical	All	All	B-2	A or C	1.50
Base-mounted	All	All	B-2	A or C	1.50
Large reciprocating	All	All	B-2	A or C	1.50
Pumps					
Close-coupled	Up to 7.5	All	B-2	A or C	.75
	10 & up	All	B-2	A or C	1.50
Large in-line	5 to 25	All	–	A or C	1.50
	30 & up	All	–	A or C	1.50
End suction and split case	Up to 40	All	B-2	A or C	1.50
	50 to 125	All	B-2	A or C	1.50
	150 & up	All	B-2	A or C	2.50
Boilers	All	All	B-1	B	1.50
Fans and Fan Sections					
Up to 22 in. diameter	All	All	-	A or C	.75
24 in. diameter	Up to 2 in. s.p.	Up to 300	B-2	A or C	3.50
		300 to 500	C	A or C	2.50
		501 & up	B	A or C	1.50
	2.1 in s.p and up	Up to 300	B-2	A or C	3.50
		300 to 500	C	A or C	2.50
		501 & up	B	A or C	1.50
Centrifugal Fans					
Up to 22 in. diameter	All	All	B-1	A or C	.75
24 in. diameter and	Up to 40	Up to	B-1	A or C	3.50

up			300			
			300 to 500	B-1	A or C	2.50
			501 & up	B-1	A or C	1.5
		50 and up	Up to 300	B-2	A or C	3.50
			300 to 500	B-2	A or C	2.50
Propeller Fans			501 & up	B-2	A or C	1.50
Wall-mounted		All	All	–	G	0.25
Air Cooled Chillers	On Roof	All	All	–	A	1.50
Packaged AHU						
All		Up to 10	All	–	A	1.0
		15 and up to 4 in. s.p.	Up to 300	–	A	3.50
			301 to 500	–	A	2.50
			501 & up	–	A	1.50
		15 and up, 4 in. s.p. & up	Up to 300	B-2	A	3.50
			301 to 500	B-2	A	2.50
			501 & up	B-2	A	1.50
Packaged Rooftop Equipment		All	All	B-3	G	2.50
Ducted Rotating Equipment						
Small fans, fan-powered boxes		Up to 600 cfm	All	–	A	0.50
		601 cfm & up	All	–	A	

Curb-Mounted Equipment	All	All	B-6	–	–
Engine-Driven Generators & Muffler	All	All	–	A	2.50

1. Pumps mounted at grade do not require inertia bases. Provide Type A isolators.

END OF SECTION

SECTION 23 05 49

NOISE CONTROL AND ACOUSTICAL PERFORMANCE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and General Provisions for Heating, Ventilating and Air Conditioning Work, including General and Supplementary Conditions and Division 1 Specification Sections apply to this Section.

1.2 SUMMARY

A. It is the objective of this Specification to provide the necessary design requirements for the noise control measures and acoustical performance criteria for mechanical systems.

Work in this section includes the providing of labor, materials, equipment and services necessary for a complete installation of sound control for every mechanical system including piping and ductwork within and on the roof of the building, complete, as shown and specified per the contract documents and all applicable codes and authorities having jurisdiction for the following:

1. Sound attenuating units
2. Sound linings
3. Sound Packing
4. Special cleaning and packaging for all operating rooms and pharmacy attenuating units.

B. Related section include the following:

1. Mechanical Vibration Isolation and Seismic Control, Section 230548.

1.3 SUBMITTAL DATA REQUIREMENTS

A. Submit data for each product indicated.

B. Sound Traps and Silencers:

1. Including certified test data of sound attenuation and self-generated flow noise.

C. Sound Linings:

1. Certification that sound lining meets erosion test method described in UL Publication No. 181.
2. Certification that sound lining meets ASTM standards C1071, G21 and G22.

D. Include product description, list of materials for each service, and locations.

E. Submit manufacturer's installation instructions.

1.4 CODE AND REFERENCE STANDARDS

A. Published Specifications' standards, tests or recommended methods of trade, industry or governmental organizations that apply to work in this Section.

B. Comply with all applicable national, state and local codes. Refer to General Provisions Section for additional reference standards.

C. ANSI/ASTM C553 - Mineral Fiber Blanket And Felt Insulation.

D. ANSI/ASTM C612 - Mineral Fiber Block And Board Thermal Insulation.

E. ASTM E84 - Surface Burning Characteristics Of Building Materials.

F. NFPA 255 - Surface Burning Characteristics Of Building Materials.

G. UL 723 - Surface Burning Characteristics Of Building Materials.

H. UL 181 - Factory-Made Air Ducts And Air Connectors

I. ASTM C1071-00 - Standard Specification For Fibrous Glass Duct Lining Insulation

J. ASTM C423-02 - Standard Test Method For Sound Absorption And Sound Absorption Coefficients By The Reverberation Room Method

K. ASTM E795-00 - Standard Practices For Mounting Test Specimens During Sound Absorption Tests

L. ASTM C919-02 - Standard Practice For Use Of Sealants In Acoustical Applications

M. NFPA 90A - Standard For The Installation Of Air-Conditioning And Ventilating Systems

N. NFPA 90B - Standard For The Installation Of Warm Air Heating And Air-Conditioning Systems

O. ARI 885-98 - Procedure For Estimating Occupied Space Sound Levels In The Application Of Air Terminals And Air Outlets

P. ASTM E1414-91 - Standard Test Method For Airborne Sound Attenuation Between Rooms Sharing A Common Ceiling Plenum.

1.5 QUALITY ASSURANCE

A. Applicator: Company specializing in sound trap construction with five years minimum experience.

B. Acoustical Criteria:

1. Noise levels due to equipment and ductwork shall permit attaining sound pressure levels in all 8 octave bands in occupied spaces conforming to noise Criteria (NC) curves as follows:

Offices	NC 35
Public Areas	NC 40
Operating Rooms	NC 40
Procedure and Examination Rooms	NC 35
Dining Facilities	NC 35

C. MECHANICAL EQUIPMENT ACOUSTICAL DESIGN PERFORMANCE

1. Air Distribution System:

a. Pressure Reducing Device Noise: Maximum permissible sound-power levels in octave bands of airborne transmission through the combination of grille, registers, diffusers, and terminal units or related pressure reducing devices, when operated at the maximum inlet pressure and cfm in installed condition per plans and specifications shall be as follows:

AIR DISTRIBUTION SYSTEM EQUIPMENT/TERMINAL DEVICE NOISE
MAX PWL (dB re 10^{-12} Watt)

Octave Band	NC-30	NC-35	NC-40	NC-45	NC-50+
1	58	62	66	68	70
2	50	56	60	63	66
3	45	49	54	58	62
4	41	46	51	56	61
5	38	43	48	53	58
6	37	42	47	52	57
7	36	41	46	51	56
8	37	42	47	52	57

2. Pressure reducing valve radiated noise, including VAV and CV Boxes.

   a. Maximum permissible radiated sound-power levels in octave bands of pressure reducing valves when operated at the maximum inlet pressure and air quantity in an installed condition over occupied spaces shall be as follows:

RADIATED SOUND POWER (dB re 10^{-12} WATT)

Octave Band	NC-35	NC-40	NC-45	NC-50+
1	72	76	79	82
2	70	74	77	80
3	61	65	68	71
4	60	64	68	72
5	57	62	68	72
6	56	60	65	70
7	66	70	75	80
8	65	70	75	80

3. Acoustical Performance within Equipment Spaces: Equipment room noise levels and noise transmission to adjacent buildings shall comply with all Federal, State and City Noise Ordinances.

PART 2 - PRODUCTS

2.1 BASE BID MANUFACTURERS

A. Sound Traps and Silencers:
   1. Price Industries
   2. Industrial Acoustics Company (IAC)
   3. United McGill Corporation
   4. VAW
   5. Vibro-Acoustics

B. Sound-Linings:
   1. Johns-Manville Corp.
   2. Owens-Corning Fiberglas Corp.

2.2 DUCT SOUND TRAPS:

A. Available shape:

1. Rectangular straight with splitters or baffles.
2. Round straight with center bodies or pods.
3. Rectangular elbow with splitters or baffles.
4. Round elbow with center bodies or pods.
5. Rectangular transitional with splitters or baffles.

B. Factory fabricated.
1. Shell:
   a. Galvanized steel: minimum 22 USSG (0.85 mm).
   b. Leakproof at pressure differential of 8 inch wg (200 mm wg).
2. Media:
   a. Flamespread: maximum 25.
   b. Fuel contributed and smoke developed: maximum 20.
   c. Minimum 1.5 lbs per cubic foot (24 kg/m) density glass or mineral fiber packed under 5 percent compression.
   d. Filler to be inert, vermin and moisture proof.
3. Provide all required duct transition pieces and connections. Connections to match ductwork being connected to.
4. Internal Construction: Galvanized perforated steel baffles: minimum 26 USSG (0.5 mm).
5. Protective Tedlar film shall be provided between air stream and fill to prevent any intermingling of the airstream with the fill material.
6. Silencers for any system and/or equipment serving operating rooms, and any fume hoods or other hazardous exhaust systems shall have no media (packless type attenuators). All fume hood or hazardous exhausts, packless sound attenuators shall be stainless steel when installed in stainless steel ductwork.
7. Net Insertion Ratings: Determined by duct-to-reverberant room test method at design airflow shall be as follows:

SOUND TRAP DYNAMIC INSERTION LOSS (FORWARD FLOW)
SPECIFICATION TYPES
(INDUSTRIAL ACOUSTICS COMPANY TYPE AS STANDARD)

Octave Band	IAC Type as Std	2	3	4	5	6
A	3L	5	9	14	23	24
B	5L	7	13	21	29	39
C	7L	13	18	28	40	47
D	3MS	7	12	19	23	23
E	5MS	10	18	30	42	34
F	7MS	14	24	36	48	44
G	3S	12	16	28	35	36
H	5S	18	24	40	45	46
I	7S	20	35	45	50	48
J	3HL	4	4	7	9	19
K	5HL	6	7	14	19	37
L	3HS	9	14	19	22	28
M	5HS	13	19	26	35	44
N	12TXS	11	19	22	14	11
O	12TXL	8	16	16	7	7
P	8TXLB	14	26	18	14	14

8. Maximum self-generated noise shall be as follows:

SOUND TRAP SELF-GENERATED NOISE AT 2000 FPM MAX PWL
(dB re 10^{-12} WATT) (10.2 m/sec)

Octave	Band	2	3	4	5	6
A,B,C, J,K	Type L,HL	51	51	49	47	50
D,E,F	Type MS	54	52	50	47	48
G,H,I,L,M	Type S, HS	69	63	64	61	63
N	Type TXS	34	35	35	35	28
O	Type TXL	22	28	28	25	<20
P	Type TXLB	29	27	32	30	23

9. Certified Tests:
   a. Submit certified test data from approved laboratory for pressure drop and insertion loss ratings.
      1) For square or rectangular attenuators: 24 inch x 24 inch (610 mm x 610 mm).
      2) For round attenuators 24 inch (610 mm) diameter.
10. Certification data for pressure drop and net insertion loss based on tests of same attenuator.
11. Attenuators and tests: subject to inspection upon request of Architect or Engineer.
12. Similar to Industrial Acoustics Company (IAC).
13. All operating room packless sound attenuators shall have all surfaces factory cleaned and caulked with VOC free sealants and then shrink wrapped prior to shipment.

2.3 SOUND LINING

A. Fibrous glass.

B. Facing for low pressure duct liners.
   1. Airstream Finish: neoprene or acrylic coated 100% coverage with acrylic coating with a United States Environmental Protection Agency registered anti-microbial agent proven resistant to microbial growth per ASTM Standards G21 and G22.
   2. Stenciled NFPA 90A and 90B.

C. Facing for circular medium and high pressure duct liner: Finish: Perforated 28 percent minimum open area 24 USSG (0.7 mm) sheet metal.

D. Where lining could be exposed to weather or other sources of moisture and in medium pressure system, protective Tedlar film shall be provided between air stream and fill to prevent contact of the liner material with moisture.

E. Protective Tedlar film shall be protected by a perforated inner sheet metal liner.

F. Minimum thickness:
   1. In ductwork less than 10 sq. ft cross section: 1 inch (25 mm).
   2. In ductwork greater than 10 sq. ft cross section: 2 inch (25 mm).
   3. In plenums: 2 inch (50 mm).

G. Minimum density:
   1. In ductwork: 1-1/2 lb per cu ft (24 kg/cu m).
   2. In plenums: 3 lb per cu ft (48 kg/cu m).

H. Flamespread: maximum 25.

I. Fuel contributed and smoke developed: maximum 50.

J. Suitable for duct velocity of 5000 fpm (20.5 m/sec).

K. Dynamic loss coefficient: maximum 1.2.

L. K Factor: maximum 0.25 BTU in/hr/deg F/sq ft (36 mW/m/K).

M. Noise reduction coefficient÷ for 1 inch (25 mm) thick lining: minimum NRC = 0.70 when tested in accordance with ASTM C423 in Type A mounting.

N. Similar to Johns Manville Permacote Linacoustic meeting ASTM C1071.

O. Adhesive and Sealer:
   1. In conformance with NFPA 90A.
   2. Maximum fire hazard ratings; as specified in insulation.
   3. Adhesive: similar to Benjamin Foster 81-99.
   4. Sealer: similar to Johns Manville Superseal or Benjamin Foster 82-07.
   5. In conformance with ASTM C919.

2.4 NON-HARDENING SOUND CAULKING:

A. Guaranteed to be permanently elastic.

B. Similar to Tremco Polybutene.

PART 3 - EXECUTION

3.1 SOUND TRAPS AND SILENCERS:

A. Install in accordance with manufacturer's recommendations to obtain published performance.

B. Maximum static pressure loss: refer to schedules.

3.2 SOUND LININGS

A. Adhere duct liner to duct wall with full coverage of adhesive conforming to ASTM C919.

B. Secure Insulation with mechanical fasteners per SMACNA, NAIMA or duct liner manufacturer's recommendations. Pin length shall be such as to limit compression of liner.

C. All exposed edges of duct liner shall be factory or field coated. For systems with air flow in excess of 2,500 fpm (12.7 m/sec) a metal nosing must be installed in all liner leading edges, trailing edges, and at all seams.

D. Repair all unprotected penetrations, tears and rips in the surface of the liner with liner adhesive meeting ASTM C919 or Johns Manville Superseal.

E. Dimensions of lined ductwork are clear inside dimensions after lining has been installed.

F. Provide 28% open perforated metal liner and plastic film, meeting the same fire and smoke characteristics as the duct liner, between air stream and duct liner to prevent any intermingling of the air stream with the liner material, for all medium and high

pressure ductwork and for all lined ductwork 25’-0” upstream and downstream from fans and HVAC units.

G. Extent of ductwork sound linings:
   1. Upstream of all exhaust fans for minimum distance of 25'-0".
   2. All toilet exhaust branch ducts. Lining can be deleted if duct configuration has at least two 90° elbows between the closest air inlets of the men's and women's toilet rooms.
   3. All air transfer and jumper ducts from rooms to return air plenums.
   4. Where indicated on drawings.

3.3 TESTS

A. Sound Traps and Duct Silencers:

   1. After installation: measure total system pressure before and after attenuators.
   2. If pressure loss exceeds maximum static pressure loss schedules on drawings: at no charge, replace attenuators and/or modify entrance and/or discharge aerodynamic flow to obtain specified performance.

END OF SECTION

This page is intentionally left blank.

SECTION 23 05 53

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 and Division 01 Specification Sections, apply to this Section.

B. Section 01 81 13 "Sustainable Design Requirements – LEED v4 for Building Design & Construction – New Construction" for sustainable design requirements and detailed sustainable design submittal requirements.

C. Section 01 74 19 "Construction and Demolition Waste Management and Disposal" for disposal of construction, demolition and packaging waste disposal requirements.

1.2 SUMMARY

A. Section Includes:
1. Equipment labels.
2. Warning signs and labels.
3. Pipe labels.
4. Duct labels.
5. Stencils.
6. Valve tags.
7. Warning tags.

B. Sustainable Building Requirements:
1. The Owner requires the Contractor to implement practices and procedures to meet the project's environmental performance goals, which include achieving LEED version 4 **Certified** level Certification. Specific project goals that may impact this area of work include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; construction waste recycling; and the implementation of a construction indoor air quality management plan. The Contractor shall ensure that the requirements related to these goals, as defined in the Articles below, are implemented to the fullest extent. Substitutions, or other changes to the work proposed by the Contractor or their Subcontractors, shall not be allowed if such changes compromise the aforementioned environmental goals and LEED certification.

1.3 SUBMITTALS

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

B. Samples: For color, letter style, and graphic representation required for each identification material and device.

C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

D. Valve numbering scheme.

E. Valve Schedules: For each piping system to include in maintenance manuals.

1.4 COORDINATION

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

B. Coordinate installation of identifying devices with locations of access panels and doors.

C. Install identifying devices before installing acoustical ceilings and similar concealment.

D. Coordinate all unit numbering, designation and label locations with the owner.

PART 2 - PRODUCTS

2.1 EQUIPMENT LABELS

A. Metal Labels for Equipment:
   1. Material and Thickness: Anodized aluminum, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.
   2. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.
   3. 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-fourths the size of principal lettering.
   4. Fasteners: Stainless-steel rivets or self-tapping screws.
   5. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

B. Label Content: Include building identification, equipment's Drawing designation or unique equipment number, manufacturer’s product name, model number and serial number, capacity, operating and power characteristics, essential data, and labels of tested compliances.

C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch (A4) bond paper. Tabulate equipment identification number and identify Drawing numbers where equipment is indicated (plans, details, and schedules), plus 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. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16 inch thick, and having predrilled holes for attachment hardware.

B. Letter Color: Black.

C. Background Color: Yellow.

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 3 by 5 ¼".

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-fourths 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.

J. Systems that shall include these labels shall include any exhaust system serving exhaust hoods, kitchen exhaust, radioactive exhaust, etc.

2.3 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Preprinted, color-coded, with lettering indicating service, and showing flow direction.

B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive.

C. 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, pipe size, and an arrow indicating flow direction.
   1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions or as separate unit on each pipe label to indicate flow direction.
   2. Lettering Size: At least 1-1/2 inches high.

2.4 DUCT LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels with permanent adhesive.

B. Letter Color: Black.

C. Background Color: Refer to Part 3.

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. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

G. Duct Label Contents: Include identification of duct service using same designations or abbreviations as used on Drawings, 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. Lettering Size: At least 1-1/2 inches high.

2.5 STENCILS

A. Stencils: Prepared with letter sizes according to ASME A13.1 for piping; minimum letter height of 1-1/4 inches for ducts; and minimum letter height of 3/4 inch for access panel and door labels, equipment labels, and similar operational instructions.
   1. Stencil Material: Fiberboard or metal
   2. Stencil Paint: Exterior, gloss, alkyd enamel black unless otherwise indicated. Paint may be in pressurized spray-can form.
   3. Identification Paint: Exterior, alkyd enamel in colors according to ASME A13.1 unless otherwise indicated.

2.6 VALVE TAGS

A. 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 minimum thickness, and having predrilled or stamped holes for attachment hardware.
   2. Fasteners: Brass wire-link or beaded chain; or S-hook.

B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch 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.

2.7 WARNING TAGS

A. Warning Tags: 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: Brass grommet and wire.
   3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."
   4. Color: 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 EQUIPMENT LABEL INSTALLATION

A. Install or permanently fasten labels on each major item of mechanical equipment.

B. Locate equipment labels where accessible and visible.

C. Ceiling labels are required for all above ceiling equipment that is concealed.

3.3 PIPE LABEL INSTALLATION

A. Locate pipe labels where piping is exposed or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:
   1. Near each valve and control device.
   2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
   3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures. Flow pattern shall be identified at the wall penetration.
   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 ~~20~~ **6** feet along each run, and on BOTH sides of any wall that the service traverses.
   7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

B. Pipe Label Color Schedule:
   1. Chilled-Water Piping (CHWS/CHWR):
      a. Background Color: Blue.
      b. Letter Color: White.
   2. Heating Water Piping (HHWS/HHWR):
      a. Background Color: Brown.
      b. Letter Color: White.
   3. Steam (STM):
      a. Background color: White
      b. Letter Color: Black
   4. Condensate Return (COND):
      a. Background color: Orange
      b. Letter Color: Black

3.4 DUCT LABEL INSTALLATION

A. Install plastic-laminated, 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.
4. ASME A13.1 Colors and Designs: For hazardous material exhaust.

B. Locate labels near points where ducts enter into concealed spaces and at maximum intervals of ~~20~~ **6** feet in each space where ducts are exposed or concealed by removable ceiling system, and BOTH sides of any wall that the duct traverses.

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 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. Chilled Water: 1-1/2 inches.
   b. Hot Water: 1-1/2 inches.
2. Valve-Tag Color:
   a. Chilled Water: Green.
   b. Hot Water: Red.
3. Letter Color:
   a. Chilled 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

SECTION 23 05 93

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 and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This Section includes TAB to produce design objectives for the following:
   1. Air Systems:
      a. Constant-volume air systems.
      b. Variable-air-volume systems.
      c. Exhaust air system.
   2. Hydronic Piping Systems:
      a. Constant-flow systems.
      b. Variable-flow systems.
      c. Hot water
      d. Chilled water.
   3. HVAC equipment quantitative-performance settings.
   4. Exhaust airflow balancing.
   5. Space pressurization testing and adjusting.
   6. Vibration measuring.
   7. Sound level measuring.
   8. Indoor-air quality measuring
   9. Verifying that automatic control devices are functioning properly.
   10. Reporting results of activities and procedures specified in this Section.
   11. Commissioning.

B. The TAB contractor shall submit all bids to the HVAC Contractor and to the Construction Manager and shall contract directly with the HVAC Contractor.

1.3 DEFINITIONS

A. Adjust: To regulate fluid flow rate and air patterns at the terminal equipment, such as to reduce fan speed or adjust a damper.

B. Balance: To proportion flows within the distribution system, including submains, branches, and terminals, according to indicated quantities.

C. Barrier or Boundary: Construction, either vertical or horizontal, such as walls, floors, and ceilings that are designed and constructed to restrict the movement of airflow, smoke, odors, and other pollutants.

D. Draft: A current of air, when referring to localized effect caused by one or more factors of high air velocity, low ambient temperature, or direction of airflow, whereby more heat is withdrawn from a person's skin than is normally dissipated.

E. NC: Noise criteria.

F. Procedure: An approach to and execution of a sequence of work operations to yield repeatable results.

G. RC: Room criteria.

H. Report Forms: Test data sheets for recording test data in logical order.

I. Static Head: The pressure due to the weight of the fluid above the point of measurement. In a closed system, static head is equal on both sides of the pump.

J. Suction Head: The height of fluid surface above the centerline of the pump on the suction side.

K. System Effect: A phenomenon that can create undesired or unpredicted conditions that cause reduced capacities in all or part of a system.

L. System Effect Factors: Allowances used to calculate a reduction of the performance ratings of a fan when installed under conditions different from those presented when the fan was performance tested.

M. TAB: Testing, adjusting, and balancing.

N. Terminal: A point where the controlled medium, such as fluid or energy, enters or leaves the distribution system.

O. Test: A procedure to determine quantitative performance of systems or equipment.

P. Testing, Adjusting, and Balancing (TAB) Firm: The entity responsible for performing and reporting TAB procedures.

1.4 SUBMITTALS

A. Qualification Data: Within 15 days from Contractor's Notice to Proceed, submit 4 copies of evidence that TAB firm and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.

B. Contract Documents Examination Report: Within 45 days from Contractor's Notice to Proceed, submit 4 copies of the Contract Documents review report as specified in Part 3.

C. Strategies and Procedures Plan: Within 60 days from Contractor's Notice to Proceed, submit 4 copies of TAB strategies and step-by-step procedures as specified in Part 3 "Preparation" Article. Include a complete set of report forms intended for use on this Project.

D. Certified TAB Reports: Submit two copies of reports prepared, as specified in this Section, on approved forms certified by TAB firm.

E. Sample Report Forms: Submit two sets of sample TAB report forms.

F. Warranties specified in this Section.

1.5 QUALITY ASSURANCE

A. TAB Firm Qualifications: Engage a TAB firm certified by NEBB.

B. TAB Conference: Meet with Owner's, Architect's and Commissioning Agent representatives on approval of TAB strategies and procedures plan to develop a mutual understanding of the details. Ensure the participation of TAB team

members, equipment manufacturers' authorized service representatives, HVAC controls installers, and other support personnel. Provide seven days' advance notice of scheduled meeting time and location.

1. Agenda Items: Include at least the following:
   a. Submittal distribution requirements.
   b. The Contract Documents examination report.
   c. TAB plan.
   d. Work schedule and Project-site access requirements.
   e. Coordination and cooperation of trades and subcontractors.
   f. Coordination of documentation and communication flow.

C. Certification of TAB Reports: Certify TAB field data reports. This certification includes the following:
   1. Review field data reports to validate accuracy of data and to prepare certified TAB reports.
   2. Certify that TAB team complied with approved TAB plan and the procedures specified and referenced in this Specification.

D. TAB Report Forms: Use standard forms from NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems." SMACNA's TABB "HVAC Systems - Testing, Adjusting, and Balancing." or TAB firm's forms approved by Architect.

E. Instrumentation Type, Quantity, and Accuracy: As described in NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems," Section II, "Required Instrumentation for NEBB Certification."

F. Instrumentation Calibration: Calibrate instruments at least every six months or more frequently if required by instrument manufacturer.
   1. Keep an updated record of instrument calibration that indicates date of calibration and the name of party performing instrument calibration.

1.6 COORDINATION

A. Coordinate the efforts of factory-authorized service representatives for systems and equipment, HVAC controls installers, and other mechanics to operate HVAC systems and equipment to support and assist TAB activities.

B. Notice: Provide seven days' advance notice for each test. Include scheduled test dates and times.

C. 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.
   1. Contract Documents are defined in the General and Supplementary Conditions of Contract.
   2. Verify that balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are required by the Contract Documents. Verify that quantities and locations of these balancing devices are accessible and appropriate for effective balancing and for efficient system and equipment operation.

B. Examine approved submittal data of HVAC systems and equipment.

C. Examine Project Record Documents described in Division 01 Section "Project Record Documents."

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 equipment performance data including fan and pump curves. 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. Calculate system effect factors to reduce performance ratings of HVAC equipment when installed under conditions different from those presented when the equipment was performance tested at the factory. To calculate system effects for air systems, use tables and charts found in AMCA 201, "Fans and Systems," Sections 7 through 10; or in SMACNA's "HVAC Systems--Duct Design," Sections 5 and 6. Compare this data with the design data and installed conditions.

F. Examine system and equipment installations to verify that they are complete and that testing, cleaning, adjusting, and commissioning specified in individual Sections have been performed.

G. Examine system and equipment test reports.

H. Examine HVAC system and equipment installations to verify that indicated balancing devices, such as test ports, gage cocks, thermometer wells, flow-control devices, balancing valves and fittings, and manual volume dampers, are properly installed, and that their locations are accessible and appropriate for effective balancing and for efficient system and equipment operation.

I. Examine systems for functional deficiencies that cannot be corrected by adjusting and balancing.

J. Examine HVAC equipment to ensure that clean filters have been installed, bearings are greased, belts are aligned and tight, and equipment with functioning controls is ready for operation.

K. Examine terminal units, such as variable-air-volume boxes, to verify that they are accessible and their controls are connected and functioning.

L. Examine plenum ceilings used for return air to verify that they are airtight. Verify that pipe penetrations and other holes are sealed.

M. Examine strainers for clean screens and proper perforations.

N. Examine valves (two–way and three-way) for proper installation for their intended function of diverting, varying or mixing fluid flows.

O. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

P. Examine system pumps and piping to ensure absence of entrained air in the suction piping.

Q. Examine all equipment for installation and for properly operating safety interlocks and controls including all boilers, chillers, air handling equipment, pumps, boxes and exhaust system equipment.

R. Examine automatic temperature system components to verify the following:
   1. Dampers, valves, and other controlled devices are operated by the intended controller.
   2. Dampers and valves are in the position indicated by the controller.
   3. Integrity of valves and dampers for free and full operation and for tightness of fully closed and fully open positions. This includes dampers in multizone units, mixing boxes, and variable-air-volume terminals.
   4. Automatic modulating and shutoff valves, including two-way valves and three-way mixing and diverting valves, are properly connected.
   5. Thermostats and humidistats are located to avoid adverse effects of sunlight, drafts, and cold walls.
   6. Sensors are located to sense only the intended conditions.
   7. Sequence of operation for control modes is according to the Contract Documents.
   8. Controller set points are set at indicated values.
   9. Interlocked systems are operating.
   10. Changeover from heating to cooling mode occurs according to indicated values.

S. 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 system readiness 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.

C. Coordinate all such checks with the owner's commissioning agent.

3.3 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system according to the procedures contained in,NEBB's "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems", ,SMACNA's TABB "HVAC Systems - Testing, Adjusting, and Balancing" and this Section.

B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary to allow adequate performance of procedures. After testing and balancing, close probe holes and patch insulation with new materials identical to those removed. Restore vapor barrier and finish according to insulation Specifications for this Project.

C. Mark equipment and balancing device settings with paint or other suitable, permanent identification material, including damper-control positions, valve position indicators, fan-speed-control levers, and similar controls and devices, 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. For variable-air-volume systems, develop a plan to simulate diversity.

D. Determine the best locations in main and branch ducts for accurate duct airflow measurements.

E. Check airflow patterns from the outside-air louvers and dampers and the return- and exhaust-air dampers, through the supply-fan discharge and mixing dampers.

F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

G. Verify that motor starters are equipped with properly sized thermal protection.

H. Check dampers for proper position to achieve desired airflow path.

I. Check for airflow blockages.

J. Check condensate drains for proper connections and functioning.

K. Check for proper sealing of air-handling unit components.

L. Check for proper sealing of air duct system.

M. When adjustable sheaves are provided with equipment for balancing, this contractor is to replace with fixed sheaves, after balancing is complete.

3.5 PROCEDURES FOR ALL AIR SYSTEMS

A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.
   1. Measure fan static pressures to determine actual static pressure as follows:

a. Measure outlet static pressure as far downstream from the fan as practicable 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 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.

2. Measure static pressure across each component that makes up an air-handling unit, and other air-handling and treating equipment.
   a. Simulate dirty filter operation and record the point at which maintenance personnel must change filters.
3. Measure static pressures entering and leaving other devices such as exposed sound traps and other such equipment, under final balanced conditions. Measure duct riser pressure drops to assimilate the pressure drops of concealed (in shaft) sound attenuators.
4. Compare design data with installed conditions to determine variations in design static pressures versus actual static pressures. Compare actual system effect factors with calculated system effect factors to identify where variations occur. Recommend corrective action to align design and actual conditions.
5. Make required adjustments to pulley sizes, motor sizes, and electrical connections to accommodate fan-speed changes.
6. 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 modes to determine the maximum required brake horsepower.
7. When balancing is complete, replace any adjustable sheaves to fixed sheaves.

B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.
1. Measure static pressure at a point downstream from the balancing damper and adjust volume dampers until the proper static pressure is achieved.
   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. 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 terminal 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 terminal outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using 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 PROCEDURES FOR VARIABLE-AIR-VOLUME SYSTEMS

A. Compensating for Diversity: When the total airflow of all terminal units is more than the indicated airflow of the fan, place a selected number of terminal units at a maximum set-point airflow condition until the total airflow of the terminal units equals the indicated airflow of the fan. Select the reduced airflow terminal units so they are distributed evenly among the branch ducts.

B. The TAB Contractor shall determine and provide the necessary information to the HVAC Contractor and Air Handling Unit manufacturer so as to determine the size of the motor/fan sheave change required for the TAB Contractor to set the Air Handling Unit performance as follows:
   1. The TAB Contractor shall provide all labor and materials to provide a sheave change to operate the air system/return systems at approximately 105%-110% above design air flow. The VAV boxes served by the particular air handing unit shall be indexed to approximately 70% of the maximum flow (system diversity) and the required static pressure with dirty filters used as the system set point. The Variable Frequency Drives (VFD) shall be set at 100% speed.
   2. The replacement sheaves shall be sized and installed by the TAB Contractor and provided by the AHU supplier to match the actual field conditions of both the supply and return fans.

C. Pressure-Independent, Variable-Air-Volume Systems: After the fan systems have been adjusted, adjust the variable-air-volume systems as follows:
   1. Set outside-air dampers at minimum, and return- and exhaust-air dampers at a position that simulates full-cooling load.
   2. Select the terminal unit that is most critical to the supply-fan airflow and static pressure. Measure static pressure. Adjust system static pressure so the entering static pressure for the critical terminal unit is not less than the sum of terminal-unit manufacturer's recommended minimum inlet static pressure plus the static pressure needed to overcome terminal-unit discharge system losses.
   3. Measure total system airflow. Adjust to within indicated airflow.
   4. Set terminal units at maximum airflow and adjust controller or regulator to deliver the designed maximum airflow. Use terminal-unit manufacturer's written instructions to make this adjustment. When total airflow is correct, balance the air outlets downstream from terminal units as described for constant-volume air systems.
   5. Set terminal units at minimum airflow and adjust controller or regulator to deliver the designed minimum airflow. Check air outlets for a proportional reduction in airflow as described for constant-volume air systems.
      a. If air outlets are out of balance at minimum airflow, report the condition but leave outlets balanced for maximum airflow.
   6. Remeasure the return airflow to the fan while operating at maximum return airflow and minimum outside airflow. Adjust the fan and balance the return-air ducts and inlets as described for constant-volume air systems.
   7. Measure static pressure at the most critical terminal unit and adjust the static-pressure controller at the main supply-air sensing station to ensure that adequate static pressure is maintained at the most critical unit.
   8. Record the final fan performance data.

3.7 PROCEDURES FOR INDOOR-AIR QUALITY MEASUREMENTS

A. After air balancing is complete and with HVAC systems operating at indicated conditions, perform indoor-air quality testing.

B. Observe and record the following conditions for each HVAC system:
   1. The distance between the outside-air intake and the closest exhaust fan discharge, flue termination, or vent termination.
   2. Specified filters are installed. Check for leakage around filters.
   3. Cooling coil drain pans have a positive slope to drain.
   4. Cooling coil condensate drain trap maintains an air seal.
   5. Evidence of water damage.
   6. Insulation in contact with the supply, return, and outside air is dry and clean.

C. Measure and record indoor conditions served by each Air Handling Unit system. Make measurements at multiple locations served by the system if required to satisfy the following:
   1. Most remote area.
   2. One location per floor.
   3. One location for every 5000 sq. ft. (500 sq. m).

D. Measure and record the following indoor conditions for each operating room two times at two-hour intervals, and in accordance with ASHRAE 113:
   1. Temperature.
   2. Relative humidity.
   3. Air velocity.
   4. Concentration of carbon dioxide (ppm).
   5. Concentration of carbon monoxide (ppm).
   6. Nitrogen oxides (ppm).
   7. Room Pressurization (in H20).

3.8 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 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 expansion tank liquid level.
   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.

3.9 PROCEDURES FOR HYDRONIC SYSTEMS

A. Measure water flow at pumps. Use the following procedures, except for positive-displacement pumps:
   1. Verify impeller size by operating the pump with the discharge valve closed. Read pressure differential across the pump. Convert pressure to head and correct for differences in gage heights. Note the point on manufacturer's pump curve at zero flow and verify that the pump has the intended impeller size.
   2. Check system resistance. With all valves open, read pressure differential across the pump and mark pump manufacturer's head-capacity curve. Adjust pump discharge valve until indicated water flow is achieved.
   3. Verify pump-motor brake horsepower. Calculate the intended brake horsepower for the system based on pump manufacturer's performance data. Compare calculated brake horsepower with nameplate data on the pump motor. Report conditions where actual amperage exceeds motor nameplate amperage.
   4. Report flow rates that are not within plus or minus 5 percent of design.

B. Set calibrated balancing valves, if installed, at calculated presettings.

C. Measure flow at all stations and adjust, where necessary, to obtain first balance.
   1. System components that have Cv rating or an accurately cataloged flow-pressure-drop relationship may be used as a flow-indicating device.

D. Measure flow at main balancing station and set main balancing device to achieve flow that is 5 percent greater than indicated flow.

E. Adjust balancing stations to within specified tolerances of indicated flow rate as follows:
   1. Determine the balancing station with the highest percentage over indicated flow.
   2. Adjust each station in turn, beginning with the station with the highest percentage over indicated flow and proceeding to the station with the lowest percentage over indicated flow.
   3. Record settings and mark balancing devices.

F. Measure pump flow rate and make final measurements of pump amperage, voltage, rpm, pump heads, and systems' pressures and temperatures including outdoor-air temperature.

G. Measure the differential-pressure control valve settings existing at the conclusions of balancing.

H. Adjust all flows through all chillers and boilers.

I. Adjust all make-up systems for flow such as glycol make-up system.

3.10 PROCEDURES FOR VARIABLE-FLOW HYDRONIC SYSTEMS

A. Balance systems with automatic two- and three-way mixing control valves by setting systems at maximum flow through heat-exchange terminals and proceed as specified above for hydronic systems.

3.11 PROCEDURES FOR MOTORS

A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:
   1. Manufacturer, model, and serial numbers.
   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 for the controller to prove proper operation. Record observations, including controller manufacturer, model and serial numbers, and nameplate data.

3.12 PROCEDURES FOR HEAT-TRANSFER COILS

A. Water Coils: Measure the following data for each 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.

3.13 PROCEDURES FOR TEMPERATURE MEASUREMENTS

A. During TAB, report the need for adjustment in temperature regulation within the automatic temperature-control system.

B. Measure indoor wet- and dry-bulb temperatures every other hour for a period of two successive eight-hour days, in each separately controlled zone, to prove correctness of final temperature settings. Measure when the building or zone is occupied.

C. Measure outside-air, wet- and dry-bulb temperatures.

3.14 PROCEDURES FOR VIBRATION MEASUREMENTS

A. Use a vibration meter meeting the following criteria:
   1. Solid-state circuitry with a piezoelectric accelerometer.
   2. Velocity range of 0.1 to 10 inches per second.
   3. Displacement range of 1 to 100 mils.
   4. Frequency range of at least 0 to 1000 Hz.
   5. Capable of filtering unwanted frequencies.

B. Calibrate the vibration meter before each day of testing.
   1. Use a calibrator provided with the vibration meter.
   2. Follow vibration meter and calibrator manufacturer's calibration procedures.

C. Perform vibration measurements when other building and outdoor vibration sources are at a minimum level and will not influence measurements of equipment being tested.
   1. Turn off equipment in the building that might interfere with testing.
   2. Clear the space of people.

D. Perform vibration measurements after air and water balancing and equipment testing is complete.

E. Clean equipment surfaces in contact with the vibration transducer.

F. Position the vibration transducer according to manufacturer's written instructions and to avoid interference with the operation of the equipment being tested.

G. Measure and record vibration on rotating equipment over 3 hp.

H. Measure and record equipment vibration, bearing vibration, equipment base vibration, and building structure vibration. Record velocity and displacement readings in the horizontal, vertical, and axial planes.
   1. Pumps:
      a. Pump Bearing: Drive end and opposite end.
      b. Motor Bearing: Drive end and opposite end.
      c. Pump Base: Top and side.
      d. Building: Floor.
      e. Piping: To and from the pump after flexible connections.
   2. Fans and HVAC Equipment with Fans:
      a. Fan Bearing: Drive end and opposite end.
      b. Motor Bearing: Drive end and opposite end.
      c. Equipment Casing: Top and side.
      d. Equipment Base: Top and side.
      e. Building: Floor.
      f. Ductwork: To and from equipment after flexible connections.
      g. Piping: To and from equipment after flexible connections.
   3. HVAC Equipment with Compressors:
      a. Compressor Bearing: Drive end and opposite end.
      b. Motor Bearing: Drive end and opposite end.
      c. Equipment Casing: Top and side.
      d. Equipment Base: Top and side.
      e. Building: Floor.
      f. Piping: To and from equipment after flexible connections.

I. For equipment with vibration isolation, take floor measurements with the vibration isolation blocked solid to the floor and with the vibration isolation floating. Calculate and report the differences.

J. Inspect, measure, and record vibration isolation.
   1. Verify that vibration isolation is installed in the required locations.
   2. Verify that installation is level and plumb.
   3. Verify that isolators are properly anchored.
   4. For spring isolators, measure the compressed spring height, the spring OD, and the travel-to-solid distance.
   5. Measure the operating clearance between each inertia base and the floor or concrete base below. Verify that there is unobstructed clearance between the bottom of the inertia base and the floor.

3.15 TEMPERATURE-CONTROL VERIFICATION

A. Verify that controllers are calibrated and commissioned.

B. Check transmitter and controller locations and note conditions that would adversely affect control functions.

C. Record controller settings and note variances between set points and actual measurements.

D. Check the operation of limiting controllers (i.e., high- and low-temperature controllers).

E. Check free travel and proper operation of control devices such as damper and valve operators at all VAV, CV boxes, etc.

F. Check the sequence of operation of control devices. Note device positions and correlate with airflow and water flow measurements. Note the speed of response to input changes.

G. Check the interaction of electrically operated switch transducers.

H. Check the interaction of interlock and lockout systems.

I. Record voltages of power supply and controller output. Determine whether the system operates on a grounded or nongrounded power supply.

J. Note operation of electric actuators using spring return for proper fail-safe operations.

3.16 TOLERANCES

A. Set HVAC system airflow and water flow rates within the following tolerances:
   1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus 5 to plus 10 percent.
   2. Air Outlets and Inlets: 0 to minus 10 percent.
   3. Heating-Water Flow Rate: 0 to minus 10 percent.
   4. Cooling-Water Flow Rate: 0 to minus 5 percent.

3.17 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: As Work progresses, prepare 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.

C. Commissioning: Attend all commissioning meetings and cooperate fully with the owners commissioning agent. Submit all test reports as requested.

3.18 FINAL REPORT

A. General: Typewritten, or computer printout in letter-quality font, on standard bond paper, in three-ring binder, tabulated and divided into sections by tested and balanced systems.

B. Include a certification sheet in front of binder signed and sealed by the certified testing and balancing engineer.
   1. Include a list of instruments used for procedures, along with proof of calibration.

C. Final Report Contents: In addition to certified field report data, include the following:
   1. Pump curves.
   2. Fan curves.
   3. Manufacturers' test data (heat wheels, heat pipes, coils and air handlers).
   4. Field test reports prepared by system and equipment installers.
   5. Other information relative to equipment performance, but do not include Shop Drawings and Product Data.

D. General Report Data: In addition to form titles and entries, include the following data in the final report, as applicable:
   1. Title page.
   2. Name and address of TAB firm.
   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 firm 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, type size, and fittings.
   14. Notes to explain why certain final data in the body of reports varies from indicated values.
   15. Test conditions for fans and pump performance forms including the following:
      a. Settings for outside-, return-, and exhaust-air dampers.
      b. Conditions of filters.
      c. Cooling coil, wet- and dry-bulb conditions.
      d. Fan drive settings including settings and percentage of maximum pitch diameter.
      e. Air Flow sensors for variable-air-volume systems.
      f. Settings for supply-air, static-pressure controller.
      g. Other system operating conditions that affect performance.

E. 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 outside, 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.

F. Air-Handling Unit Test Reports: For air-handling units with coils, include the following:
1. Unit Data: Include the following:
   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 (mm), and bore.
   i. Sheave dimensions, center-to-center, and amount of adjustments in inches (mm).
   j. Number of belts, make, and size.
   k. Number of filters, type, and size.
2. Motor Data:
   a. 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 (mm), and bore.
   f. Sheave dimensions, center-to-center, and amount of adjustments in inches (mm).
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. Filter static-pressure differential in inches wg.
   f. Heat Pipe or Heat Wheel 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. Outside airflow in cfm.
   j. Return airflow in cfm.
   k. Outside-air damper position.
   l. Return-air damper position.
   m. VFD settings.

G. 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 (mm) o.c.
   f. Make and model number.

g. Face area in sq. ft. (sq. m).
h. Tube size in NPS (DN).
i. Tube and fin materials.
j. Circuiting arrangement.

2. Test Data (Indicated and Actual Values):
   a. Airflow rate in cfm (L/s).
   b. Average face velocity in fpm (m/s).
   c. Air pressure drop in inches wg (Pa).
   d. Outside-air, wet- and dry-bulb temperatures in deg F (deg C).
   e. Return-air, wet- and dry-bulb temperatures in deg F (deg C).
   f. Entering-air, wet- and dry-bulb temperatures in deg F (deg C).
   g. Leaving-air, wet- and dry-bulb temperatures in deg F (deg C).
   h. Water flow rate in gpm (L/s).
   i. Water pressure differential in feet of head or psig (kPa).
   j. Entering-water temperature in deg F (deg C).
   k. Leaving-water temperature in deg F (deg C).
   l. Refrigerant expansion valve and refrigerant types. (Air cooled chiller)
   m. Refrigerant suction pressure in psig (kPa). (air cooled chiller)
   n. Refrigerant suction temperature in deg F (deg C). (air cooled chiller)

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 (mm), and bore.
   h. Sheave dimensions, center-to-center, and amount of adjustments in inches (mm).
2. Motor Data:
   a. 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 (mm), and bore.
   f. Sheave dimensions, center-to-center, and amount of adjustments in inches (mm).
   g. Number of belts, make, and size.
3. Test Data (Indicated and Actual Values):
   a. Total airflow rate in cfm (L/s).
   b. Total system static pressure in inches wg (Pa).
   c. Fan rpm.
   d. Discharge static pressure in inches wg (Pa).
   e. Suction static pressure in inches wg (Pa).

I. Round 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 (deg C).

d. Duct static pressure in inches wg (Pa).
e. Duct size in inches (mm).
f. Duct area in sq. ft. (sq. m).
g. Indicated airflow rate in cfm (L/s).
h. Indicated velocity in fpm (m/s).
i. Actual airflow rate in cfm (L/s).
j. Actual average velocity in fpm (m/s).
k. Barometric pressure in psig (Pa).

J. Air-Terminal-Device Reports:
1. Unit Data:
a. System and air-handling unit identification.
b. Location and zone.
c. Test apparatus used.
d. Area served.
e. Air-terminal-device make.
f. Air-terminal-device number from system diagram.
g. Air-terminal-device type and model number.
h. Air-terminal-device size.
i. Air-terminal-device effective area in sq. ft. (sq. m).
2. Test Data (Indicated and Actual Values):
a. Airflow rate in cfm (L/s).
b. Air velocity in fpm (m/s).
c. Preliminary airflow rate as needed in cfm (L/s).
d. Preliminary velocity as needed in fpm (m/s).
e. Final airflow rate in cfm (L/s).
f. Final velocity in fpm (m/s).
g. Space temperature in deg F (deg C).

K. System-Coil Reports: For zone coils and water coils of terminal units, include the following:
1. Unit Data:
a. System and air-handling unit identification.
b. Location and zone.
c. Room or riser served.
d. Coil make and size.
e. Flowmeter type.
2. Test Data (Indicated and Actual Values):
a. Airflow rate in cfm (L/s).
b. Entering-water temperature in deg F (deg C).
c. Leaving-water temperature in deg F (deg C).
d. Water pressure drop in feet of head or psig (kPa).
e. Entering-air temperature in deg F (deg C).
f. Leaving-air temperature in deg F (deg C).

L. 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 and serial numbers.
f. Water flow rate in gpm (L/s).

g. Water pressure differential in feet of head or psig (kPa).
h. Required net positive suction head in feet of head or psig (kPa).
i. Pump rpm.
j. Impeller diameter in inches (mm).
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 (kPa).
   b. Pump shutoff pressure in feet of head or psig (kPa).
   c. Actual impeller size in inches (mm).
   d. Full-open flow rate in gpm (L/s).
   e. Full-open pressure in feet of head or psig (kPa).
   f. Final discharge pressure in feet of head or psig (kPa).
   g. Final suction pressure in feet of head or psig (kPa).
   h. Final total pressure in feet of head or psig (kPa).
   i. Final water flow rate in gpm (L/s).
   j. Voltage at each connection.
   k. Amperage for each phase.

M. Vibration Measurement Reports:
1. Date and time of test.
2. Vibration meter manufacturer, model number, and serial number.
3. Equipment designation, location, equipment, speed, motor speed, and motor horsepower.
4. Diagram of equipment showing the vibration measurement locations.
5. Measurement readings for each measurement location.
6. Calculate isolator efficiency using measurements taken.
7. Description of predominant vibration source.

N. Instrument Calibration Reports:
1. Report Data.
   a. Instrument type and make.
   b. Serial number.
   c. Applcation.
   d. Dates of use.
   e. Dates of calibration.

3.19 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. Randomly check the following for each system:
   a. Measure airflow of at least 10 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. Measure sound levels at two locations.

e. Measure space pressure of at least 10 percent of locations.
f. Verify that balancing devices are marked with final balance position.
g. Note deviations to the Contract Documents in the Final Report.

END OF SECTION

This page is intentionally left blank.

SECTION 23 07 00

HVAC INSULATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Section 01 81 13 "Sustainable Design Requirements – LEED v4 for Building Design & Construction – New Construction" for sustainable design requirements and detailed sustainable design submittal requirements.

C. Section 01 74 19 "Construction and Demolition Waste Management and Disposal" for disposal of construction, demolition and packaging waste disposal requirements.

1.2 SUMMARY

A. Section Includes:
1. Insulation Materials:
   a. Calcium silicate.
   b. Flexible elastomeric.
   c. Mineral fiber (blanket and board).
2. Fire-rated insulation systems.
3. Insulating cements.
4. Adhesives.
5. Mastics.
6. Lagging adhesives.
7. Sealants.
8. Factory-applied jackets.
9. Field-applied fabric-reinforcing mesh.
10. Field-applied cloths.
11. Field-applied jackets.
12. Tapes.
13. Securements.

B. Related Sections:
1. Division 23 Section "Common Works Results for HVAC."
2. Division 23 Section "Hydronic Pumps."
3. Division 23 Section "Piping."
4. Division 23 Section "Metal Ducts."

C. Sustainable Building Requirements:
1. The Owner requires the Contractor to implement practices and procedures to meet the project's environmental performance goals, which include achieving LEED version 4 Certified level Certification. Specific project goals that may

impact this area of work include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; construction waste recycling; and the implementation of a construction indoor air quality management plan. The Contractor shall ensure that the requirements related to these goals, as defined in the Articles below, are implemented to the fullest extent. Substitutions, or other changes to the work proposed by the Contractor or their Subcontractors, shall not be allowed if such changes compromise the aforementioned environmental goals and LEED certification.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, thickness, and jackets (both factory and field applied, if any).

B. Shop Drawings:
   1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
   2. Detail attachment and covering of heat tracing inside insulation.
   3. Detail insulation application at pipe expansion joints for each type of insulation.
   4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
   5. Detail removable insulation at piping specialties, equipment connections, and access panels.
   6. Detail application of field-applied jackets.
   7. Detail application at linkages of control devices.
   8. Detail field application for each equipment type.

C. Qualification Data: Provide a firm or individual experienced in installing, erecting, or assembling work similar in material, design, and extent to that indicated for this project, whose work has resulted in construction with a record of successful in-service performance.

D. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

E. Field quality-control reports.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less and as tested and certified in accordance with ASTME-84.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.6 COORDINATION

A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with Piping Installer for piping insulation application, Duct Installer for duct insulation application, and Equipment Installer for equipment insulation application. Before preparing piping and 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.

1.7 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

1.8 DEFINITIONS

A. Indoor Exposed: Indoor ducts, piping or equipment located in mechanical equipment rooms, penthouse, and in areas which will be visible without removing ceilings or opening access panels.

B. Indoor Concealed: Indoor ducts, piping or equipment which are not exposed to the weather.

C. Outdoor: All Ducts, piping or equipment which is exposed to the weather. All piping outdoors is considered to be exposed to the weather

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in Part 3 schedule articles for where insulating materials shall be applied. Refer to paragraph 3.14 for insulation schedules.

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. Calcium Silicate:
   1. Products: Subject to compliance with requirements, provide the following:
      a. Industrial Insulation Group (The); Thermo-12 Gold.
   2. Preformed Pipe Sections: Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C 533, Type I.
   3. Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C 533, Type I.
   4. Prefabricated Fitting Covers: Comply with ASTM C450 and ASTM C585 for dimensions used in performing insulation to cover valves, elbows, tees and flanges.

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. Products: Subject to compliance with requirements, provide one of the following:
      a. Johns Manville; Microlite.
      b. Knauf Insulation; Duct Wrap.
      c. Owens Corning; All-Service Duct Wrap.
      d. Certainteed Corp; Duct Wrap.

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 FSK jacket. For equipment applications, provide insulation with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
   1. Products: Subject to compliance with requirements, provide the following:
      a. Johns Manville; 800 Series Spin-Glas.
      b. Knauf Insulation; Insulation Board.
      c. Owens Corning; Fiberglas 700 Series.
      d. Certanteed Corp; Commercial Board

I. High Temperature, Mineral Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C553, type V, without factory applied jacket.
   1. Products: Subject to compliance with requirements. Provide the following:
      a. Johns Manville; HTB 23 Spin-Glas.

b. Ownes Corning; High temperature flexible batt insulations.

J. Mineral-Fiber, Preformed Pipe Insulation:
1. Products: Subject to compliance with requirements, provide the following available products that may be incorporated
a. Fibrex Insulations Inc.; Coreplus 1200.
b. Johns Manville; Micro-Lok.
c. Knauf Insulation; 1000 Pipe Insulation.
d. Manson Insulation Inc.; Alley-K.
e. Owens Corning; Fiberglas Pipe Insulation.
2. 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-SSL. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

K. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied ASJcomplying 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. Products: Subject to compliance with requirements, provide the following :
a. Johns Manville; MicroFlex.
b. Knauf Insulation; Pipe and Tank Insulation.
c. Manson Insulation Inc.; AK Flex.
d. Owens Corning; Fiberglas Pipe and Tank Insulation.
e. Certainteed Corp; CrimpWrap.

2.2 FIRE-RATED INSULATION SYSTEMS

A. Fire-Rated Board: Structural-grade, press-molded, xonolite calcium silicate, fireproofing board suitable for operating temperatures up to 1700 deg F. Comply with ASTM C 656, Type II, Grade 6. tested and certified to provide a 2-hour fire rating by a NRTL acceptable to authority having jurisdiction.
1. Products: Subject to compliance with requirements, provide the following :
a. Johns Manville; Super Firetemp M.

B. Fire-Rated Blanket: High-temperature, flexible, blanket insulation with FSK jacket that is tested and certified to provide a 2-hour fire rating by a NRTL acceptable to authority having jurisdiction.
1. Products: Subject to compliance with requirements, provide the following :
a. CertainTeed Corp.; FlameChek.
b. Johns Manville; Firetemp Wrap.
c. Nelson Firestop Products; Nelson FSB Flameshield Blanket.
d. Thermal Ceramics; FireMaster Duct Wrap.
e. 3M; Fire Barrier Wrap Products.
f. Unifrax Corporation; FyreWrap.
g. Vesuvius; PYROSCAT FP FASTR Duct Wrap.

2.3 INSULATING CEMENTS

A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.
   1. Products: Subject to compliance with requirements, provide the following :
      a. Insulco, Division of MFS, Inc.; Triple I.
      b. P. K. Insulation Mfg. Co., Inc.; Super-Stik.

B. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C 196.
   1. Products: Subject to compliance with requirements, provide the following :
      a. P. K. Insulation Mfg. Co., Inc.; Thermal-V-Kote.

C. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449/C 449M.
   1. Products: Subject to compliance with requirements, provide the following :
      a. Insulco, Division of MFS, Inc.; SmoothKote.
      b. P. K. Insulation Mfg. Co., Inc.; PK No. 127, and Quik-Cote.
      c. Rock Wool Manufacturing Company; Delta One Shot.

2.4 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: Solvent-based resin adhesive, with a service temperature range of minus 75 to plus 300 deg F.
   1. Products: Subject to compliance with requirements, provide the following:
      a. Childers Products, Division of ITW; CP-96.
      b. Foster Products Corporation, H. B. Fuller Company; 81-33.

C. Flexible Elastomeric Adhesive: Comply with MIL-A-24179A, Type II, Class I.
   1. Products: Subject to compliance with requirements, provide the following:
      a. Aeroflex USA Inc.; Aeroseal.
      b. Armacell LCC; 520 Adhesive.
      c. Foster Products Corporation, H. B. Fuller Company; 85-75.
      d. RBX Corporation; Rubatex Contact Adhesive.

D. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
   1. Products: Subject to compliance with requirements, provide the following:
      a. Childers Products, Division of ITW; CP-82.
      b. Foster Products Corporation, H. B. Fuller Company; 85-20.
      c. ITW TACC, Division of Illinois Tool Works; S-90/80.
      d. Marathon Industries, Inc.; 225.
      e. Mon-Eco Industries, Inc.; 22-25.

E. ASJ Adhesive, and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
   1. Products: Subject to compliance with requirements, provide the following:
      a. Childers Products, Division of ITW; CP-82.
      b. Foster Products Corporation, H. B. Fuller Company; 85-20.
      c. ITW TACC, Division of Illinois Tool Works; S-90/80.
      d. Marathon Industries, Inc.; 225.
      e. Mon-Eco Industries, Inc.; 22-25.

F. PVC Jacket Adhesive: Compatible with PVC jacket.
   1. Products: Subject to compliance with requirements, provide the following:

a. Dow Chemical Company (The); 739, Dow Silicone.
b. Johns-Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
c. P.I.C. Plastics, Inc.; Welding Adhesive.
d. Red Devil, Inc.; Celulon Ultra Clear.
e. Speedline Corporation; Speedline Vinyl Adhesive.

2.5 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II.

B. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services. All mastics shall have low VOC content in compliance with U.S. Green Building Council/LEED® guidelines.
1. Products: Subject to compliance with requirements, provide the following:
a. Childers Products, Division of ITW; CP-35.
b. Foster Products Corporation, H. B. Fuller Company; 30-90.
c. ITW TACC, Division of Illinois Tool Works; CB-50.
d. Marathon Industries, Inc.; 590.
e. Mon-Eco Industries, Inc.; 55-40.
f. Vimasco Corporation; 749.
2. Water-Vapor Permeance: ASTM E 96, Procedure B, 0.013 permat 43-mil dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F.
4. Solids Content: ASTM D 1644, 59 percent by volume and 71 percent by weight.
5. Color: White.

2.6 LAGGING ADHESIVES

A. Description: Comply with MIL-A-3316C Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.
1. Products: Subject to compliance with requirements, provide the following:
a. Childers Products, Division of ITW; CP-52.
b. Foster Products Corporation, H. B. Fuller Company; 81-42.
c. Marathon Industries, Inc.; 130.
d. Mon-Eco Industries, Inc.; 11-30.
e. Vimasco Corporation; 136.
2. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over duct, equipment, and pipe insulation.
3. Service Temperature Range: Minus 50 to plus 180 deg F.
4. Color: White.

2.7 SEALANTS

A. Joint Sealants:

B. FSK and Metal Jacket Flashing Sealants:
1. Products: Subject to compliance with requirements, provide the following :

a. Childers Products, Division of ITW; CP-76-8.
b. Foster Products Corporation, H. B. Fuller Company; 95-44.
c. Marathon Industries, Inc.; 405.
d. Mon-Eco Industries, Inc.; 44-05.
e. Vimasco Corporation; 750.

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.

C. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, provide the following :
   a. Childers Products, Division of ITW; CP-76.
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.

2.8 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 vapor barrier 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 vapor barrier, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
4. FSP Jacket: Aluminum-foil vapor barrier, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C 1136, Type II.
5. PVDC Jacket for Indoor Applications: 4-mil-thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perms when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.
   a. Products: Subject to compliance with requirements, provide the following :
      1) Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.

2.9 FIELD-APPLIED FABRIC-REINFORCING MESH

A. Woven Glass-Fiber Fabric for Pipe Insulation: Approximately 2 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. inchfor covering pipe and pipe fittings.

1. Products: Subject to compliance with requirements, provide the following :
   a. Vimasco Corporation; Elastafab 894.

B. Woven Glass-Fiber Fabric for Duct and Equipment Insulation: Approximately 6 oz./sq. yd. with a thread count of 5 strands by 5 strands/sq. inchfor covering equipment.
   1. Products: Subject to compliance with requirements, provide the following :
      a. Childers Products, Division of ITW; Chil-Glas No. 5.

C. Woven Polyester Fabric: Approximately 1 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. inch, in a Leno weave, for duct, equipment, and pipe.
   1. Products: Subject to compliance with requirements, provide the following :
      a. Foster Products Corporation, H. B. Fuller Company; Mast-A-Fab.
      b. Vimasco Corporation; Elastafab 894.

2.10 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.
   1. Products: Subject to compliance with requirements, provide the following :
      a. Alpha Associates, Inc.; Alpha-Maritex 84215 and 84217/9485RW, Luben 59.

2.11 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. FSK Jacket: Aluminum-foil-face vapor barrier, fiberglass-reinforced scrim with kraft-paper backing.

C. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C and ASTME-84 (25/50); thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
   1. Products: Subject to compliance with requirements, provide the following :
      a. Johns Manville; Zeston.
      b. P.I.C. Plastics, Inc.; FG Series.
      c. Proto PVC Corporation; LoSmoke.
      d. Speedline Corporation; SmokeSafe.
   2. Adhesive: As recommended by jacket material manufacturer.
   3. Color: White.
   4. 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.
   5. Factory-fabricated tank heads and tank side panels.

D. Metal Jacket:
   1. Products: Subject to compliance with requirements, provide the following :
      a. Childers Products, Division of ITW; Metal Jacketing Systems.
      b. PABCO Metals Corporation; Surefit.
      c. RPR Products, Inc.; Insul-Mate.

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: 2.5-mil-thick Polysurlyn.
   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.

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 cross laminated polyethylene film covered with white aluminum-foil facing.
   1. Products: Subject to compliance with requirements, provide the following :
      a. Polyguard; Alumaguard 60.

2.12 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
   1. Products: Subject to compliance with requirements, provide the following :
      a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0835.
      b. Compac Corp.; 104 and 105.
      c. Ideal Tape Co., Inc., an American Biltrite Company; 428 AWF ASJ.
      d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
   2. Width: 3 inches.
   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. Products: Subject to compliance with requirements, provide the following :
      a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
      b. Compac Corp.; 110 and 111.
      c. Ideal Tape Co., Inc., an American Biltrite Company; 491 AWF FSK.
      d. Venture Tape; 1525 CW, 1528 CW, and 1528 CW/SQ.
   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. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive. Suitable for indoor and outdoor applications.
1. Products: Subject to compliance with requirements, provide the following :
   a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0555.
   b. Compac Corp.; 130.
   c. Ideal Tape Co., Inc., an American Biltrite Company; 370 White PVC tape.
   d. Venture Tape; 1506 CW NS.
2. Width: 2 inches.
3. Thickness: 6 mils.
4. Adhesion: 64 ounces force/inch in width.
5. Elongation: 500 percent.
6. Tensile Strength: 18 lbf/inch in width.

D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.
1. Products: Subject to compliance with requirements, provide the following :
   a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
   b. Compac Corp.; 120.
   c. Ideal Tape Co., Inc., an American Biltrite Company; 488 AWF.
   d. Venture Tape; 3520 CW.
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.

2.13 SECUREMENTS

A. Bands:
1. Products: Subject to compliance with requirements, provide the following :
   a. Childers Products; Bands.
   b. PABCO Metals Corporation; Bands.
   c. RPR Products, Inc.; Bands.
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 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 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, 0.106-inch-diameter shank, length to suit depth of insulation indicated.
   a. Products: Subject to compliance with requirements, provide the following :

1) AGM Industries, Inc.; CWP-1.
2) GEMCO; CD.
3) Midwest Fasteners, Inc.; CD.
4) Nelson Stud Welding; TPA, TPC, and TPS.

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. Products: Subject to compliance with requirements, provide the following :
      1) AGM Industries, Inc.; CWP-1.
      2) GEMCO; Cupped Head Weld Pin.
      3) Midwest Fasteners, Inc.; Cupped Head.
      4) Nelson Stud Welding; CHP.
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. Products: Subject to compliance with requirements, provide the following :
      1) AGM Industries, Inc.; Tactoo Insul-Hangers, Series T.
      2) GEMCO; Perforated Base.
      3) Midwest Fasteners, Inc.; Spindle.
   b. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inchthick by 2 inches square.
   c. Spindle: Copper- or zinc-coated, low carbon steel Aluminum, 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. Products: Subject to compliance with requirements, provide the following :
      1) GEMCO; Nylon Hangers.
      2) Midwest Fasteners, Inc.; Nylon Insulation Hangers.
   b. Baseplate: Perforated, nylon sheet, 0.030 inchthick 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. Products: Subject to compliance with requirements, provide the following :
   1) AGM Industries, Inc.; Tactoo Insul-Hangers, Series TSA.
   2) GEMCO; Press and Peel.
   3) Midwest Fasteners, Inc.; Self Stick.
b. Baseplate: Galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.
c. Spindle: Copper- or zinc-coated, low carbon steel Aluminum, 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 sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
   a. Products: Subject to compliance with requirements, provide the following :
      1) AGM Industries, Inc.; RC-150.
      2) GEMCO; R-150.
      3) Midwest Fasteners, Inc.; WA-150.
      4) Nelson Stud Welding; Speed Clips.
   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. Products: Subject to compliance with requirements, provide 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-inchsoft-annealed, stainless steel.

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

   a. C & F Wire.

   b. Childers Products.

   c. PABCO Metals Corporation.

   d. RPR Products, Inc.

2.14 THERMAL-HANGER SHIELD INSERTS

A. Description: 100 PSIG minimum, compressive-strength insulation insert encased in sheet metal shield.

B. Manufacturers:

1. Carpenter & Paterson, Inc.
2. ERICO/Michigan Hanger Co.
3. PHS Industries, Inc.
4. Pipe Shields, Inc.
5. Rilco Manufacturing Company, Inc.
6. Value Engineered Products, Inc.

C. Insulation-Insert Material for Cold Piping: Water-repellent treated, ASTM C 533 Type I calcium silicate or ASTM C 552, Type II cellular glass with vapor barrier.

D. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533 Type I calcium silicate or ASTM C 552, Type II cellular glass.

E. For Trapeze or Clamped Systems: Insert and shield shall cover entire circumference of pipe.

F. For Clevis or Band Hangers: Insert and shield shall cover lower 180 degrees of pipe.

G. Insert Length: Extend 2 inches beyond sheet metal shield for piping operating below ambient air temperature.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.
   1. Verify that systems and equipment to be insulated have been tested and are free of defects.
   2. Verify that surfaces to be insulated are clean and dry.
   3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

C. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment, ducts and fittings, and piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment, duct system, and pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. 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 incheso.c.
      a. For below ambient services, apply vapor-barrier mastic over staples.
   4. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.
   5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct and 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. 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 Division 07 Section "Penetration Firestopping"firestopping and fire-resistive joint sealers.

F. Insulation Installation at Floor Penetrations:
1. Duct: Install insulation continuously through floor penetrations that are not fire rated. 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. Pipe: Install insulation continuously through floor penetrations.
3. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 07 Section "Penetration Firestopping."

3.5 EQUIPMENT, TANK, AND VESSEL INSULATION INSTALLATION

A. Mineral Fiber, Pipe and Tank Insulation Installation for Tanks and Vessels: Secure insulation with adhesive and anchor pins and speed washers.
1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of tank and vessel surfaces.
2. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.
3. Protect exposed corners with secured corner angles.
4. Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels as follows:
   a. Do not weld anchor pins to ASME-labeled pressure vessels.
   b. Select insulation hangers and adhesive that are compatible with service temperature and with substrate.
   c. On tanks and vessels, maximum anchor-pin spacing is 3 inchesfrom insulation end joints, and 16 inches o.c. in both directions.
   d. Do not overcompress insulation during installation.
   e. Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.
   f. Impale insulation over anchor pins and attach speed washers.
   g. 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.
5. Secure each layer of insulation with stainless-steel or aluminum bands. Select band material compatible with insulation materials.
6. Where insulation hangers on equipment and vessels are not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch prestressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs. Place one circumferential girdle around equipment approximately 6 inchesfrom each end. Install wire or cable between two circumferential girdles 12 inches o.c. Install a wire ring around each end and around outer periphery of center openings, and stretch prestressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of 48 inches o.c. Use this network for securing insulation with tie wire or bands.

7. Stagger joints between insulation layers at least 3 inches.
8. Install insulation in removable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.
9. Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.
10. For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.

B. Flexible Elastomeric Thermal Insulation Installation for Tanks and Vessels: Install insulation over entire surface of tanks and vessels.
1. Apply 100 percent coverage of adhesive to surface with manufacturer's recommended adhesive.
2. Seal longitudinal seams and end joints.

C. Insulation Installation on Pumps:
1. Fabricate metal boxes lined with insulation. Fit boxes around pumps and coincide box joints with splits in pump casings. Fabricate joints with outward bolted flanges. Bolt flanges on 6-inch centers, starting at corners. Install 3/8-inch-diameter fasteners with wing nuts. Alternatively, secure the box sections together using a latching mechanism.
2. Fabricate boxes from galvanized steel , at least 0.050 inch thick.
3. For below ambient services, install a vapor barrier at seams, joints, and penetrations. Seal between flanges with replaceable gasket material to form a vapor barrier.

3.6 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, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:
1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges except divide the two-part section on the vertical center line of valve body.
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.

E. Saddles and Shields: Unless otherwise indicated and except as specified in piping system Sections, install the following types:

1. Steel Pip-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. Include steel weight distribution plate for pipe NPS 4 and larger if pipe is installed on rollers.

3.7 CALCIUM SILICATE INSULATION INSTALLATION

A. Insulation Installation on Boiler Breechings and Ducts:
1. Secure single-layer insulation with stainless-steel bands at 12-inch intervals and tighten bands without deforming insulation material.
2. Install 2-layer insulation with joints tightly butted and staggered at least 3 inches. Secure inner layer with wire spaced at 12-inch intervals. Secure outer layer with stainless-steel bands at 12-inch intervals.
3. On exposed applications without metal jacket, finish insulation surface with a skim coat of mineral-fiber, hydraulic-setting cement. When cement is dry, apply flood coat of lagging adhesive and press on one layer of glass cloth. Overlap edges at least 1 inch. Apply finish coat of lagging adhesive over glass cloth. Thin finish coat to achieve smooth, uniform finish.

B. Insulation Installation on Straight Pipes and Tubes:
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 wire spaced at 12-inch intervals. Secure outer layer with stainless-steel bands at 12-inch intervals.
3. Apply a skim coat of mineral-fiber, hydraulic-setting cement to insulation surface. When cement is dry, apply flood coat of lagging adhesive and press on one layer of glass cloth or tape. Overlap edges at least 1 inch. Apply finish coat of lagging adhesive over glass cloth or tape. Thin finish coat to achieve smooth, uniform finish.

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.
4. Finish flange insulation same as pipe insulation.

D. 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 insulation sections of insulation are not available, install mitered sections of calcium silicate insulation. Secure insulation materials with wire or bands.
3. Finish fittings insulation same as pipe insulation.

E. Insulation Installation on Valves and Pipe Specialties:
   1. Install mitered segments of calcium silicate insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
   2. Install insulation to flanges as specified for flange insulation application.
   3. Finish valve and specialty insulation same as pipe insulation.

3.8 FLEXIBLE ELASTOMERIC INSULATION INSTALLATION

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.

3.9 MINERAL-FIBER INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:
   1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
   2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
   3. For insulation with factory-applied jackets on above ambient surfaces, secure laps with outward clinched staples at 6 inches o.c.
   4. For insulation with factory-applied jackets on below ambient surfaces, do not staple longitudinal tabs but secure tabs with additional adhesive as

recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe 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.

E. 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 inchesand 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 1 edge and 1 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 2 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 incheso.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.

F. 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 inchesand 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 1 edge and 1 end of

insulation segment. Secure laps to adjacent insulation section with 1/2-inchoutward-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 Fat 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 2 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 incheso.c.

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 PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. 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.

3.11 FIRE-RATED INSULATION SYSTEM INSTALLATION

A. Where fire-rated insulation system is indicated, secure system to ducts and duct hangers and supports to maintain a continuous fire rating.

B. Insulate duct access panels and doors to achieve same fire rating as duct.

C. Install firestopping at penetrations through fire-rated assemblies. Fire-stop systems are specified in Division 07 Section "Penetration Firestopping."

3.12 FINISHES

A. Duct, Equipment, and Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Division 09 painting Sections.
   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.

3.13 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 Engineer, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three location(s) for each duct system defined in the "Duct Insulation Schedule, General" Article.
   2. Inspect field-insulated equipment, randomly selected by Engineer, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three location(s) for each type of equipment defined in the "Equipment Insulation Schedule" Article. For large equipment, remove only a portion adequate to determine compliance.
   3. Inspect pipe, fittings, strainers, and valves, randomly selected by Engineer, 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, three locations of threaded strainers, three 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.

3.14 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, return located in the penthouse and mechanical rooms.
4. Indoor, concealed exhaust between automatic damper and penetration of building exterior.
5. Indoor, exposed exhaust between automatic damper and penetration of building exterior.
6. Indoor, concealed oven and warewash exhaust.
7. Indoor, exposed oven and warewash exhaust.
8. Outdoor, exposed supply and return

B. Items Not Insulated:
1. Fibrous-glass ducts.
2. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
3. Factory-insulated flexible ducts.
4. Factory-insulated plenums and casings.
5. Flexible connectors.
6. Vibration-control devices.
7. Factory-insulated access panels and doors.
8. Return ducts in return air plenums and shafts, **and in ceilings above conditioned occupied spaces**.

3.15 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

A.

DUCTWORK AND PLENUM INSULATION SCHEDULE				
Service	Insulation Type	Minimum Installed R-Value (hr*ft^2*°F)/BTU (See Note 6 and 7)	Facing and Jacket	Notes
Supply and Return Air				
Concealed, Supply ~~and Return~~ Air Ductwork	Flexible Mineral - Fiber Glass	R-6	FSK or FRK	Refer to Notes 1, 2, 3 and 5

DUCTWORK AND PLENUM INSULATION SCHEDULE				
Service	Insulation Type	Minimum Installed R-Value (hr*ft^2*°F)/BTU (See Note 6 and 7)	Facing and Jacket	Notes
Exposed, Supply and Return Air Ductwork	Rectangular Ductwork: Rigid Mineral – Fiber Glass Board Round and Flat Oval Ductwork: Flexible Mineral - Fiber Glass	R-6	White ASJ or PSK	Refer to Notes 1, 2, 3 and 5
Exposed in Mechanical Room, Supply and Return Air Ductwork Located Below 10 Feet	Rectangular Ductwork: Rigid Mineral – Fiber Glass Board Round and Flat Oval Ductwork: Flexible Mineral - Fiber Glass	R-6	PSK with White ASJ	Refer to Notes 1, 2, 3, 5 and 9
Exposed in Mechanical Room, Supply and Return Air Ductwork Located Above 10 Feet	Flexible Mineral - Fiber Glass	R-6	White ASJ or PSK	Refer to Notes 1, 2, 3 and 5
Outdoor Air				
Concealed, Outdoor Air Ductwork and Intake Air Plenums	Flexible Mineral - Fiber Glass	R-8 Climate Zones 1 – 4 R-12 Climate Zones 5 – 8	FSK or FRK	Refer to Note 4
Exposed, Outdoor Air Ductwork and Intake Air Plenums	Rectangular Ductwork: Rigid Mineral – Fiber Glass Board Round and Flat Oval Ductwork: Flexible Mineral - Fiber Glass	R-8 Climate Zones 1 – 4 R-12 Climate Zones 5 – 8	White ASJ or PSK	Refer to Note 4

DUCTWORK AND PLENUM INSULATION SCHEDULE				
Service	Insulation Type	Minimum Installed R-Value (hr*ft^2*°F)/BTU (See Note 6 and 7)	Facing and Jacket	Notes
Exposed in Mechanical Room, Outdoor Air Ductwork and Intake Air Plenums Located Below 10 Feet	Rectangular Ductwork: Rigid Mineral – Fiber Glass Board Round and Flat Oval Ductwork: Flexible Mineral - Fiber Glass	R-8 Climate Zones 1 – 4 R-12 Climate Zones 5 – 8	PSK with White ASJ	Refer to Notes 4 and 9
Exposed in Mechanical Room, Outdoor Air Ductwork and Intake Air Plenums Located Above 10 Feet	Flexible Mineral - Fiber Glass	R-8 Climate Zones 1 – 4 R-12 Climate Zones 5 – 8	White ASJ or PSK	Refer to Note 4
Exhaust Air				
Concealed, Exhaust and Relief Air Ductwork and Discharge Air Plenums Downstream of Isolation Damper	Flexible Mineral - Fiber Glass	R-8 Climate Zones 1 – 4 R-12 Climate Zones 5 – 8	FSK or FRK	Refer to Notes 2 and 3
Exposed, Exhaust and Relief Air Ductwork and Discharge Air Plenums Downstream of Isolation Damper	Rectangular Ductwork: Rigid Mineral – Fiber Glass Board Round and Flat Oval Ductwork: Flexible Mineral - Fiber Glass	R-8 Climate Zones 1 – 4 R-12 Climate Zones 5 – 8	White ASJ or PSK	Refer to Notes 2 and 3

DUCTWORK AND PLENUM INSULATION SCHEDULE				
Service	Insulation Type	Minimum Installed R-Value (hr*ft^2*°F)/BTU (See Note 6 and 7)	Facing and Jacket	Notes
Exposed in Mechanical Room, Exhaust and Relief Air Ductwork and Discharge Air Plenums Downstream of Isolation Damper and Located Below 10 Feet	Rectangular Ductwork: Rigid Mineral – Fiber Glass Board Round and Flat Oval Ductwork: Flexible Mineral - Fiber Glass	R-8 Climate Zones 1 – 4 R-12 Climate Zones 5 – 8	PSK with White ASJ	Refer to Notes 2, 3 and 9
Exposed in Mechanical Room, Exhaust and Relief Air Ductwork and Discharge Air Plenums Downstream of Isolation Damper and Located Above 10 Feet	Flexible Mineral - Fiber Glass	R-8 Climate Zones 1 – 4 R-12 Climate Zones 5 – 8	White ASJ or PSK	Refer to Notes 2 and 3
Misc. Exhaust Air				
Concealed, Oven and Warewash Exhaust Air Ductwork and Discharge Air Plenums	Flexible Mineral - Fiber Glass	R-6 minimum or as required to limit the surface temperature to 120°F	FSK or FRK	Refer to Notes 3 and 8
Exposed, Oven and Warewash Exhaust Air Ductwork and Discharge Air Plenums	Rectangular Ductwork: Rigid Mineral – Fiber Glass Board Round and Flat Oval Ductwork: Flexible Mineral - Fiber Glass	R-6 minimum or as required to limit the surface temperature to 120°F	PSK with White ASJ	Refer to Notes 3 and 8

DUCTWORK AND PLENUM INSULATION SCHEDULE				
Service	Insulation Type	Minimum Installed R-Value (hr*ft^2*°F)/BTU (See Note 6 and 7)	Facing and Jacket	Notes
Exposed in Mechanical Room, Oven and Warewash Exhaust Air Ductwork and Discharge Air Plenums Located Below 10 Feet	Rectangular Ductwork: Rigid Mineral – Fiber Glass Board Round and Flat Oval Ductwork: Flexible Mineral - Fiber Glass	R-6 minimum or as required to limit the surface temperature to 120°F	PSK with White ASJ	Refer to Notes 3, 8 and 9
Exposed in Mechanical Room, Oven and Warewash Exhaust Air Ductwork and Discharge Air Plenums Located Above 10 Feet	Flexible Mineral - Fiber Glass	R-6 minimum or as required to limit the surface temperature to 120°F	White ASJ or PSK	Refer to Notes 3 and 8
Misc.				
Louver Blocked-off Panels	Rigid Mineral - Fiber Glass Board	R-8 Climate Zones 1 – 4 R-12 Climate Zones 5 – 8	White ASJ or PSK	
Diffusers and Equipment				
Diffuser ~~and Chilled Beam~~ Plenums, Backs and Necks	Flexible Mineral - Fiber Glass or Rigid Mineral - Fiber Glass Board	R-6 R-8 Rhode Island *See Notes*	FSK or FRK	
Exterior Supply and Return Air				

DUCTWORK AND PLENUM INSULATION SCHEDULE				
Service	Insulation Type	Minimum Installed R-Value (hr*ft^2*°F)/BTU (See Note 6 and 7)	Facing and Jacket	Notes
Aboveground, Exterior Supply and Return Air Ductwork	Rigid Mineral - Fiber Glass Board	R-8 Climate Zones 1 – 4 R-12 Climate Zones 5 – 8	FSK or FRK with All-Weather Flexible Weather-Proofing Jacket, 0.032 inch thick smooth or stucco embossed aluminum jacket or approved equal	Refer to Note 10

Notes:
1. Return air ductwork that is located in a return air plenum**, <u>above an occupied conditioned space,</u>** or exposed in the area served does not require insulation.
2. Exhaust air ductwork associated with energy recovery units and/or systems is to be considered return air ductwork.
3. Exhaust air ductwork serving areas within the building that are humidified and are located in unconditioned spaces or exterior to the building is to be considered return air ductwork.
4. Combustion air ductwork is to be considered outside air ductwork.
5. Exposed low pressure supply ductwork provided with duct mounted side wall diffusers and is located in the area that it is serving is to be provided with duct liner to meet the specified R-Value.
6. Installed R-Value considers 25% compression of non-rigid insulation.
7. R-Values specified may be obtained by adding the R-Values of both the duct liner (where applicable) and the external duct insulation.
8. Ducts that operate at temperatures exceeding 120°F are to have sufficient thermal insulation to limit the surface temperature to 120°F.
9. Ductwork insulation located within 10 feet from the finished floor in mechanical rooms or exposed areas is to be protected with 30 mils thick high impact PVC jacket.
10. Exterior ductwork insulation is to be provided with adequate slope (watershed) to prevent ponding water.
11. Definitions:
    a. ASJ – All-Service Jacket (PVC)
    b. PSK – Polypropylene-Scrim-Kraft
    c. FSK – Foil-Scrim-Kraft
    d. FRK – Foil-Reinforced-Kraft

3.16 EQUIPMENT INSULATION SCHEDULE

A. Insulation materials and thicknesses are identified below.

B. Insulate indoor and outdoor equipment in paragraphs below that is not factory insulated.

C. Chilled-water pumps insulation shall be the following:
   1. Mineral-Fiber Board: 2 inches thick and 6-lb/cu. ft. nominal density.

D. Heating-hot-water pump insulation shall be the following:
   1. Mineral-Fiber Board: 2 inches thick and 6-lb/cu. ft. nominal density.

E. Heating-hot-water and chilled water air-separator insulation shall be the following:
   1. Mineral-Fiber Board: 2 inchesthick and 6-lb/cu. ft. nominal density.

3.17 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. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.18 INDOOR PIPING INSULATION SCHEDULE

A. Cold water Makeup, condensate and Equipment Drain Water below 60 Deg F
   1. All Pipe Sizes: Insulation shall be the following:
      a. Mineral Fiber Preformed pipe type I: 1 inch thick

B. Chilled Water Supply and Return, 40 Deg F
   1. NPS 3 and smaller: Insulation shall be the following:
      a. Mineral Fiber Preformed pipe type I : 1 inch thick
   2. NPS 4 TO NPS 12 : Insulation shall be the following:
      a. Mineral Fiber Preformed pipe insulation type 1: 1-1/2 inch thick
   3. NPS 14 and larger: Insulation to be the followings;
      a. Mineral Fiber Preformed pipe insulation type 1: 1-1/2 inch thick

C. Heating-Hot-Water Supply and Return, 200 Deg Fand below:
   1. NPS 12 and Smaller: Insulation shall be the following:
      a. Mineral-Fiber, Preformed Pipe, Type I: 2 inches thick.

D. Refrigerant Suction and Hot-Gas Piping:
   1. All Pipe Sizes: Insulation shall be the following:
      a. Flexible Elastomeric: 1 inch thick.

E. Hot Service Drains:
   1. All Pipe Sizes: Insulation shall be the following:
      a. Mineral-Fiber, Preformed Pipe, Type I or II: 1 inch thick.

F. Hot Service Vents:
   1. All Pipe Sizes: Insulation shall be the following:
      a. Mineral-Fiber, Preformed Pipe, Type I or II: 1 inch thick.

G. Steam and Steam Condensate, 350 Deg F (177 Deg C) and below:
   1. NPS ¾ inches and Smaller: Insulation shall be the following:
      a. Mineral-Fiber, Preformed Pipe, Type I or II: 3 inches thick.
   2. NPS 1 inch to 6 inch: Insulation shall be the following:
      a. Mineral- Fiber, Performed Pipe, Type I or II: 4.5 inches thick.
   3. NPS 8 inch and Larger: Insulation shall be the following:
      a. Mineral-Fiber, Preformed Pipe, Type I or II: 4.5 inches thick.

H. Steam and Steam Condensate, above 350 Deg F (177 Deg C):
   1. NPS ¾ inches and Smaller: Insulation shall be the following:
      a. Mineral-Fiber, Preformed Pipe, Type I or II: 4.5 inches thick.
   2. NPS 1 inch and Larger: Insulation shall be the following:
      a. Mineral- Fiber, Preformed Pipe, Type I or II: 5 inches thick.

3.19 OUTDOOR, ABOVEGROUND AND UNHEATED ENCLOSURE PIPING INSULATION SCHEDULE

A. Piping that is exposed to outside elements or below building ambient temperatures shall be heat traced and insulated. Coordinate all requirements with electrical contractor for piping lengths. All piping insulation installed outdoors or exposed above ground shall be protected by a wrapped weather proof all aluminum heavy duty jacket (.050” thick) with z-shaped locking seams.

B. Cold water Makeup and Equipment Drain Water:
   1. All Pipe Sizes: Insulation shall be the following:
      a. Mineral Fiber Preformed pipe type I: 1-1/2 inch thick
      b. Allow for heat traced piping surfaces

C. Chilled Water Supply and Return:
   1. All Pipe Sizes: Insulation shall be the following:
      a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 3 inchesthick.

D. Heating-Hot-Water Supply and Return, 200 Deg F:
   1. All Pipe Sizes: Insulation shall be the following:
      a. Mineral-Fiber, Preformed Pipe Insulation, Type I or II: 3 inchesthick.
      b. Allow for heat traced piping surfaces.

E. Heating-Hot-Water Supply and Return, above 250 Deg F (121 Deg C) and Steam and Steam Condensate, 350 Deg F and below:

   1. All Pipe Sizes: Insulation shall be the following:
      a. Mineral-Fiber, Preformed Pipe Insulation, Type I or II: 4 1/2 inchesthick.

F. Steam and Steam Condensate, above 350 Deg F:

   1. All Pipe Sizes: Insulation shall be the following:
      a. Mineral-Fiber, Preformed Pipe Insulation, Type I or II: 5 inches thick.

G. Refrigerant Suction and Hot-Gas Piping:
   1. All Pipe Sizes: Insulation shall be the following:
      a. Flexible Elastomeric: 2 inches thick.

3.20 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. Ducts and Plenums, Concealed:
   1. None.

C. Ducts and Plenums, Exposed:
   1. None.

D. Equipment, Concealed:
   1. None.

E. Equipment, Exposed, up to 48 Inches in Diameter or with Flat Surfaces up to 72 Inches:
   1. None.

F. Equipment, Exposed, Larger Than 48 Inches in Diameter or with Flat Surfaces Larger Than 72 Inches:
   1. None.

G. Piping, Concealed:
   1. None.

H. Piping, exposed:
   1. PVC Jackets in Mechanical rooms up to 10 feet AFF and on all exposed piping in occupied spaces.

I. Piping, Fittings and Elbows:
   1. PVC fitting Jackets on all pipe fittings, elbows, valves, tees and mechanical couplings.
   2. Extended valve stems shall be fitted with PVC jackets and insulation.
   3. Provide continuous vapor barrier on all cold surfaces.

3.21 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. Ducts and Plenums, Exposed

   1. Self-adhesive Aluminized Outdoor Jacket, White, stucco-embossed, 24 mil Ventureclad 1579.

D. Piping, Exposed:

   1. Self-adhesive Aluminized Outdoor Jacket, White, stucco-embossed, 24 mil Ventureclad 1579.

END OF SECTION

SECTION 23 08 00

COMMISSIONING OF HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Section 01 81 13 “Sustainable Design Requirements – LEED v4 for Building Design & Construction – New Construction” for sustainable design requirements and detailed sustainable design submittal requirements.

C. Section 01 74 19 “Construction and Demolition Waste Management and Disposal” for disposal of construction, demolition and packaging waste disposal requirements.

1.2 SUMMARY

A. Section includes commissioning process requirements for HVAC&R systems, assemblies, and equipment.

B. Related Sections:
   1. Division 01 9100 Section "General Commissioning Requirements" for general commissioning process requirements.

C. Sustainable Building Requirements:
   1. The Owner requires the Contractor to implement practices and procedures to meet the project’s environmental performance goals, which include achieving LEED version 4 Certified level Certification. Specific project goals that may impact this area of work include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; construction waste recycling; and the implementation of a construction indoor air quality management plan. The Contractor shall ensure that the requirements related to these goals, as defined in the Articles below, are implemented to the fullest extent. Substitutions, or other changes to the work proposed by the Contractor or their Subcontractors, shall not be allowed if such changes compromise the aforementioned environmental goals and LEED certification.

1.3 ALLOWANCES

A. Labor, instrumentation, tools, and equipment costs for technicians for the performance of commissioning testing are covered by the "Schedule of Allowances" Article in Division 01 Section "Allowances."

1.4 UNIT PRICES

A. Commissioning testing allowance may be adjusted up or down by the "List of Unit Prices" Article in Division 01 Section "Unit Prices" when actual man-hours are computed at the end of commissioning testing.

1.5 CONTRACTOR'S RESPONSIBILITIES

A. Perform commissioning tests at the direction of the CxA.

B. Attend construction phase controls coordination meeting.

C. Attend testing, adjusting, and balancing review and coordination meeting.

D. Participate in HVAC&R systems, assemblies, equipment, and component maintenance orientation and inspection as directed by the CxA.

E. Provide information requested by the CxA for final commissioning documentation.

F. Provide measuring instruments and logging devices to record test data, and provide data acquisition equipment to record data for the complete range of testing for the required test period.

1.6 CxA'S RESPONSIBILITIES

A. Provide Project-specific construction checklists and commissioning process test procedures for actual HVAC&R systems, assemblies, equipment, and components to be furnished and installed as part of the construction contract.

B. Direct commissioning testing.

C. Verify testing, adjusting, and balancing of Work are complete.

D. Provide test data, inspection reports, and certificates in Systems Manual.

1.7 COMMISSIONING DOCUMENTATION

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

1.8 SUBMITTALS

A. Certificates of readiness.

B. Certificates of completion of installation, prestart, and startup activities.

PART 2 - PRODUCTS

(Not Used)

PART 3 - EXECUTION

3.1 TESTING PREPARATION

A. Certify that HVAC&R systems, subsystems, and equipment have been installed, calibrated, and started and are operating according to the Contract Documents.

B. Certify that HVAC&R instrumentation and control systems have been completed and calibrated, that they are operating according to the Contract Documents, and that pretest set points have been recorded.

C. Certify that testing, adjusting, and balancing procedures have been completed and that testing, adjusting, and balancing reports have been submitted, discrepancies corrected, and corrective work approved.

D. Set systems, subsystems, and equipment into operating mode to be tested (e.g., normal shutdown, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).

E. Inspect and verify the position of each device and interlock identified on checklists.

F. Check safety cutouts, alarms, and interlocks with smoke control and life-safety systems during each mode of operation.

G. Testing Instrumentation: Install measuring instruments and logging devices to record test data as directed by the CxA.

3.2 TESTING AND BALANCING VERIFICATION

A. Prior to performance of testing and balancing Work, provide copies of reports, sample forms, checklists, and certificates to the CxA.

B. Notify the CxA at least [10] <Insert number> days in advance of testing and balancing Work, and provide access for the CxA to witness testing and balancing Work.

C. Provide technicians, instrumentation, and tools to verify testing and balancing of HVAC&R systems at the direction of the CxA.
   1. The CxA will notify testing and balancing [Contractor] [Subcontractor] [10] <Insert number> days in advance of the date of field verification. Notice will not include data points to be verified.
   2. The testing and balancing [Contractor] [Subcontractor] shall use the same instruments (by model and serial number) that were used when original data were collected.
   3. Failure of an item includes, other than sound, a deviation of more than 10 percent. Failure of more than 10 percent of selected items shall result in rejection of final testing, adjusting, and balancing report. For sound pressure readings, a deviation of 3 dB shall result in rejection of final testing. Variations in background noise must be considered.

4. Remedy the deficiency and notify the CxA so verification of failed portions can be performed.

3.3 GENERAL TESTING REQUIREMENTS

A. Provide technicians, instrumentation, and tools to perform commissioning test at the direction of the CxA.

B. Scope of HVAC&R testing shall include entire HVAC&R installation, from central equipment for heat generation and refrigeration through distribution systems to each conditioned space. Testing shall include measuring capacities and effectiveness of operational and control functions.

C. Test all operating modes, interlocks, control responses, and responses to abnormal or emergency conditions, and verify proper response of building automation system controllers and sensors.

D. The CxA along with the HVAC&R [Contractor] [Subcontractor], testing and balancing [Contractor] [Subcontractor], and HVAC&R Instrumentation and Control [Contractor] [Subcontractor] shall prepare detailed testing plans, procedures, and checklists for HVAC&R systems, subsystems, and equipment.

E. Tests will be performed using design conditions whenever possible.

F. Simulated conditions may need to be imposed using an artificial load when it is not practical to test under design conditions. Before simulating conditions, calibrate testing instruments. Provide equipment to simulate loads. Set simulated conditions as directed by the CxA and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.

G. The CxA may direct that set points be altered when simulating conditions is not practical.

H. The CxA may direct that sensor values be altered with a signal generator when design or simulating conditions and altering set points are not practical.

I. If tests cannot be completed because of a deficiency outside the scope of the HVAC&R system, document the deficiency and report it to the Owner. After deficiencies are resolved, reschedule tests.

J. If the testing plan indicates specific seasonal testing, complete appropriate initial performance tests and documentation and schedule seasonal tests.

3.4 HVAC&R SYSTEMS, SUBSYSTEMS, AND EQUIPMENT TESTING PROCEDURES

A. Boiler Testing and Acceptance Procedures: Testing requirements are specified in Division 23 boiler Sections. Provide submittals, test data, inspector record, and boiler certification to the CxA.

B. HVAC&R Instrumentation and Control System Testing: Field testing plans and testing requirements are specified in Division 23 Sections "Instrumentation and Control for HVAC" and "Sequence of Operations for HVAC Controls." Assist the CxA with preparation of testing plans.

C. Pipe system cleaning, flushing, hydrostatic tests, and chemical treatment requirements are specified in Division 23 piping Sections. HVAC&R [Contractor] [Subcontractor] shall prepare a pipe system cleaning, flushing, and hydrostatic

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

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

D. Energy Supply System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of [oil] [gas] [coal] [steam] [hot-water] [and] [solar] systems and equipment at the direction of the CxA. The CxA shall determine the sequence of testing and testing procedures for each equipment item and pipe section to be tested.

E. Refrigeration System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of chillers, cooling towers, refrigerant compressors and condensers, heat pumps, and other refrigeration systems. The CxA shall determine the sequence of testing and testing procedures for each equipment item and pipe section to be tested.

F. HVAC&R Distribution System Testing: Provide technicians, instrumentation, tools, and equipment to test performance of air, steam, and hydronic distribution systems; special exhaust; and other distribution systems, including HVAC&R terminal equipment and unitary equipment.

G. Vibration and Sound Tests: Provide technicians, instrumentation, tools, and equipment to test performance of vibration isolation and seismic controls.

END OF SECTION

This page is intentionally left blank.

SECTION 230900

HVAC INSTRUMENTATION AND CONTROLS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this section.

B. Section 01 81 13 “Sustainable Design Requirements – LEED v4 for Building Design & Construction – New Construction” for sustainable design requirements and detailed sustainable design submittal requirements.

C. Section 01 74 19 “Construction and Demolition Waste Management and Disposal” for disposal of construction, demolition and packaging waste disposal requirements

1.2 SUMMARY

A. This Section includes control equipment for HVAC systems and components, including control components for terminal heating and cooling units not supplied with factory-wired controls.

B. Sustainable Building Requirements:

1. The Owner requires the Contractor to implement practices and procedures to meet the project’s environmental performance goals, which include achieving LEED version 4 Certified level Certification. Specific project goals that may impact this area of work include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; construction waste recycling; and the implementation of a construction indoor air quality management plan. The Contractor shall ensure that the requirements related to these goals, as defined in the Articles below, are implemented to the fullest extent. Substitutions, or other changes to the work proposed by the Contractor or their Subcontractors, shall not be allowed if such changes compromise the aforementioned environmental goals and LEED certification.

1.3 DEFINITIONS

A. AHU: Air Handling Unit.

B. ATC: Automatic Temperature Control.

C. BMS: Building Management System.

D. CFM: Cubic Feet per Minute.

E. DDC: Direct-digital controls.

F. FAS: Fire Alarm System.

G. HVAC: Heating, Ventilating and Air Conditioning.

H. LAN: Local area network.

I. LCD: Liquid Crystal Display

J. MER: Mechanical Equipment Room.

K. PID: Proportional Integral Derivative.

L. POT: Portable Operators Terminal.

M. VFD: Variable Frequency Drive.

1.4 SYSTEM DESCRIPTION

A. Control system consists of sensors, indicators, actuators, final control elements, interface equipment, other apparatus and accessories to control mechanical systems.

B. Control system shall consist of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, accessories and software connected to distributed controllers operating in multiuser, multitasking environment on a network and programmed to control mechanical systems. An operator workstation permits interface with the network via dynamic color graphics with each mechanical system, building floor plan and control device depicted by point-and-click graphics.

C. Furnish a totally BACnet-based system, based on a distributed control system in accordance with this specification. The operator's workstation, all controllers and all input/output devices shall communicate using the protocols and network standards as defined by ANSI/ASHRAE Standard 135 - 2010 - BACnet. In other words, all workstations and controllers shall be BACnet devices. No gateways shall be used for communication to controllers installed under this section. Gateways may be used for communication to existing systems or to systems installed under other sections. Use of proprietary protocol on any part of the network is prohibited.

D. Provide Building Controllers (BC), Advanced Application Controllers (AAC), Application Specific Controllers (ASC), Smart Actuators (SA) and Smart Sensors (SS) as required. Every device in the system which executes control logic and directly controls HVAC equipment must conform to a standard BACnet Device profile as specified in the latest version of ANSI/ASHRAE 135, BACnet Annex L. Unless otherwise specified, hardwired actuators and sensors may be used in lieu of BACnet Smart Actuators and Smart Sensors.

1.5 SYSTEM PERFORMANCE

A. Comply with the following performance requirements:

B. Graphic Display: Display graphic with minimum 20 dynamic points with current data within 10 seconds.

1. Graphic Refresh: Update graphic with minimum 20 dynamic points with current data within 8 seconds.

2. Object Command: Reaction time of less than 2 seconds between operator command of a binary object and device reaction.

3. Object Scan: Transmit change of state and change of analog values to control units or workstation within 6 seconds.

4. Alarm Response Time: Annunciate alarm at workstation within 45 seconds. Multiple workstations must receive alarms within 5 seconds of each other.

1.6 WORK INCLUDED

A. Furnish a complete distributed direct digital control system in accordance with this specification section. This includes all supervisory controllers, network controllers, logic controllers and all input/output devices. Items of work included are as follows:

1. Provide a submittal that meets the requirements below for approval.

2. Coordinate installation schedule with the mechanical contractor and general contractor.

3. Provide installation of all panels and devices unless otherwise stated.

4. Provide power for panels and control devices from a source designated by the electrical contractor. All 120 volt power circuits to the DDC panel(s) shall be provided by this Contractor (unless specifically shown on the electrical drawings).

5. Provide all low voltage control wiring for the DDC system. All wiring of sensors and control devices including any power wiring of devices and necessary conduit shall be provided under this section of the specifications.

6. Provide miscellaneous control wiring for HVAC and related systems regardless of voltage.

7. Provide engineering and technician labor to program and commission software for each system and operator interface. Submit start up reports for approval.

8. Provide testing, demonstration and training as specified below.

9. Provide all necessary BACnet-compliant hardware and software to meet the system's functional specifications. Provide Protocol Implementation Conformance Statement (PICS) for Windows-based control software and every controller in system.

10. The BMS server licensing options shall allow a minimum of five (5) local workstation connections/access concurrently.

11. The web server licensing options shall allow concurrent access by a minimum of five (5) remote browser connections. These licenses shall be in addition to the five (5) licenses assigned for local connections

12. BMS controllers must be powered off the equipment branch. Applies to all central equipment (AHUs, pumps, condensate pumps, etc.) and any fan serving isolation rooms, protective environment rooms or any other space that must maintain a pressure relationship to its surroundings.

13. BMS controllers shall be connected to UPS power. Installation shall incorporate a bypass switch to allow for a faulty UPS to be replaced without interrupting power to the controller or controllers it serves.

14. All setpoints shall be user adjustable from the BMS graphics.

15. Coordinate with MMC for BACNet device numbering for new equipment HVAC controllers.

16. Utilize mechanical design plans for building floor plans on the BMS graphics.

17. AHU controls shall be accessible from the floor. A ladder shall not be necessary to reset or read these devices. Tubing or wires shall be run to a convenient location.

    a. Example: High static resets shall be resettable from the floor level.

    b. Flow station controllers, and other readout devices shall be visible from the floor level.

18. Read out devices, control resets, etc. shall be accessible from the floor.

19. BMS contractors to provide a user change log for MMC BMS.

20. BMS software shall have the ability to have owner create customized reports without assistance from the controls vendor (at no additional cost to the owner).

21. VAV box controllers and actuators shall be shipped to the VAV box manufacturer for factory installation. Coordinate with Mechanical Contractor.

1.7 SUBMITTALS

A. One (1) submittal package shall be provided for the project that includes information for controls for all systems being provided as part of the project. Partial submittals are not acceptable and shall not be reviewed by the Engineer. For example, it is not acceptable to submit a control valve schedule as part of one package and control diagrams as part of a later package. For large projects or where partial submittals may be required to maintain the project schedule, the contractor shall coordinate a schedule for delivery of each partial submittal and the items to be contained within each submittal. It shall not be up to the contractor's discretion as to what shall be included in each partial submittal.

B. Product Data: Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials and installation and startup instructions for each type of product indicated.

    1. Each control device labeled with setting or adjustable range of control.

    2. DDC System Hardware: Include technical data for operator workstation equipment, interface equipment, control units, transducers/transmitters, sensors, actuators, valves, relays/switches, control panels and operator interface equipment.

    3. Control System Software: Include technical data for operating system software, operator interface, color graphics and other third-party applications.

    4. 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.

C. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components and location and size of each field connection. Submittal shall include the following as a minimum:

1. Schematic flow diagrams showing fans, pumps, coils, dampers, valves, instrumentation and control devices.
2. Wiring Diagrams: Power, signal and control wiring.
3. Architecture drawing including all communication wiring, network devices, etc. Indicate type of cabling and number of conductors.
4. Symbol and abbreviation list for control diagrams.
5. Points list including hardwired and software points.
6. Manufacturer's technical cut sheets which include a table of contents and an associated sheet numbering system for all pages. Model number shall be circled or pointed with an arrow.
7. A complete bill of materials specific to each system detailing the equipment to be used, quantity, manufacturer, specific model number and tag number.
8. List of color graphics indicating monitored systems, data (connected and calculated) point addresses, output schedule and operator notations.
9. Details of control panel faces, including controls, instruments and labeling.
10. Schedule of dampers including size, leakage and flow characteristics.
11. Schedule of valves including leakage, flow characteristics, GPM, design pressure drop, actual pressure drop, design CV, calculated CV, valve body pressure rating, and close-off pressure rating at a minimum.
12. All shop drawings used by field personnel for the installation of equipment shall bear an Engineer's approval stamp.
13. Architectural floor plans indicating proposed locations of all wall-mounted devices (i.e., DDC units, control panels, sensors, thermostats, etc.) and mechanical drawings indicating proposed locations of all temperature, flow and pressure transmitters.
14. Qualification Data: For firms and persons specified in "Quality Assurance" Article.

D. Data Communications Protocol Certificates: Certify that each proposed DDC system component complies with the latest version of ASHRAE 135 related to BACnet.

E. Samples for Initial Selection: For each color required, of each type of thermostat and/or sensor cover with factory-applied color finishes.

F. Operation and Maintenance Data: For HVAC instrumentation and control system to include in emergency, operation and maintenance manuals. In addition to items specified in Division 1 Section "Operation and Maintenance Data," include the following:

1. Maintenance instructions and lists of spare parts for each type of control device and compressed-air station.
2. Inspection period, cleaning methods, cleaning materials recommended and calibration tolerances.
3. Calibration records and list of set points.

G. The BMS Contractor shall correct any errors or omissions noted by the Owner and Engineer during review.

H. Device substitutions shall be considered as long as they are submitted to the engineer one week in advance of the bid via a formal RFI. Contractor shall provide a technical comparison in spreadsheet format that includes, at a minimum, comparison of physical size, accuracy, drift, cost, turndown, options provided, device warranty, as applicable.

1.8 SEQUENCING AND SCHEDULING

A. Sequence and coordinate the work of this Section with the scheduling requirements and the Engineer. Review the approved schedule with the Engineer, sub-contractors, manufacturers, vendors, suppliers and all other contractors. Schedule and sequence all Work with the adjoining Work, and Work of others such that the all Work can be accomplished concurrently during the same time period.

1.9 QUALITY ASSURANCE

A. Installer Qualifications: A qualified installer who is an authorized representative of the automatic control system manufacturer for both installation and maintenance of units required for this Project.

B. Electrical Components, Devices and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction and marked for intended use.

C. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilation Systems."

D. Materials and equipment shall be the catalogued products of manufacturers regularly engaged in production and installation of automatic temperature control systems and shall be manufacturer's latest standard design that complies with the specification requirements.

E. All portions of the system must be designed, furnished, installed, commissioned and serviced by manufacturer-approved, factory-trained employees.

F. Single source responsibility of supplier shall be the complete installation and proper operation of the BMS and control system and shall include debugging and proper calibration of each component in the entire system.

G. Supplier shall have an in-place support facility within 50 miles of the site with technical staff, spare parts inventory and all necessary test and diagnostic equipment.

H. All electronic equipment shall conform to the requirements of FCC Regulation, Part 15, Section 15, Governing Radio Frequency Electromagnetic Interference and be so labeled.

I. All system components shall be fault-tolerant. System shall include:

1. Satisfactory operation without damage at 110% and 90% of rated voltage and at plus 3 Hertz variation in line frequency.

2. Static, transient and short-circuit protection on all inputs and outputs.

3. Protection for communication lines against incorrect wiring, static transients and induced magnetic interference.

4. Network-connected devices to be AC coupled or equivalent so that any single device failure will not disrupt or halt network communication.

5. All real time clocks and data file RAM to be battery-backed for a minimum 100 hours and include local and remote system low battery indication.

J. The BMS contractor shall be regularly engaged in the installation and maintenance of BMS systems and shall meet the following qualifications.

1. A minimum of 10 years of demonstrated technical expertise and experience in the installation and maintenance of BMS systems similar in size and complexity to this project.
2. A minimum of 10 years experience installing the control system of the manufacturer that is to be proposed.
3. Shall be a certified-to-install, direct representative of a control system manufacturer that has a minimum of 10 years experience producing control systems similar to that which is to be proposed.
4. A maintained service organization consisting of at least 8 competent servicemen, within 50 miles of the project site, for a period of not less than 10 years.
5. The Bidder shall not be considered qualified to bid this project unless they can provide a list of 10 projects, similar in size and scope to this project, completed within the last 4 years.
6. The system manufacturer/installer shall provide an experienced project manager for this work from beginning of control installation until final completion. The project manager is responsible for direct supervision of the design, installation, start-up and commissioning of the BMS as well as attending of project meetings whenever directed by the owner, construction manager and/or mechanical contractor. It shall not be acceptable to change the project manager after the project has begun and before final completion. If the BMS manufacturer wishes to change the project manager, the construction manager and/or owner's representative must be notified immediately and both the new project manager and the previous project manager shall spend three (3) consecutive business days together on-site performing a project management switchover. Exceptions may be allowed for small projects as determined by the construction manager and/or owner's representative.

K. Comply with all current governing codes, ordinances and regulations including UL, NFPA, the local Building Code, NEC, etc.

L. The system shall have a documented history of compatibility by design for a minimum of 15 years. Future compatibility shall be supported for no less than 10 years. Compatibility shall be defined as the ability for any existing control system component including but not limited to primary control panels, secondary control panels, personal operator workstations and portable operator's terminals, to be connected and directly communicate with any new BMS system equipment without bridges, routers or protocol converters.

1.10 DELIVERY, STORAGE AND HANDLING

A. Factory-Mounted Components: Where control devices specified in this Section are indicated to be factory mounted on equipment, arrange for shipping of control devices to unit manufacturer.

B. Provide factory shipping cartons for each piece of equipment and control device. Maintain cartons while shipping, storing and handling as required to prevent equipment damage, and to eliminate dirt and moisture from equipment. Store equipment and materials inside and protect from weather. The stored products

shall be protected from the weather, humidity and temperature variations, dirt and dust, and other contaminants, within the storage condition limits published by the equipment manufacturer.

C. System Software: Update to latest version of software at project completion.

1.11 COORDINATION

A. Coordinate location of temperature sensors, humidity sensors and other exposed control sensors with plans and room details before installation.

B. Coordinate installation of taps, valves, airflow stations, etc. with the mechanical contractor.

C. Coordinate BMS equipment with all relevant divisions including, but not limited to, Fire Alarm to achieve compatibility with equipment that interfaces with that system.

D. Coordinate BMS equipment to achieve compatibility with motor starters and annunciation devices.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:

1. Automated Logic Corporation NY/NJ – Branch Office.

2. Honeywell, Inc. – Branch Office.

3. Schneider Electric - Branch Office

4. Siemens Building Technologies, Inc.

5. Trane – Branch Office

2.2 CONTROL PANELS

A. Fully enclosed, steel-rack-type cabinet with locking doors or locking removable backs. Match finish of panels and provide laminated as-built wiring diagrams, flow diagrams, etc. related to the system being controlled inside the associated cabinet. Each control panel shall be clearly and permanently labeled with the controller designation and indication of the mechanical equipment served.

B. Where applicable, existing primary control panel enclosures shall be reused where possible. Replacement of any control panel enclosure and sub-panel shall be included in the base contract.

C. Unitize cabinet with suitable brackets for wall or floor mounting, located adjacent to each system under automatic control. Provide common keying for all panels.

1. Fabricate panels of furniture-quality steel or extruded-aluminum alloy, totally enclosed, with hinged doors and keyed lock and with manufacturer's standard shop-painted finish. All panels shall have common keying.

2. Primary control panel: Provide minimum NEMA 12 rating for indoor application and NEMA 4 rating for outdoor application or the appropriate NEMA rating for application. Electrical piping and wiring shall be penetrated through the bottom of the panel with 4 inch nipples and 4 inches wiring trough. All control panel conduit penetrations shall be done at the side or the bottom of the panel as per MMC standards.
3. Secondary control panel: Provide minimum NEMA 1 rating for indoor application.
4. Size control panel enclosures for twenty percent spare mounting capacity for future expansion.
5. Multiple controllers shall be allowed in a control panel with expansion modules if extra points are needed.

D. Control panel shop drawings shall be submitted for each system (air handling unit, chilled water system, hot water system, etc.) for approval prior to fabrication.

E. BMS panels shall include panel drawings, points list, wiring diagrams, controller logic, sequences of operations, inside the pouch on the enclosure door.

F. Coordinate installation of the control panels with the engineer/architect. Coordinate power for the panels with the electrical contractor.

G. Control Panel Internal Components:

1. Provide identification sleeves at each termination.
2. All control devices such as relays, transformers, transducers, power supplies, associated I/O devices, etc shall be installed inside the panel, not at the starter or electrical junction box.
3. All panel wirings shall in be installed in Panduit and wiring duct. This shall include but not be limited to wiring from the DDC controller to the terminal block, between DDC controller and relay (and other panel mounted control devices), power wiring for the controller, communication, etc.
4. Mounting any control devices on the back of the control panel enclosure door is not acceptable.
5. The use of wire nuts in the control panel enclosures is also prohibited.

H. Power wiring and communication wiring shall be provided in separate conduits with separate hot, neutral, and ground wire runs and separate breakers.

I. Coordinate installation of the control panels with the Owner. Coordinate power for the panels with the electrical contractor.

2.3 BMS SYSTEM ARCHITECTURE

A. The BMS system shall use a Client/Server architecture based on a modular PC network, utilizing industry standard operating systems, networks and protocols.

B. The system shall allow the distribution of system functions such as monitoring and control and graphical user interface etc. across the network to achieve maximum flexibility and performance.

C. Data communications protocol shall be BACnet and shall comply with the latest version of ASHRAE 135.

D. The BMS shall utilize the campus LAN (MMC IT backbone) as the primary network. Ethernet drops shall be provided by others as required. Coordinate exact locations of all Ethernet drops. The BMS contractor is responsible for all other wiring, devices, etc. required to connect to the LAN. The BMS contractor shall coordinate with MMC IT for all network tie-in requirements.

2.4 ETHERNET COMMUNICATION NETWORK

A. The Communication Network provided for the BMS should comply with IEEE 802.3, IEEE 802.3u IEEE 802.3z. The Ethernet interface to be employed should be a combination of 100BASE-T, 100BASE-TX, and 1000BASE-LX. No other brands of technology are acceptable.

B. The connection between Ethernet Switches and field 100BASE-TX hubs or field Ethernet devices, should be using electrical Category 6a UTP cable.

C. The bandwidth requirement should be analyzed by the contractor, such that predetermined bandwidth should be provided for individual systems and sub-systems, by implementing Virtual LANs techniques.

D. All network devices shall be UL Listed.

2.5 FLOOR LEVEL NETWORK SWITCH (FLNS)

A. The network switches shall be provided by MMC IT group. Coordinate with MMC IT for all IP drops and network tie-ins.

2.6 UNINTERRUPTIBLE POWER SUPPLY

A. An Uninterruptible Power Supply (UPS) shall be provided and installed by the Contractor for each of the following devices that are powered by the BMS including; BMS primary control panels and BMS secondary control panels. Each UPS shall power the device for a minimum of 30 minutes, in the case of power interruption.

B. Each UPS shall be DIN-Rail mounted in control cabinets for all new HVAC controllers. All control cabinets shall be properly labeled with the unit served.

C. The UPS shall consist of a battery power source, charger, AC output inverter system and automatic load transfer circuits for a full automatic operation. The UPS shall be an on-line type. When normal AC power returns, the UPS shall transfer the load to the rectifier output. At this time, the charger shall turn on to its ‘high’ charge rate until the batteries are charged approximately 80% of their rated capacity and then automatically shall switch to its maintenance ‘sensing’ position to keep the batteries in their best full-charge condition. Battery recharge time shall not be more than 3 hours.

D. Each UPS shall be provided, as a minimum, with pilot lights for the following conditions: “Incoming AC Power is Available”, “UPS Ready Mode” and “UPS in Standby Mode”. The UPS shall have the capability to hot-swap batteries without interrupting the supply of power to its users.

E. The batteries shall be of the totally enclosed nickel-cadmium type or equal. Batteries that can leak gas shall not be acceptable. There shall not be any damages should the emergency outage of line power exceed the maximum operation time of the UPS. Automatic shutdown shall occur when the UPS’ maximum duty cycle is exceeded.

F. Provide APC, Liebert, or pre-approved equal.

2.7 PRIMARY CONTROL PANEL HARDWARE

A. Provide one (1) primary control panel to each AHU, hot water system, chilled water system, (larger equipment), etc.

B. ASHRAE 135 Compliance: Primary control panels shall use the latest version of BACnet/ASHRAE 135 protocol and communicate using ISO 8802-3 (Ethernet) datalink/physical layer protocol.

C. Spare Capacity

1. All primary control panels shall be installed with 10% spare points (of each type) and 10% spare memory capacity for future connections. The type of spare point capacity shall be in the same proportion as the implemented I/O functions of the panel, but in no case shall there be less than two (2) spares of each implemented I/O type. Provide all hardware modules, software modules, processors, power supplies, communication controllers, etc. required to ensure adding a point to the spare point location only requires the addition of the appropriate sensor/actuator and field wiring/tubing.

2. Provide all processors, power supplies and communication controllers so that the implementation of adding a point to the spare point location only requires the addition of the appropriate:

a. Expansion modules.

b. Sensor/actuator.

c. Field wiring/tubing.

D. Provide all necessary hardware for a complete operating system as required. All hardware shall reside in each primary control panel. Primary control panels shall not be dependent upon any higher level computer or another controller for operation.

E. Each primary control panel shall, at a minimum, be provided with:

1. Appropriate NEMA 12 rated metal enclosure.

2. An integral real-time clock.

3. The most recent version of the manufacturer's microprocessor module.

4. Primary Network communication module, if needed for primary network communications.

5. Secondary Network communication module, if needed for secondary network communications.

6. Memory to accommodate all primary control panel software requirements, including but not limited to, its own operating system and databases, including control processes, energy management applications, alarm management applications, historical/trend data for points specified, maintenance support applications, custom processes, operator I/O, dial-up communications. Controller shall be provided with battery backup capable of supporting all RAM, clock functions, DDC database and operating programs within the controller for a minimum of 72 hours in the event of power failure or power interruption (if information is not stored in non-volatile memory). Controller shall be the most recent version of the manufacturer's primary control panel.

7. Data collection/ Data Trend module sized for 3 years of data on all hardware and software BAS points monitored by the BAS.
8. Power supplies as required for all associated modules, sensors, actuators, etc.
9. Software modules as required for all sequences of operation, logic sequences and energy management routines. Relay logic is not acceptable.
10. A portable operator terminal connection port to allow the temporary use of portable devices without interrupting the normal operation of permanently connected printers or terminals.
11. Monitoring of the status of all HOA switches (related life safety/fire system fans only). The status of the HOA switch shall be available as a BMS data point.
12. Monitoring of all industry standard types of analog and digital inputs and outputs, without the addition of equipment to the primary control panel.
13. Auxiliary enclosure for analog output transducers, isolation relays, etc. Auxiliary enclosure shall be part of primary enclosure or mounted adjacent to the primary enclosure.
14. Local status indication for each digital input and output for constant, up-to-date verification of all point conditions without the need for an operator I/O device. Each primary control panel shall perform diagnostics on all inputs and outputs and a failure of any input or output shall be indicated both locally and at the operator workstation.

F. The operator shall have the ability to manually override automatic or centrally executed commands at the primary control panels via local, point discrete, on-board hand/off/auto operator override switches. If on board switches are not available, provide separate control panels with HOA switches. Mount panel adjacent to primary control panel. These override switches shall be operable whether the panel processor is operational or not. Provide HOA switch for each digital output, including spares (related life safety/fire system fans only). Provide hand/auto switch and gradual positioning potentiometer for each analog output, including spares (related life safety/fire system fans only).

G. Each primary control panel shall continuously perform self-diagnostics on all hardware modules and network communications. The primary control panel shall provide both local and remote annunciation of any detected component failures, or repeated failure to establish communication with any system.

H. All databases and programs shall be stored in non-volatile EEPROM, EPROM and PROM.

I. Each primary control panel shall support firmware upgrades without the need to replace hardware.

J. Primary control panels shall provide at least two (2) EIA-232C serial data communication ports for operation of operator I/O devices such as industry standard printers, operator terminals, and portable laptop operator's terminals. Primary control panels shall allow temporary use of portable devices without interrupting the normal operation of permanently connected printers or terminals.

K. Immunity to power and noise.

1. Controller shall be able to operate at 90% – 110% of nominal voltage rating and shall perform an orderly shutdown below 80% nominal voltage.
2. Operation shall be protected against electrical noise of 5 – 120 Hz and from keyed radios up to 5W at 1m (3').
3. Isolation shall be provided at all primary network terminations, as well as all field point terminations to suppress induced voltage transients consistent with:
   a. RF-Conducted Immunity (RFCI) per ENV 50141 (IEC 1000-4-6) at 3V.
   b. Electro Static Discharge (ESD) Immunity per EN 61000-4-2 (IEC 1000-4-2) at 8kV air discharge, 4kV contact.
   c. Electrical Fast Transient (EFT) per EN 61000-4-4 (IEC 1000-4-4) at 500V signal, 1kV power.
   d. Output Circuit Transients per UL 864 (2,400V, 10A, 1.2 Joule max).
4. Isolation shall be provided at all Primary Controller's AC input terminals to suppress induced voltage transients consistent with:
   a. IEEE Standard 587 1980.
   b. UL 864 Supply Line Transients.
   c. Voltage Sags, Surge and Dropout per EN 61000-4-11 (EN 1000-4-11).

L. BMS controllers must be powered off the equipment branch. Applies to all central equipment (AHUs, pumps, condensate pumps, etc.) and any fan serving isolation rooms, protective environment rooms or any other space that must maintain a pressure relationship to its surroundings.

M. BMS controllers shall be connected to UPS power. Installation shall incorporate a bypass switch to allow for a faulty UPS to be replaced without interrupting power to the controller or controllers it serves.

2.8 PRIMARY CONTROL PANEL SOFTWARE

A. Furnish the following applications software to form complete operating system for building and energy management as described in this specification.

B. Provide all necessary software for a complete operating system as required. All software shall reside in each primary control panel. Primary control panels shall not be dependent upon any higher level computer or another controller for operation.

C. All points, panels and programs shall be identified by a 30 character name and a 16 character point descriptor. The same names shall be displayed at both the primary control panel(s) (via portable terminal or printer) and the PC operator workstation(s).

D. All digital points shall have a user-defined, 2-state status indication with 8 characters minimum (e.g., Summer, Enabled, Disabled, Abnormal).

E. System Security

1. User access shall be secured using individual security passwords and user names.

2. Passwords shall restrict the user to the objects, applications and system functions as assigned by the system manager.

3. Primary Controllers shall be able to assign a minimum of 50 passwords access and control priorities to each point individually. The logon password (at any Operator Interface or portable operator terminal) shall enable the operator to monitor, adjust and control only the points that the operator is authorized for. All other points shall not be displayed at the Operator Interface or portable terminal. Passwords and priorities for every point shall be fully programmable and adjustable.

4. User Log On / Log Off attempts shall be recorded.

5. The system shall protect itself from unauthorized use by automatically logging off following the last keystroke. The delay time shall be user-definable.

F. Each primary control panel shall, at a minimum, be provided with software for the following scenarios, if specified in the sequence of operations, 230993:

1. 2-position control, proportional control, proportional plus integral control, proportional, integral, plus derivative control algorithms, all with automatic control loop tuning.

2. Limiting the number of times each piece of equipment may be cycled within any 1-hour period.

3. The system shall provide protection against excessive demand situations during start-up periods by automatically introducing time delays between successive start commands to heavy electrical loads. Upon the resumption of power, each DDC Controller shall analyze the status of all controlled equipment, compare it with normal occupancy scheduling and turn equipment on or off as necessary to resume normal operations.

4. Priority load shedding (10 zones).

5. Energy management routines including time of day scheduling, calendar-based scheduling, holiday scheduling, temporary schedule overrides, start-stop time optimization, automatic daylight savings time switch over, night setback control, enthalpy switch over, peak demand limiting, temperature-compensated duty cycling, heating/ cooling interlock, supply temperature reset, priority load shedding and power failure restart.

6. Custom, job-specific processes defined by the user, to automatically perform calculations and special control routines and sequences of operations.

   a. Controllers shall be able to execute custom, job-specific processes defined by the user, to automatically perform calculations and special control routines.

   b. It shall be possible to use any system measured point data or status, any system calculated data, a result from any process or any user-defined constant in any controller in the system.

   c. Any process shall be able to issue commands to points in any and all other controllers in the system.

   d. Processes shall be able to generate operator messages and advisories to other operator I/O devices. A process shall be able to directly send a

message to a specified device or cause the execution of a dial-up connection to a remote device such as a printer or pager.

e. The custom control programming feature shall be documented via English language descriptors.

f. Each controller shall support text comment lines in the operating program to allow for quick troubleshooting, documentation and historical summaries of program development.

g. Controller shall provide a HELP function key, providing enhanced context sensitive on-line help with task orientated information from the user manual.

7. Generate and receive automatic and manual operator messages and advisories.

8. Comment lines for all programs.

9. Distributed independent alarm analysis and filtering. Reporting of selected alarms during system shutdown and start-up shall be automatically inhibited. A minimum of 6 priority levels shall be provided for each point.

10. Automatically accumulate and store run-time hours for all digital points.

11. Automatically sample, calculate and store consumption totals on a daily, weekly or monthly basis for all analog and pulse input type points.

G. Trend data shall be stored at the primary control panels and automatically uploaded to the PC workstation. Uploads shall occur based on user-defined intervals, manual commands, or automatically when the trend buffer is 80% full. All trend data shall be available for use in any 3rd party personal computer applications located in the BMS.

H. Primary control panels shall be able to access any data from, or send control commands and alarm reports directly to, any other primary control panel or combination of controllers on the network without dependence upon a central or intermediate processing device. Primary control panels shall also be able to send alarm reports to multiple operator workstations without dependence upon a central or intermediate processing device.

I. Alarm management shall be provided to monitor and direct alarm information to operator devices. Each DDC Controller shall perform distributed, independent alarm analysis and filtering to minimize operator interruptions due to non-critical alarms, minimize network traffic and prevent alarms from being lost. At no time shall the DDC Controllers ability to report alarms be affected by either operator or activity at a PC workstation, local I/O device or communications with other panels on the network.

1. All alarm or point change reports shall include the point's English language description and the time and date of occurrence.

2. The user shall be able to define the specific system reaction for each point. Alarms shall be prioritized to minimize nuisance reporting and to speed operator response to critical alarms. A minimum of 6 priority levels shall be provided for each point. Point priority levels shall be combined with user definable destination categories (PC, printer, DDC Controller, etc.) to provide full flexibility in defining the handling of system alarms. Each DDC Controller shall automatically inhibit the reporting of selected alarms during system

shutdown and start-up. Users shall have the ability to manually inhibit alarm reporting for each point.

3. Alarm reports and messages shall be routed to user-defined list of operator workstations or other devices based on time and other conditions. An alarm shall be able to start programs, print, be logged in the event log, generate custom messages and display graphics.

4. In addition to the point's descriptor and the time and date, the user shall be able to print, display or store a 200 character alarm message to more fully describe the alarm condition or direct operator response.

   a. Each DDC Controller shall be capable of storing a library of at least 50 alarm messages. Each message may be assignable to any number of points in the Controller.

5. Operator-selected alarms shall be capable of initiating a call to a remote operator device.

J. Scheduling:

1. Provide a comprehensive menu driven program to automatically start and stop designated object or group of objects in the system according to a stored time.

2. It shall be possible to define a group of objects as a custom event (i.e., meeting, athletic activity, etc.). Events can then be scheduled to operate all necessary equipment automatically.

3. For points assigned to one (1) common load group, it shall be possible to assign variable time delays between each successive start and stop within that group.

4. The operator shall be able to define the following information:

   a. Time, day.

   b. Commands such as on, off, auto and so forth.

   c. Time delays between successive commands.

   d. There shall be provisions for manual overriding of each schedule by an appropriate operator.

5. It shall be possible to schedule calendar-based events up to 1 year in advance based on the following:

   a. Weekly Schedule. Provide separate schedules for each day of the week. Each of these schedules should include the capability for start, stop, optimal start, optimal stop and night economizer. When a group of objects are scheduled together as an Event, provide the capability to adjust the start and stop times for each member.

   b. Exception Schedules. Provide the ability for the operator to designate any day of the year as an exception schedule. Exception schedules may be defined up to a year in advance. Once an exception schedule is executed, it will be discarded and replaced by the standard schedule for that day of the week.

   c. Holiday Schedules. Provide the capability for the operator to define up to 99 special or holiday schedules. These schedules may be placed on

the scheduling calendar and will be repeated each year. The operator shall be able to define the length of each holiday period.

K. Temperature-compensated duty cycling.

1. The DCCP (Duty Cycle Control Program) shall periodically stop and start loads according to various patterns.

2. The loads shall be cycled such that there is a net reduction in both the electrical demands and the energy consumed.

L. Automatic Daylight Savings Time Switchover: The system shall provide automatic time adjustment for switching to/from Daylight Savings Time.

M. Night setback control. The system shall provide the ability to automatically adjust setpoints for night control.

N. Enthalpy switchover (economizer). The Primary Controller Software shall control the position of the air handler relief, return and outside air dampers. If the outside air enthalpy is below the return air enthalpy, the software will modulate the dampers to provide 100% outside air. The user will be able to quickly changeover to an economizer system based on enthalpy and will be able to override the economizer cycle and return to minimum outside air operation at any time.

O. PID Control. A PID (proportional-integral-derivative) algorithm with direct or reverse action and anti-windup shall be supplied. The algorithm shall calculate a time-varying analog value that is used to position an output or stage a series of outputs. The controlled variable, set point and PID gains shall be user-selectable.

P. Sequencing. Provide application software based upon the sequences of operation specified to properly sequence equipment.

Q. Staggered Start:

1. This application shall prevent all controlled equipment from simultaneously restarting after a power outage. The order, in which equipment (or groups of equipment) is started, along with the time delay between starts, shall be user definable.

2. Upon the resumption of power, each Primary Controller shall analyze the status of all controlled equipment, compare it with normal occupancy scheduling and turn equipment on or off as necessary to resume normal operations.

R. Totalization:

1. Run-Time Totalization. Primary Controllers shall automatically accumulate and store run-time hours for all digital input and output points. A high runtime alarm shall be assigned, if required, by the operator.

2. Consumption totalization. Primary Controllers shall automatically sample, calculate and store consumption totals on a daily, weekly or monthly basis for all analog and digital pulse input type points.

3. Event totalization. Primary Controllers shall have the ability to count events such as the number of times a pump or fan system is cycled on and off. Event totalization shall be performed on a daily, weekly or monthly basis for all points. The event totalization feature shall be able to store the records associated with events before reset.

4. Totalization calculated on the front end is acceptable.

S. A variety of historical data collection utilities shall be provided to manually or automatically sample, store and display system data for all points.

1. DDC Controllers shall store point history data for selected analog and digital inputs and outputs:

a. Any point, physical or calculated may be designated for trending. Any point, regardless of physical location in the network, may be collected and stored in each DDC Controllers point group. Two (2) methods of collection shall be allowed: either by a pre-defined time interval or upon a pre-defined change of value. Sample intervals of l minute to 7 days shall be provided. Each DDC Controller shall have a dedicated RAM-based buffer for trend data and shall be capable of storing a minimum of 10,000 data samples.

b. Trend data shall be stored at the DDC Controllers and automatically uploaded to the workstation. Uploads shall occur based upon user-defined interval, manual command or automatically when the trend buffers are 80% full. All trend data shall be available for use in any third party personal computer applications located on the MLN.

c. DDC Controllers shall also provide high resolution sampling capability for verification of control loop performance. Operator-initiated automatic and manual loop tuning algorithms shall be provided for a minimum of 36 operator-selected PID control loops. Provide capability to view or print trend and tuning reports.

1) The controller shall perform a step response test with a minimum 1-second resolution, evaluate the trend data, calculate the new PID gains and input these values into the selected LOOP statement.

2) Loop tuning shall be capable of being initiated either locally at the DDC Controller, from a network workstation, or remotely using web page interface. For all loop tuning functions, access shall be limited to authorized personnel through password protection.

3) Controllers shall have automatic loop tuning function disabled as a default.

T. DDC Controllers shall automatically accumulate and store run-time hours for all digital input and output points.

U. DDC Controllers shall automatically sample, calculate and store consumption totals on a daily, weekly, or monthly basis for all analog and digital pulse input type points.

V. DDC Controllers shall count events such as the number of times a pump or fan system is cycled on and off. Event totalization shall be performed on a daily, weekly and monthly basis for all points. The event totalization feature shall be able to store the records associated with a minimum of 9,999.9 events before reset.

W. Totalization calculated on the front end is acceptable.

2.9 SECONDARY CONTROL PANEL HARDWARE

A. Provide one (1) secondary control panel to each terminal unit, exhaust fan, AC unit, (smaller equipment), etc.

B. ASHRAE 135 Compliance: Secondary control panels shall use the latest version of BACnet/ASHRAE 135 protocol over MS/TP.

C. Each secondary control panel shall operate as a stand-alone controller capable of performing its user selectable control routines independently of any other controller in the system. Each secondary control panel shall be a microprocessor-based, multi-tasking, real-time digital control processor.

D. Each Primary Controller shall be able to communicate with secondary controllers over the Secondary Network to control terminal equipment only.

E. Each secondary controller shall include all point inputs and outputs necessary to perform the specified control sequences. The secondary controller shall accept input and provide output signals that comply with industry standards. Controllers utilizing proprietary control signals shall not be acceptable. Outputs may be utilized either for 2-state, modulating, floating or proportional control, allowing for additional system flexibility.

F. Each secondary control panel shall, at a minimum, be provided with:

1. Appropriate NEMA rated enclosure.
2. A stand-alone real-time digital control microprocessor module.
3. Secondary network communications ability.
4. Power supplies as required for all associated modules, sensors, actuators, etc.
5. Input/output points as required.
6. Software as required for all sequences of operation, logic sequences and energy management routines. Relay logic is not acceptable.
7. A portable operator terminal connection port.
8. Auxiliary enclosure for analog output transducers, isolation relays, etc. Auxiliary enclosure shall be part of primary enclosure or mounted adjacent primary enclosure.
9. Local LED status indication for each digital input and output.
10. Each controller measuring air volume shall include provisions for manual and automatic calibration of the differential pressure transducer in order to maintain stable control and insuring against drift over time.
11. Each controller measuring air volume shall include a differential pressure transducer.
12. Fan speed controller for fan powered VAV boxes.
13. Fan relay for fan powered VAV boxes and fan coil units.

G. Communication. Each controller shall perform its primary control function independent of other Secondary Network communication or if Secondary Network communication is interrupted. Reversion to a fail-safe mode of operation during Secondary Network interruption is not acceptable.

H. Control Algorithms. The controller shall receive its real-time data from the Primary Controller time clock to insure Secondary Network continuity. Each controller shall include algorithms incorporating proportional, integral and derivative (PID) gains for all applications. Controllers that incorporate proportional and integral (PI) control algorithms only shall not be acceptable.

I. Control Applications. Operating programs shall be field-selectable for specific applications. In addition, specific applications may be modified to meet the user's exact control strategy requirements, allowing for additional system flexibility. Controllers that require factory changes of all applications are not acceptable.

J. Calibration. Each controller shall include provisions for manual and automatic calibration of the differential pressure transducer in order to maintain stable control and insuring against drift over time.

1. Manual calibration may be accomplished by either commanding the actuator to 0% via the POT or by depressing the room sensor override switch. Calibration of the transducer at the controller location shall not be necessary.

K. Each secondary control panel shall continuously perform self-diagnostics on all hardware and secondary network communications. The secondary control panel shall provide both local and remote annunciation of any detected component failures or repeated failure to establish communication to the system.

L. Controllers shall include all point inputs and outputs necessary to perform the specified control sequences. As a minimum, 50% of the point outputs shall be of the Universal type; that is, the outputs may be utilized either as modulating or two-state, allowing for additional system flexibility. In lieu of Universal outputs, provide a minimum of 50% spare outputs of each type via additional point termination boards or controllers. Analog outputs shall be industry standard signals such as 24 VAC floating control, allowing for interface to a variety of modulating actuators. Terminal equipment controllers utilizing proprietary control signals and actuators shall not be acceptable.

M. Provide each secondary control panel with sufficient memory to accommodate point databases, operating programs, local alarming and local trending. All databases and programs shall be stored in non-volatile EEPROM, EPROM and PROM. The controllers shall be able to return to full normal operation without user intervention after a power failure of unlimited duration. Provide uninterruptible power supplies (UPSs) of sufficient capacities for all terminal controllers that do not meet this protection requirement. Operating programs shall be field-selectable for specific applications. In addition, specific applications may be modified to meet the user's exact control strategy requirements, allowing for additional system flexibility. Controllers that require factory changes of all applications are not acceptable. Controller shall have a minimum of 16K EPROM or EEPROM.

N. The secondary control panels shall be powered from a 24 VAC source provided by this contractor and shall function normally under an operating range of 18 – 28 VAC (-25% – 17%), allowing for power source fluctuations and voltage drops. Install plenum data line and sensor cable in accordance with local code and NEC. The BMS contractor shall provide a dedicated power source and separate isolation transformer for each controller to function normally under the specified operating range. The controllers shall also function normally under ambient conditions of 32º – 122ºF (0º – 50ºC) and 10% – 95% RH (non-condensing). Provide each controller with a suitable cover or enclosure to protect the intelligence board assembly. Power supply must be rated at a minimum of 125% of power consumption and shall be of the fused or current limiting type. The BMS contractor shall provide 24 VAC power to the terminal units by utilizing:

1. The existing line voltage power trunk and installing separate isolation transformers for each controller.

2. Dedicated line voltage power source and isolation transformers at a central location and installing 24 VAC power trunk to supply multiple controllers in the area.

O. Environment. The controllers shall function normally under ambient conditions of 32º – 122ºF (0º – 50ºC) and 10% – 95% RH (non-condensing). Provide each controller with a suitable cover or enclosure to protect the circuit board assembly.

P. Immunity to noise. Operation shall be protected against electrical noise of 5 – 120Hz and from keyed radios up to 5W at 1m (3').

2.10 SECONDARY CONTROL PANEL SOFTWARE

A. Provide all necessary software for a complete operating system as required. All software shall reside in each secondary control panel. Secondary control panels shall not be dependent upon any higher level computer or another controller for operation.

B. Secondary control panel software configured for CAV or VAV control algorithms shall include provisions for manual and automatic calibration of attached differential pressure transducer in order to maintain stable control and insuring against drift over time. Calibration shall be accomplished by stroking the terminal unit damper actuator to a 0% position so that a 0 CFM air volume reading is sensed. The controller shall automatically accomplish this whenever the system mode switches from occupied to unoccupied or vice versa. Manual calibration may be accomplished by either commanding the actuator to 0% via the POT or by depressing the room sensor override switch. Calibration of the transducer at the controller location shall not be necessary.

C. Each secondary controller shall perform its primary control function independent of primary controller LAN communication, or if LAN communication is interrupted. Reversion to a fail-safe mode of operation during LAN interruption is not acceptable. The controller shall receive its real-time data from the primary control panel time clock to insure LAN continuity. Each controller shall include algorithms incorporating proportional, integral and derivative (PID) control for all applications. All PI parameters shall be field-adjustable by the user via a portable operator's terminal.

D. Secondary control panels shall support pressure independent terminal boxes including VAV cooling only, VAV with hot water or electric reheat, Fan-powered VAV and Fan-powered VAV with hot water or electric reheat. All VAV box control applications shall be field-selectable such that a single controller may be used in conjunction with any of the above types of terminal units to perform the specified sequences of control. This requirement must be met in order to allow for future design and application changes and to facilitate system expansions. Controllers that require factory application changes are not acceptable.

2.11 OPERATOR WORKSTATION HARDWARE

A. Provide one (1) workstation. Coordinate with MMC for location.

B. Personal computer operator workstation(s) shall be provided for command entry, information management, network alarm management and database management

functions. All real-time control functions shall be resident in the DDC Controllers to facilitate greater fault tolerance and reliability.

C. Each workstation shall consist of the following, at a minimum:

1. Intel core 6 core processor i7-8700 3.20 GHz with 8 MB l3 cache, 16 GB of DDR3 ram (2666 MHz), XUGA graphics card capable of 1280x1024 pixel resolution (or better) and 64 bit colors, non-interlaced (70hz or better vertical refresh rate), 12 function-key keyboard, 2-button intellimouse pointing device, speakers, 1.0tb data, 3.0 GB/s, 16 MB databurst cache hard disk drive. Multiple USB 2.0 ports located in the front and back of workstation, ATAPI DVD+/-RW drive and network interface card for ethernet networking compatible with TCP/IP network protocols, Windows 10 professional including latest Microsoft Office software. A celeron processor or other manufacturer's equivalent is not acceptable.

2. Color monitor shall be a minimum of 22”, Flat Panel type with height adjustable stand which allows the panel to swivel, tilt and pivot. Separate controls shall be provided for color, contrasts, brightness, size, geometry, position and degauss. The screen shall be non-reflective. The LCD module shall be active matrix, thin film transistor (TFT). The monitor shall support a resolution of 1280 x 1024 pixels at 60 Hz, at a minimum. Available power supply is 120VAC at 60Hz.

D. Provide a color printer at one (1) workstation, for printing of graphics and any other screen displays. The owner shall choose the workstation to be connected to the color printer. The printer shall have the following requirements at a minimum:

1. 1200x1200DPI (Dot/Inch) color print resolution.

2. 600DPI black and white print resolution.

3. Draft and letter quality print selection for alpha-numeric operations.

4. Four (4) color mix capability to provide true color printing of screen graphics.

5. Three (3) built-in letter quality fonts from selectable front panel buttons.

6. 2MB memory to store complete graphics for printing.

7. Color print speed of .3 – 3 ppm.

8. Black and white print speed of 2.9 – 12 ppm.

9. Duty cycle of 2,000.

2.12 OPERATOR WORKSTATION SOFTWARE

A. General

1. Provide software which includes the following:

a. Scheduling and override of building operations.

b. Collection and analysis of historical data.

c. Editing, programming, storage and downloading of controller databases, programs and parameters.

d. Microsoft Windows 8 professional with Microsoft Office Professional 2013 at a minimum.

e. A 64-bit, multi-tasking Microsoft Windows 8 environment that allows the user to run several applications simultaneously. Other Windows applications shall run simultaneously with the BMS software including, but not limited to, Word, Excel, Access, etc.

f. Provide a user interface that shall minimize the use of a typewriter style keyboard through the use of a mouse or similar pointing device and "point and click" approach to menu selection.

g. The operator shall be able to drag and drop information between applications (e.g., click on a point in the alarm screen and drag it into the dynamic trend graph screen to initiate a dynamic trend).

h. Operator specific password access protection shall allow the user to limit workstation control, display and data base manipulation capabilities for each object in the system. An object shall be defined as any input or output point, setpoint, system program, etc. The operator privileges shall “follow” the operator to any workstation or primary control panel that the operator logs on to. Provide a minimum of 1000 passwords.

i. Operators will be able to perform only those commands on the objects available based on their respective passwords. Menu selections displayed shall be limited to only those items defined for the access level of the password used to log-on.

j. An audit trail report to track system object changes that shall record operator initiated actions. These actions shall include, but not be limited to, changes made by a particular person, changes made to a specific piece of equipment and/or changes made during a designated time frame. The changes shall be printed and archived for future reference either on command or automatically, at the operator’s option. The operator activity tracking data shall be stored in a tamper proof buffer.

k. Software shall allow the operator to perform commands including, but not limited to:

1) Start up and shutdown of equipment.

2) Setpoint adjustment.

3) Add/modify/delete time programming.

4) Enable/disable process execution.

5) Lock/unlock alarm reporting.

6) Enable/disable totalization and/or trending.

7) Override PID loop setpoints.

8) Enter temporary override schedules.

9) Define holiday schedules.

10) Change time/date.

11) Automatic daylight savings time adjustments.

12) Enter/modify analog warning and alarm limits.

a) Reporting.

13) Reports shall be generated and directed to CRT displays, printers or disk. As a minimum, the system shall allow the user to easily obtain the following types of reports:

a) A general listing of all points in the network.

b) List of all points currently in alarm.

c) List of all points currently in override status.

d) List of all disabled points.

e) List of all points currently locked out.

f) DDC Controller trend overflow warning.

g) List all weekly schedules.

l. Scheduling

1) Provide a graphical spreadsheet-type format for simplification of time-of-day scheduling and overrides of building operations. Provide schedules for 365 days in advance.

2) Weekly schedules shall be provided for each building zone or piece of equipment with a specific occupancy schedule. Temporary overrides and associated times may be inserted into blocks for modified operating schedules. After overrides have been executed, the original schedule will automatically be restored.

3) Zone schedules shall be provided for each building zone as previously described. Each schedule shall include all points that can be commanded residing within the zone. Each point may have a unique schedule of operation relative to the zone's occupancy schedule, allowing for sequential starting and control of equipment within the zone. Scheduling and rescheduling of points may be accomplished easily via the zone schedule graphic.

m. Collection and Analysis of Historical Data

1) Provide trending capabilities that allow the user to easily monitor and preserve records of system activity over an extended period of time. Any system point may be trended automatically at time-based intervals or changes of value, both of which shall be user-definable. Trend data shall be stored on hard disk for future diagnostics and reporting.

2) Trend data report graphics shall be provided to allow the user to view all trended point data. Reports may be customized to include individual points or pre-defined groups of at least 6 points. Provide additional functionality to allow any trended data to be transferred directly to an off-the-shelf spreadsheet package such as Excel. This shall allow the user to perform custom calculations such as energy usage, equipment efficiency and energy costs and shall allow for generation of these reports on high-quality plots, graphs and charts.

3) Provide additional functionality that allows the user to view trended data on trend graph displays. Displays shall be actual plots of both historical and/or real-time dynamic point data. A minimum of 10 points shall be viewed simultaneously on a single graph. The user may pause the graph and take "snapshots" of screens to be stored on the hard disk for future recall and analysis. Displays shall include an 'X' axis indicating elapsed time and a 'Y' axis indicating a range scale in engineering units for each point. The 'Y' axis shall have the ability to be manually or automatically scaled at the user's option. Different ranges for each point may be used with minimum and maximum values listed at the bottom and top of the 'Y' axis. All 'Y' axis data shall be color-coded to match the line color for the corresponding point.

4) Static graphs shall represent actual point data that has been trended and stored on disk. Exact point values may be viewed on a data window by pointing or scrolling to the place of interest along the graph. Provide capability to print any graph on the system printer for use as a building management and diagnostics tool.

5) Dynamic graphs shall represent real-time point data. Any point or group of points may be graphed, regardless of whether they have been predefined for trending. The graphs shall continuously update point values. At any time the user may redefine sampling times or range scales for any point. In addition, the user may pause the graph and take "snapshots" of screens to be stored on the workstation disk for future recall and analysis. As with static graphs, exact point values may be viewed and the graphs may be printed.

n. Dynamic Color Graphic Displays

1) All workstation(s) shall be provided with color graphics. All workstation(s) software shall include a graphical viewing and

control environment and definition and construction of dynamic color graphic displays.

2) Provide system color graphics for each HVAC system and for each electrical, plumbing and/or piping system that is monitored and/or controlled by the BMS. Provide scaled floor plans indicating equipment location, service and system data as required.

3) Provide color graphic floor plan displays and system schematics for each piece of mechanical equipment, including but not limited to air handling units, chilled water systems and hot water systems to optimize system performance analysis and speed alarm recognition.

4) Provide links on each graphic to PDF files of the associated sequence of operation, flow diagram, and wiring diagram.

5) The operator interface shall allow users to access the various system schematics and floor plans via a graphical penetration scheme, menu selection or text-based commands.

6) Dynamic temperature values, humidity values, flow values and status indication shall be shown in their actual respective locations and shall automatically update to represent current conditions without operator intervention.

7) The windowing environment of the PC operator workstation(s) shall allow the user to simultaneously view several graphics at a time to analyze total building operation or to allow the display of a graphic associated with an alarm to be viewed without interrupting work in progress.

8) Graphic generation software shall be provided to allow the user to add, modify, or delete system graphic displays via an off the shelf graphics package similar to MicroGraphix Designer.

9) Provide libraries of pre-engineered screens and symbols depicting standard air handling unit components (e.g., fans, cooling coils, filters, dampers, etc.), complete mechanical systems (e.g., constant volume-terminal reheat, VAV, etc.) and electrical symbols.

10) Graphical displays can be created to represent any logical grouping of system points or calculated data based upon building function, mechanical system, building layout, or any other logical grouping of points that aids the operator in the analysis of the facility.

11) Graphical displays shall contain animation to assist the operator in determining status of the equipment being displayed (e.g., a fan that is energized shall rotate).

12) Provide an automatically updated, dynamic display of the site-specific BMS architecture indicating the status of primary and secondary controllers, PC workstation(s) and networks.

13) Provide a separate dynamic display page of each HVAC (AHU, AC, chiller, cooling tower, fuel oil, etc.), electrical and/or plumbing system connected to the BMS.

14) Provide a separate dynamic display page of each piece of terminal equipment (VAV box, fan coil unit, etc.) connected to the BMS.

15) Provide a separate dynamic display page for each floor or zone. At a minimum, each page shall display the associated space temperature readings and links to equipment located on the floor or in the zone.

16) Provide an additional (10) separate dynamic, graphic display pages at each workstation as required by the operating staff to further assist in daily system operations.

17) Graphics shall incorporate all system integration points communicated via hardware or software gateways and/or interfaces. Origin of information shall be transparent to the operator and shall be controlled, displayed, trended, etc. as if the points were hardwired to the BMS.

2. System Configuration and Definition

a. All temperature and equipment control strategies and energy management routines shall be definable by the operator. System definition and modification procedures shall not interfere with normal system operation and control.

b. The system shall be provided complete with all equipment and documentation necessary to allow an operator to independently add, delete or modify any system object including primary control panel(s), operator workstations(s), secondary control panels, reporting definitions, control loops, energy management applications, time and calendar-based programming, totalization, historical data trending, custom control processes, graphic displays, operator passwords, alarm messages, etc.

c. Definition of operator device characteristics for individual points, applications and control sequences shall be performed using instructive prompting software.

d. Programming shall be performed with the BMS system online and shall not interfere with BMS system operation.

e. Inputs and outputs for any process shall not be restricted to a single primary control panel, but shall be able to include data from any and all other network panels to allow the development of network-wide control

strategies. Processes shall also allow the operator to use the results of 1 process as the input to any number of other processes (cascading).

f. Provide the capability to backup and store all system databases on the workstation hard disk. In addition, all database changes shall be performed while the workstation(s) are on-line without disrupting other system operations. Changes shall be automatically recorded and downloaded to the appropriate primary control panel. Similarly, changes made at the primary control panels shall be automatically uploaded to the workstation, ensuring system continuity. The user shall also have the option to selectively download changes as desired.

g. Provide context-sensitive help menus to provide instructions appropriate with operations and applications currently being performed.

2.13 WEB BASED OPERATOR INTERFACE

A. Operator Interface. Web server shall reside on high-speed network with primary controllers. Each standard browser connected to server shall be able to access all system information. In addition to the primary operator interface, the system shall include a secondary interface compatible with a locally available commercial wireless network and viewable on a commercially available wireless device such as a Wireless Access Protocol (WAP) enabled cellular telephone or personal digital assistant (PDA). This secondary interface may be text-based and shall provide a summary of the most important data. As a minimum, the following capabilities shall be provided through this interface:

1. An operator authentication system that requires an operator to log in before viewing or editing any data and which can be configured to limit the privileges of an individual operator.

2. The ability to view and acknowledge any alarm in the system. Alarms or links to alarms shall be provided on a contiguous list so the operator can quickly view all alarms.

3. A summary page or pages for each piece of equipment in the system. This page shall include the current values of all critical I/O points and shall allow the operator to lock binary points on or off and to lock analog points to any value within their range.

4. Navigation links that allow the operator to quickly navigate from the home screen to any piece of equipment in the system and then return to the home screen. These links shall be arranged in a hierarchical fashion, such as navigating from the home screen to a particular building, then to a specific floor in the building and then to a specific room or piece of equipment.

B. Communication. Web server or workstation and controllers shall communicate using BACnet protocol. Web server or workstation and control network backbone shall communicate using ISO 8802-3 (Ethernet) Data Link/Physical layer protocol and BACnet/IP addressing as specified in the latest version of ANSI/ASHRAE 135, BACnet Annex J.

C. Hardware. Each workstation or web server shall consist of the following:

1. Industry-standard hardware shall meet or exceed DDC system manufacturer's recommended specifications and shall meet requirements included herein.

Hard disk shall have sufficient memory to store system software, 1 year of data for trended points and a system database at least twice the size of the existing database at system acceptance. Configure computers and network connections if multiple computers are required to meet specified memory and performance.

D. Operator Functions. Operator interface shall allow each authorized operator to execute the following functions as a minimum:

1. Log In and Log Out. System shall require user name and password to log in to operator interface.
2. Point-and-click Navigation. Operator interface shall be graphically based and shall allow operators to access graphics for equipment and geographic areas using point-and-click navigation.
3. View and Adjust Equipment Properties. Operators shall be able to view controlled equipment status and to adjust operating parameters such as setpoints, PID gains, on and off controls and sensor calibration.
4. View and Adjust Operating Schedules. Operators shall be able to view scheduled operating hours of each schedulable piece of equipment on a weekly or monthly calendar-based graphical schedule display, to select and adjust each schedule and time period and to simultaneously schedule related equipment. System shall clearly show exception schedules and holidays on the schedule display.
5. View and Respond to Alarms. Operators shall be able to view a list of currently active system alarms, to acknowledge each alarm and to clear (delete) unneeded alarms.
6. View and Configure Trends. Operators shall be able to view a trend graph of each trended point and to edit graph configuration to display a specific time period or data range. Operator shall be able to create custom trend graphs to display on the same page data from multiple trended points.
7. View and Configure Reports. Operators shall be able to run preconfigured reports, to view report results and to customize report configuration to show data of interest.
8. Manage Control System Hardware. Operators shall be able to view controller status, to restart (reboot) each controller and to download new control software to each controller.
9. Manage Operator Access. Typically, only a few operators are authorized to manage operator access. Authorized operators shall be able to view a list of operators with system access and of functions they can perform while logged in. Operators shall be able to add operators, to delete operators and to edit operator function authorization. Operator shall be able to authorize each operator function separately.

E. System Software.

1. Operating System. Web server shall have an industry-standard professional-grade operating system. Acceptable systems include Microsoft Windows 10. The operating system shall be coordinated with MMC IT.
2. System Graphics. Operator interface shall be graphically based and shall include at least one (1) graphic per piece of equipment, air handling unit or

occupied zone, graphics for each chilled water and hot water system and graphics that summarize conditions on each floor. The BMS contractor shall review and standardize these graphics with the owner on site team.

a. All system graphic updates must be approved by MMC HVAC Lead.

3. Provide links on each graphic to PDF files of the associated sequence of operation, flow diagram, and wiring diagrams.

4. Functionality. Graphics shall allow operator to monitor system status, to view a summary of the most important data for each controlled zone or piece of equipment, to use point-and-click navigation between zones or equipment and to edit setpoints and other specified parameters.

5. Animation. Graphics shall be able to animate by displaying different image files for changed object status.

6. Alarm Indication. Indicate areas or equipment in an alarm condition using color or other visual indicator.

7. Format. Graphics shall be saved in an industry-standard format such as BMP, JPEG, PNG or GIF. Web-based system graphics shall be viewable on browsers compatible with World Wide Web Consortium browser standards. Web graphic format shall require no plug-in (such as HTML and JavaScript) or shall only require widely available no-cost plug-ins (such as Active-X and Macromedia Flash).

F. System Tools. System shall provide the following functionality to authorized operators as an integral part of the operator interface or as stand-alone software programs. If furnished as part of the interface, the tool shall be available from each workstation or web browser interface. If furnished as a stand-alone program, software shall be installable on standard IBM-compatible PCs with no limit on the number of copies that can be installed under the system license.

1. Automatic System Database Configuration. Each workstation or web server shall store on its hard disk a copy of the current system database, including controller firmware and software. Stored database shall be automatically updated with each system configuration or controller firmware or software change.

2. Controller Memory Download. Operators shall be able to download memory from the system database to each controller.

3. System Configuration. Operators shall be able to configure the system.

4. Online Help. Context-sensitive online help for each tool shall assist operators in operating and editing the system.

5. Security. System shall require a user name and password to view, edit, add or delete data.

6. Operator Access. Each user name and password combination shall define accessible viewing, editing, adding and deleting functions in each system application, editor and object.

7. Automatic Log Out. Automatically log out each operator if no keyboard or mouse activity is detected. Operators shall be able to adjust automatic log out delay.

8. Encrypted Security Data. Store system security data including operator passwords in an encrypted format. System shall not display operator passwords.

9. System Diagnostics. System shall automatically monitor controller and I/O point operation. System shall annunciate controller failure and I/O point locking (manual overriding to a fixed value).

10. Alarm Processing. System input and status objects shall be configurable to alarm on departing from and on returning to normal state. Operator shall be able to enable or disable each alarm and to configure alarm limits, alarm limit differentials, alarm states and alarm reactions for each system object. Configure and enable alarm points as specified.

11. Alarm Messages. Alarm messages shall use an English language descriptor without acronyms or mnemonics to describe alarm source, location and nature.

12. Alarm Reactions. Operator shall be able to configure (by object) actions workstation or web server shall initiate on receipt of each alarm. As a minimum, workstation or web server shall be able to log, print, start programs, display messages, send e-mail, send page and audibly annunciate.

13. Alarm Maintenance. Operators shall be able to view system alarms and changes of state chronologically, to acknowledge and delete alarms and to archive closed alarms to the workstation or web server hard disk from each workstation or web browser interface.

14. Trend Configuration. Operator shall be able to configure trend sample or change of value (COV) interval, start time and stop time for each system data object and shall be able to retrieve data for use in spreadsheets and standard database programs. Controller shall sample and store trend data and shall be able to archive data to the hard disk. Configure trends as specified or required by the Owner.

15. Object and Property Status and Control. Operator shall be able to view and to edit if applicable, the status of each system object and property by menu, on graphics or through custom programs.

16. Reports and Logs. Operator shall be able to select, to modify, to create and to print reports and logs. Operator shall be able to store report data in a format accessible by standard spreadsheet and word processing programs.

17. Standard Reports. Furnish the following standard system reports:

18. Objects. System objects and current values filtered by object type, by status (in alarm, locked, normal), by equipment, by geographic location or by combination of filter criteria.

19. Alarm Summary. Current alarms and closed alarms. System shall retain closed alarms for an adjustable period.

20. Logs. System shall log the following to a database or text file and shall retain data for an adjustable period:

    a. Alarm History.

    b. Trend Data. Operator shall be able to select trends to be logged.

c. Operator Activity. At a minimum, system shall log operator log in and log out, control parameter changes, schedule changes and alarm acknowledgment and deletion. System shall date and time stamp logged activity.

21. Custom Reports. Operator shall be able to create custom reports that retrieve data, including archived trend data, from the system, that analyze data using common algebraic calculations and that present results in tabular or graphical format. Reports shall be launched from the operator interface.

22. Graphics Generation. Graphically based tools and documentation shall allow Operator to edit system graphics, to create graphics and to integrate graphics into the system. Operator shall be able to add analog and binary values, dynamic text, static text and animation files to a background graphic using a mouse.

23. Graphics Library. Complete library of standard HVAC equipment graphics shall include equipment such as chillers, boilers, air handlers, terminals, fan coils and unit ventilators. Library shall include standard symbols for other equipment including fans, pumps, coils, valves, piping, dampers and ductwork. Library graphic file format shall be compatible with graphics generation tools.

24. Custom Application Programming. Operator shall be able to create, edit, debug and download custom programs. System shall be fully operable while custom programs are edited, compiled and downloaded. Programming language shall have the following features:

25. Language. Language shall be graphically based and shall use function blocks arranged in a logic diagram that clearly shows control logic flow. Function blocks shall directly provide functions listed below and operators shall be able to create custom or compound function blocks.

26. Programming Environment. Tool shall provide a full-screen, cursor-and-mouse-driven programming environment that incorporates word processing features such as cut and paste. Operators shall be able to insert, add, modify and delete custom programming code and to copy blocks of code to a file library for reuse in other control programs.

27. Independent Program Modules. Operator shall be able to develop independently executing program modules that can disable, enable and exchange data with other program modules.

28. Debugging and Simulation. Operator shall be able to step through the program observing intermediate values and results. Operator shall be able to adjust input variables to simulate actual operating conditions. Operator shall be able to adjust each step's time increment to observe operation of delays, integrators and other time-sensitive control logic. Debugger shall provide error messages for syntax and for execution errors.

29. Conditional Statements. Operator shall be able to program conditional logic using compound Boolean (AND, OR and NOT) and relational (EQUAL, LESS THAN, GREATER THAN, NOT EQUAL) comparisons.

30. Mathematical Functions. Language shall support floating-point addition, subtraction, multiplication, division and square root operations, as well as

absolute value calculation and programmatic selection of minimum and maximum values from a list of values.

31. Variables: Operator shall be able to use variable values in program conditional statements and mathematical functions.

    a. Time Variables. Operator shall be able to use predefined variables to represent time of day, day of the week, month of the year and date. Other predefined variables or simple control logic shall provide elapsed time in seconds, minutes, hours and days. Operator shall be able to start, stop and reset elapsed time variables using the program language.

    b. System Variables. Operator shall be able to use predefined variables to represent status and results of Controller Software and shall be able to enable, disable and change setpoints of Controller Software as described in Controller Software section.

2.14 INTERNET BASED COMMUNICATION

A. Web Based Operator Interface

1. The BMS shall provide a web based graphical interface that allows users to access the BMS data via the Internet, extranet, or Intranet. The interface shall use HTML based ASP pages to send and receive data from the BMS to a web browser.

2. A web server computer will be supplied (if required). The web server shall support browser access via a modern web browser as approved by MMC IT.

3. All information exchanged over Internet shall be optionally encrypted and secure via SSL (provided by Owner).

4. Access to the web interface shall be password protected. Users' rights and privileges to points and graphics will be the same as those assigned at the BMS workstation. An option will exist to only allow users "read" access via the web browser, while maintaining "command" privileges via the BMS workstation.

5. The web interface shall not require modification or creation of HTML or ASP pages using an HTML editor. All graphics available at the BMS graphical workstation shall be automatically generated to a web server.

6. The web based interface shall provide the following functionality to users, based on their access and privilege rights:

    a. Logon Screen - allows the user to enter their name, password and domain name for logging into the web server.

    b. Alarm Display - a display of current BMS System alarms to which the user has access will be displayed. Users will be able to acknowledge and erase active alarms and link to additional alarm information including alarm messages. Any alarm acknowledgments initiated through the web interface will be recorded to the BMS System activity log.

    c. Graphic Display - Display of system graphics, including animated motion, available in the BMS system workstation will be available for viewing over the web browser. Software that requires the creation of

dedicated "web" graphics in order to display the via the browser interface will not be acceptable. A graphic selector list will allow users to select any graphics to which they have access. Graphics displays will automatically refresh with the latest change of values. Users will have the ability to command and override points from the graphic display as determined by their user account rights.

1) All system graphic updates must be approved by MMC HVAC Lead.

d. Point Details - users will have access to point detail information including operational status, operational priority, physical address and alarm limits, for point objects to which they have access.

e. Point Commanding - users will be able to override and command points they have access to via the web browser interface. Any commands or overrides initiated via the web browser interface will be written to the BMS system central workstation activity log.

7. The web server licensing options will allow concurrent access by a minimum of five (5) browser connections.

8. Internet connections, ISP services, as well as necessary firewalls or proxy servers shall be provided by the owner as required to support the web access feature.

2.15 SENSORS

A. Electronic Sensors: Vibration and corrosion resistant; for wall, immersion or duct mounting as required.

B. Instruments and control devices shall be provided for all required points detailed herein. Instruments shall have accuracies as stated herein. Instrument characteristics such as hysteresis, relaxation time, span, and maximum and minimum limits, shall be accounted for in applications of instruments and controls. Not all devices specified may be required for this project.

C. Field wiring for each digital device shall be as per the manufacturer's standard. The details of the wiring shall be included in the submittal.

D. Sensors for duct locations shall not be affected by vibrations encountered in normal duct systems.

E. Temperature Sensors

1. Temperature sensors used in duct or space sensing applications shall be thermistors. Temperature sensors shall have the following characteristics.

a. Accuracy: $\pm$0.5ºF.

b. Wire: Twisted, shielded-pair cable.

2. Insertion Elements in Ducts: Single point; use where not affected by temperature stratification or where ducts are smaller than 9sq ft. (1sq m). The length of the sensor shall be a minimum of one-third of the width of the duct with a maximum length of eighteen (18) inches. Provide duct mounted metal housing with conduit entrance.

3. Averaging Elements in Ducts: Use where prone to temperature stratification or where ducts are larger than 9sq ft (1sq m); length as required. The length

of the sensor shall be twelve (12) feet minimum or one (1) linear foot per every one (1) sq ft of cut cross section, whichever is greater. Provide duct mounted metal housing with conduit entrance and mounting clips

4. Provide one (1) averaging temperature sensor for each preheat or heating coil section in an air handling unit. The sensor shall be installed on the discharge side of each preheat coil.

5. Insertion Elements for Liquids: Provide 304 stainless steel thermowell with tapered pattern, ¾ inch NPT external connection, ½ inch internal thread. Include lagging extension equal to insulation thickness where installed in insulated piping. Insertion length shall be a minimum of 1/3 of pipe diameter but in no case shall be less than 2 ½ inches and a maximum of ¾ pipe diameter or 6 inches, whichever is smaller.

6. Space sensors:

   a. Set-Point Adjustment: Exposed.

   b. Set-Point Indication: Exposed.

   c. LCD display for temperature reading.

   d. Color: White.

   e. Orientation: Vertical.

   f. Space sensors provided for existing facilities shall match existing site standard. Coordinate with the owner and the architect for all requirements.

F. Humidity Sensors: Bulk polymer sensor element

1. Duct and Outside Humidity Air Sensors:

   a. Factory calibrated to an accuracy of ±2% RH over a range of 0%-100% RH

   b. With element guard and mounting plate, span of 0 to 100% RH.

   c. Sensors shall be Vaisala HMD60/70 Series or pre-approved equal.

2. Sensors shall be provided with a 3-point NIST traceable calibration certificate.

G. Static Pressure Transmitter: Nondirectional sensor with suitable range for expected input and temperature compensated.

1. Accuracy: 1% of full scale with repeatability of 0.1%.

2. Output: 4 – 20 mA.

3. Building Static-Pressure Range: 0-0.25” wg (0-62 Pa).

4. Duct Static-Pressure Range: 0-5” wg (0-1243 Pa).

5. Provide a Setra M264 or pre-approved equal.

6. These sensors shall be used for control of fan VFDs, monitoring of filter DP, etc.

H. Pressure Transmitters: Direct acting for gas, liquid or steam service; range suitable for system; proportional output 4-20 mA.

1. 2-wire variable capacitance.

2. NEMA 4X enclosure.

3. Rated for 0% to 100% RH and -40ºF – 185ºF.
4. Dual component housing with a moisture barrier completely isolating the electronic circuitry from the field wiring and calibration terminals.
5. Operates with a 10 – 55 VDC power supply.
6. Zero and span adjustments.
7. Accuracy shall be ± 0.075% of calibrated span.
8. Transmitter shall be furnished complete with coplanar style factory mounted 5-valve manifold and mounting bracket manufactured by Rosemount Model 305 or pre-approved equal.
9. Provide Rosemount 2051 or pre-approved equal.

I. Damper End Switches

1. Provide a compact, SPDT switch for sensing of damper position. Shall be rated to operate from -13°F – 158°F. Shall have a side rotary switch for use with interchangeable levers. Shall be Telemechanique XCKL series or pre-approved equal.

J. Air Differential Pressure Switches

1. Diaphragm type air differential pressure switches with die-cast aluminum housing, adjustable setpoint and minimum 5A switch rating at 120 VAC, SPST switches and the switch pressure range shall be suited for the application. Switch shall be automatic or manual reset type. Manual reset switches shall be Dwyer 1800 series and automatic reset switches shall be Dwyer 1900 series. High and low ports shall be 1/8 inch NPT connected to angle type tips designed to sense pressure.

K. Point Leak Detector

1. Leak detector shall have mounting feet with legs adjustable up to 1-1/2”, gold-plated water detection probes, adjustable height, a green LED to indicate power, a red LED to indicate water detected, SPDT alarm contacts. The enclosure shall be cast aluminum, weatherproof with adjustable legs. The leak detector shall operate between 11 and 27 VAC/DC. Provide Kele and Associates WD-1B, Liebert LT 410 or preapproved equal.

L. Equipment operation sensors as follows:

1. Status Inputs for Electric Motors: Current sensor with current transformers, adjustable and set to 175% of rated motor current.

M. Current Sensing Relay

1. Provide and install current sensors for all motor status points. Current sensor shall combine a status sensor for monitoring positive status and a command relay for starting or stopping motors in a single package. Current sensor shall be split core, 2-wire, loop powered and sized for expected amperage. Unit shall be UL listed. Provide status LEDs for current sensed below setpoint, current sensed above setpoint and loop power failure. The current sensor output shall be N.O., solid state and rated for 0.1A at 30 VAC/DC. The relay output shall be N.O. and rated for 5A resistive, 3A inductive at 30 VDC, 240 VAC. Current sensor with command relay shall be a Hawkeye model H938 or pre-approved equal.

N. Current Sensor

1. Provide and install current sensors for all motor status points. Current sensor shall be split core, 2-wire, loop powered and sized for expected amperage. Unit shall be UL listed. Provide status LEDs for current sensed below setpoint, current sensed above setpoint and loop power failure. The current sensor output shall be N.O., solid state and rated for 0.1A at 30 VAC/DC. Current sensor shall be manufactured by Hawkeye or pre-approved equal.

2.16 AQUASTATS

A. Aquastats shall be a SPDT or SPST switch, strap-on mountable, liquid bulb type used for high or low limit application. The temperature range shall be between 65°F TO 200°F and with a differential temperature adjustable range of 5°F TO 30°F. They shall be mounted on the inlet piping and have an external adjustable temperature setpoint. Provide Honeywell L6006C1018 or pre-approved equal.

2.17 FREEZESTATS

1. Freezestat shall monitor steam condensate. The freezestat remote bulb shall be the bulb well assembly.
2. Provide JCI A70HA-2 or pre-approved equal.

2.18 STEAM FLOW METERS

A. Vortex Steam Flow Meter

1. Accuracy: +1% of reading.
2. Output: 4-20 mA.
3. Range: Appropriate for application.
4. 316 stainless steel valve ball.
5. Grade CF8M stainless steel manifold body.
6. Nema 4X enclosure.
7. The furnished flowmeter shall be a VLM20 Spirax-Sarco or approved equal.

2.19 WATER ENERGY AND FLOW METERS

A. Insertion Electromagnetic Meters

1. Mag meter specification:
   a. Size and flow range shall be selected by the contractor and approved by the engineer.
   b. 304 SS tube material.
   c. Teflon (PTFE) lining material.
   d. 316L SS electrode material.
   e. Standard electrode type (two).
   f. Carbon steel flange material – ANSI rated.
   g. Remote mounted transmitter.

h. Local display.

i. NEMA 4 enclosure.

j. Accuracy= 0.5 %.

k. Provide Rosemount Series 8700.

2. Provide required temperature transmitters as required and as specified.

3. Provide an ONICON Model F-3500 Insertion Electromagnetic Flow Meter. Materials of construction for wetted metal components shall be 316 SS. For installations in non-metallic pipe, install grounding rings or probes. The flow meter shall average velocity readings from two sets of diametrically opposed electrodes. Each flow meter shall be individually wet-calibrated against a primary volumetric standard that is accurate to within 0.1% and traceable to NIST*. A certificate of calibration shall be provided with each flow meter. Accuracy shall be within ± 1% of rate from 2-20 ft/s. Overall turndown shall exceed 100:1. Output signals shall be completely isolated and shall consist of the following: (1) high resolution frequency output for use with peripheral devices such as an ONICON display module or Btu meter, (1) analog output; 4-20mA, 0-10V, or 0-5V jumper selectable and (1) scalable dry contact output for totalization. Each flow meter shall be covered by the manufacturer's two-year warranty.

4. Install meters in straight section of piping as required by the manufacturer.

2.20 SPACE PRESSURE MONITORS

A. Room Pressure Module

1. The alarm monitor device shall have an LCD display which continuously scrolls and displays pressure direction, pressure magnitude and alarms, if any. The measured room pressure shall be continuously compared to the adjustable pressure set point. If the room pressure falls below or rises above this set point for more than an adjustable time delay, a red alarm light and an audible alarm on the monitor shall be activated. Alarm device shall also have a silence button to mute the audible alarm and a green light to indicate that room pressure is in the normal operating range. Alarming device shall be TSI Model RPM20, RPC30 or pre-approved equal.

2. Coordinate the model number / requirements for the associated pressure transducers with the owner and the facility standards.

2.21 AIRFLOW MEASURING STATIONS/DEVICES

A. Airflow/Temperature Measurement Device

1. Provide airflow/temperature measurement devices (ATMD) where specified and/or indicated on the plans.

2. Fan inlet measurement devices shall not be substituted for duct or plenum measurement devices unless an authorized EBTRON representative deems duct work to be too restrictive for probes. Written authorization is required by EBTRON and the specifying engineer.

3. Each ATMD shall consist of one (1) or more sensor probes and a single, remotely mounted, microprocessor-based transmitter capable of independently processing up to 16 independently wired sensor assemblies.

a. Each sensor assembly shall contain 2 individually wired, hermetically sealed bead-in-glass thermistors.

b. Thermistors shall be mounted in the sensor assembly using a marine-grade, waterproof epoxy. Thermistor leads shall be protected and not exposed to the environment.

c. The airflow rate of each sensor assembly shall be equally weighted and averaged by the transmitter prior to output.

d. The temperature of each sensor assembly shall be velocity weighted and averaged by the transmitter prior to output.

e. Each transmitter shall have a 16-character alpha-numeric display capable of displaying airflow, temperature, system status, configuration settings and diagnostics.

f. Devices using chip-in-glass or diode-case chip thermistors are not acceptable.

g. Devices using less than two (2) thermistors in each sensor assembly are not acceptable.

h. Devices using platinum wire RTDs are not acceptable.

i. Devices having electronic circuitry mounted in or at the sensor probe are not acceptable.

j. Pitot tubes and arrays are not acceptable.

k. Vortex shedding devices are not acceptable.

4. All Sensor Probes

a. Each sensor assembly shall independently determine the airflow rate and temperature at each measurement point.

b. Each sensor assembly shall be calibrated at a minimum of 16 airflow rates and 3 temperatures to standards that are traceable to the National Institute of Standards and Technology (NIST).

c. Airflow accuracy shall be ± 2% of reading over the entire operating airflow range.

1) Devices whose accuracy is the combined accuracy of the transmitter and sensor probes must demonstrate that the total accuracy meets the performance requirements of this specification throughout the measurement range.

d. Temperature accuracy shall be ±0.15°F over the entire operating temperature range of -20°F to 160°F.

e. The operating humidity range for each sensor probe shall be 0-99% RH (non-condensing).

f. Each sensor probe shall have an integral, U.L. listed, plenum rated cable and terminal plug for connection to the remotely mounted transmitter. All terminal plug interconnecting pins shall be gold plated.

g. Each sensor assembly shall not require matching to the transmitter in the field.

h. A single manufacturer shall provide both the airflow/temperature measuring probe(s) and transmitter for each measurement location.

5. Duct and Plenum Probes

a. Probes shall be constructed of extruded, gold anodized, 6063 aluminum tube. All wires within the aluminum tube shall be Kynar coated.

b. Probe assembly mounting brackets shall be constructed of 304 stainless steel. Probe assemblies shall be mounted using 1 of the following options:

1) Insertion mounted through the side or top of the duct.

2) Internally mounted inside the duct or plenum.

3) Standoff mounted inside the plenum.

c. The number of sensor housings provided for each location shall be as follows:

Duct or Plenum Area (sq. ft)	Total # Sensors/Location
<2	4
>2 and <4	6
>4 and <8	8
>8 and <16	12
≥16	16

d. The operating airflow range shall be 0 to 5,000 FPM unless otherwise indicated on the plans.

6. Transmitters

a. The transmitter shall have an integral LCD display capable of simultaneously displaying airflow and temperature. The LCD display shall be capable of displaying individual airflow and temperature readings of each independent sensor assembly.

b. The transmitter shall be capable of field configuration and diagnostics using an on-board pushbutton interface and LCD display.

c. The transmitter shall have a power switch and operate on 24 VAC (isolation not required).

1) The transmitter shall use a switching power supply fused and protected from transients and power surges.

2) The transmitter shall use “watch-dog” circuitry to assure reset after power disruption, transients and brown-outs.

d. All interconnecting pins, headers and connections on the main circuit board, option cards and cable receptacles shall be gold plated.

e. The operating temperature range for the transmitter shall be -20°F to 120°F. The transmitter shall be installed at a location that is protected from weather and water.

f. The transmitter shall be capable of communicating with other devices using 1 of the following interface options:

1) Linear analog output signals for airflow and temperature: Field selectable, fuse protected and isolated, 0-10 VDC/4-20 mA (4-wire).

2) RS-485: Field selectable BACnet-ARCNET, BACnet-MS/TP, Modbus-RTU or Johnson Controls N2-Bus

a) BACnet devices shall provide analog variables for airflow and temperature containing individual sensor airflow rate and temperature data.

3) 10 Base-T Ethernet: Field selectable BACnet Ethernet, BACnet-IP, Modbus-TCP and TCP/IP

a) Provide dynamic link libraries and VBA functions to interface Ethernet devices to Microsoft Excel for remote monitoring of airflow and temperature using a Windows 2000 or Windows XP based PC.

g. The transmitter shall be capable of accepting an infra-red interface card for downloading airflow and temperature data or uploading transmitter configuration data using a handheld PDA (Palm or Microsoft Windows Mobile operating systems).

1) Provide PDA upload/download software.

a) Download software shall be capable of displaying and saving individual sensor airflow rates, the average airflow rate, individual sensor temperatures and the average temperature received from the transmitter.

b) Upload software shall be capable of displaying and saving all setup parameters that can be configured using the on-board pushbutton interface and LCD display.

2) Provide a Microsoft Excel file capable of creating balance reports from PDA data files transferred to a Windows 98 or higher based PC.

3) Provide a Microsoft Excel file to create configuration data files that can be transferred from a Windows 2000, Windows XP or higher based PC to a PDA for upload to 1 or more transmitters.

7. The ATMD shall be UL listed as an entire assembly.

8. The manufacturer's authorized representative shall review and approve placement and operating airflow rates for each measurement location indicated on the plans.

a. A written report shall be submitted to the consulting mechanical engineer if any measurement locations do not meet the manufacturer's placement requirements.

9. Integral sleeve for outside air measurement:

a. Provide an extruded aluminum (6063T5) sleeve. Sleeve depth shall be 15" for ducted applications and 18" for un-ducted applications. Unducted applications shall include a 3" radius aluminum entry flair. Provide an additional 7" (10" for ducted applications) between the downstream edge of an intake louver and the leading edge of the entry

flair for outside air intake applications that are close coupled to intake louvers.

10. Provide Ebtron Model GTx116-P, GTx116-F or pre-approved equal.

11. Install meters in straight section of ductwork as required by the manufacturer.

2.22 AUTOMATIC CONTROL VALVES

A. All automatic control valves shall meet the following requirements:

1. Fully proportioning.

2. Capable of operating at varying rates of speed to correspond to the exact dictates of the controllers and variable load requirements.

3. Body pressure rating and connection type construction shall conform to piping and fittings in which the valve is to be installed and to the valve schedules.

4. Isolation valve shall be line size, full port ball valve with stainless steel ball and stem. Isolation valve 4” and large shall be globe valves.

5. Control valves 2” and smaller shall have screwed connections.

6. Control valves larger than 2-1/2” shall have flanged connections.

B. Water Control Valves: Chilled water, hot water

1. Two-position valves shall be quick opening type with the following characteristics:

a. Valves shall have replaceable seat, plug, or disc.

b. Valves shall be line size.

c. Valve body shall be bronze, cast iron, forged brass, or red brass.

d. Ball valve shall have stainless steel stem, stainless steel ball, and PTFE seats.

e. Globe valve shall have stainless steel stem and single stainless steel seat.

f. The pressure drop shall not exceed 10-20% of the piping system pressure differential, leaving the other 80-90% for the load and piping connections.

g. Two-Way Valve

1) Valve actuator and trim shall provide close-off (differential) pressure ratings greater than or equal to 150% of the total system (pump) head.

2. Modulating control valves shall have the following characteristics:

a. Valve shall be one size below pipe size.

b. Valve shall have replaceable seat, plug, or disc.

c. Equal percentage flow characteristic (characterized ball or globe type valves).

d. Valve body shall be bronze, cast iron, forged brass or red brass.

e. Ball valve shall have stainless steel stem, stainless steel ball, and PTFE seats.

f. Globe valve shall have stainless steel stem and single stainless steel seat.

g. Two-Way Valve

1) Calculate Cv based upon maximum design flow and a pressure drop equal to the pressure drop through the coil with a maximum of 5 psi (35 kPa).

2) Valve actuator and trim shall provide close-off (differential) pressure ratings greater than or equal to 150% of the total system (pump) head.

C. Steam Control Valves

1. Control valves shall be globe type with linear flow characteristic.

2. Valves shall have replaceable seat or plug.

3. Valve body shall be bronze, cast iron, or brass.

4. Globe valves shall have stainless steel stem, single stainless steel seat, and stainless steel plug.

5. Sizing:

a. Two-position service: valve shall be line size with maximum pressure drop equal to 10-20% of inlet pressure (psig).

b. Modulating service at 15 psig (100 kPa) or less: Calculate Cv based upon maximum flow and pressure drop equal to 80% of inlet pressure (psig) or as required to provide design inlet pressure to coil.

c. Modulating service at 16-50 psig (101-350 kPa): Calculate Cv based upon maximum flow and pressure drop equal to 42% of inlet pressure (psig) or as required to provide design inlet pressure to coil.

d. Modulating service at over 50 psig (350 kPa): Calculate Cv based upon maximum flow and pressure drop as scheduled on drawings or as required to provide design inlet pressure to coil.

6. Close-off (differential) pressure rating: Valve actuator and trim shall provided minimum close-off pressure rating equal to 150% of operating (inlet) pressure.

7. Whenever the steam flow rate requires a single valve larger than 2 ½", provide two (2) valves in parallel, sized for 1/3, 2/3 capacity, operating sequentially.

D. Provide one (1) control valve for each preheat or heating coil at a minimum.

E. Control valves shall be Belimo, Honeywell, Johnson Controls, Siemens or pre-approved equal.

F. Control valves 4" and larger shall be globe valves.

G. All valve actuators shall meet the following requirements:

1. All valve actuation shall be electric. Pneumatic actuation is not acceptable.

2. Valve actuator shall be by same manufacturer as valve body unless pre-approved.
3. Valve actuators shall:
   a. Be quiet in operation.
   b. Provide smooth modulation at design flow and pressure conditions.
   c. Be capable of operating in sequence with other valves and/or damper actuators when required by the sequence of operation.
   d. Be sized to close against a differential pressure equal to the design pump head plus 15%. Where pressure and flow combinations exceed ratings for commercial valves and actuators, industrial class valves and actuators shall be provided.
   e. Valve actuators shall fail-safe in either the normally open or normally closed position in the event of power failure, signal failure or compressed air failure. Fail Safe positions are as follows:

1)	Air-Handling Unit Preheat Valves	Fail Open
2)	Air-Handling Unit Cooling Valves	Fail Closed
3)	Air-Handling Unit Heating Valves	Fail Open
4)	VAV Box Hot Water Rehear Valves	Fail–In-Place
5)	All Humidification Valves	Fail Closed
6)	Radiant Panel Valves	Fail Open
7)	Unit Heater Valves	Fail Closed
8)	Heat Exchanger Steam Control Valves (1/3, 2/3)	Fail Closed
9)	Isolation Valve	Fail Closed

4. Incremental Electronic Actuator for Terminal Equipment Valve Actuation
   a. Incremental actuators shall be allowed for terminal equipment only.
   b. Actuators shall be proportional, electronic, direct-coupled actuators used for modulating service. Actuators shall be equipped with metal housings and visual stroke indicators.
   c. Actuators shall be equipped with a permanent manual adjustment.
   d. Minimum Torque: 35” lb.
   e. Operating Voltage: 24 VAC.
   f. Input Signal: 3-wire floating, 0 – 10 VDC or 4 – 20 mA.
   g. Frequency: 50 – 60 Hz.
   h. Power Consumption: 1.5VA maximum.
   i. Spring Return Time: 20 sec maximum.
   j. Spring return position should be field adjustable with a switch.
   k. Nominal Force: 90lb Minimum.
   l. Stroke: 7/32" (5.5mm) maximum.
   m. For use when the maximum media temperature is 230°F.

5. Electric Valve Actuation
   a. Actuator shall have electronic, proportional control and shall be direct-coupled with spring return.
   b. Actuators shall be equipped with a permanent manual override hand wheel and visual and electronic stroke indicators.
   c. Operating Voltage: 24 VAC.
   d. Input Signal: 0-10 VDC, 4 – 20 mA.
   e. Power Consumption: 18VA maximum (valves 2” and under), 28VA maximum (valves 2-1/2” – 4”)
   f. Spring Return Time: 15 seconds maximum
   g. Spring return position should be field adjustable with a switch.
   h. Nominal Force: 225lb Minimum (valves 2” and under), 610lb. (valves 2-1/2”-4”)
   i. Stroke: 3/4" (20mm) maximum (valves 2” and under), 1-1/2” (valves 2-1/2”-4”)
   j. For use when the maximum media temperature is 300ºF.

2.23 DAMPER ACTUATION

A. All damper actuation shall be electric. Pneumatic actuation is not acceptable.

B. Damper actuators used for emergency generator intake or exhaust applications shall be fast-acting type.

C. Size actuators for running torque calculated as follows:
   1. Parallel-Blade Damper with Edge Seals:7”-lb/sq. ft. (86.8 kg-cm/sq. m) of damper.
   2. Opposed-Blade Damper with Edge Seals: 5”-lb/sq. ft. (62 kg-cm/sq. m) of damper.
   3. Parallel-Blade Damper without Edge Seals: 4”-lb/sq. ft (49.6 kg-cm/sq. m) of damper.
   4. Opposed-Blade Damper without Edge Seals: 3”-lb/sq. ft. (37.2 kg-cm/sq. m) of damper.
   5. Dampers with 2” to 3” wg (500 to 750 Pa) of Pressure Drop or Face Velocities of 1000 to 2500 fpm (5 to 13 m/s): Increase running torque by 1.5.
   6. Dampers with 3” to 4” wg (750 to 1000 Pa) of Pressure Drop or Face Velocities of 2500 to 3000 fpm (13 to 15 m/s): Increase running torque by 2.0.

D. All damper actuators shall meet the following requirements:
   1. Damper actuators shall have external adjustable stops to limit the stroke in either direction.
   2. All damper actuators shall have sufficient power to overcome friction of damper linkage and air pressure acting on louvers and to operate the damper smoothly throughout the entire damper range.

3. Actuators shall be sized with a torque greater than 150% of the design damper torque.
4. Actuators shall have mounting arrangement for location outside of the air stream. The damper actuators shall be mounted on the damper extension so that it is not buried in the wall construction.
5. Damper actuators shall fail-safe in either the normally open or normally closed position in the event of power failure, signal failure or compressed air failure. Fail Safe Positions are as follows:
   a. Outside Air Dampers — Normally Closed
   b. Return Air Dampers — Normally Open
   c. Exhaust Air Dampers — Normally Closed
   d. Isolation Dampers — Normally Closed
6. Incremental Electronic Actuator for Terminal Equipment Damper Actuation
   a. Incremental actuators shall be allowed for terminal equipment only.
   b. Actuators shall be proportional, electronic, direct-coupled actuators used for modulating service. Actuators shall be equipped with metal housings and visual stroke indicators.
   c. Actuators shall be equipped with a permanent manual adjustment.
   d. Minimum Torque: 35” lb.
   e. Operating Voltage: 24 VAC.
   f. Input Signal: 3 wire floating, 0 – 10 VDC, or 4 – 20 mA.
   g. Frequency: 50 – 60 Hz.
   h. Power Consumption: 1.5VA maximum.
   i. Spring Return Time: 20sec maximum.
   j. Spring return position should be field adjustable with a switch.
   k. Nominal Force: 90lb Minimum.
   l. Stroke: 7/32" (5.5mm) maximum.
   m. For use when the maximum media temperature is 230°F.
7. Electric Damper Actuation
   a. Provide proportional, electronic, direct-coupled spring return actuators for all automatic dampers used for modulating service. Each actuator shall be equipped with a brushless DC motor, self centering shaft coupling, metal housing, permanent manual override, visual stroke indicators and built in adjustable start and span controls with the following specifications:
      1) Operating Voltage: 24 VAC./ 120 VAC (Hardwired to starter circuit)
      2) Input Signal: 0-10 VDC, 4 – 20 mA (modulating), on/off (2 position).
      3) Frequency: 50 – 60 Hz.

4) Power Consumption: 9 VA Maximum.

5) Spring Return Time: 15 seconds Maximum.

6) Spring return position should be field adjustable with a switch.

7) Minimum Torque: 133" lb.

8) Angular Rotation: 90°.

E. Damper actuators shall be Belimo or pre-approved equal.

2.24 SMOKE PURGE PANEL

A. General:

1. This specification defines the basic construction and components for a Firefighter's Override Control Panel. The control panel shall be a graphic display with switches and LED indicators. The control panel shall be mounted on a surface mounted enclosure.

2. Construction:

a. The control panel shall be constructed with a .125-inch aluminum substrate and a 7-mil polyester film overlay. The polyster film overlay shall be protected by a non-glare textured coating, which is non-yellowing, durable, and scratch resistant. LEDs, resistors, diodes, etc. shall be mounted on printed circuit boards (PCBs). All wiring to the PCBs shall be made on solder type terminal turrets. All switches shall be securely mounted to the panel.

B. Graphic - Graphic Colors:

1. The film overlay shall be a graphic as shown in the architect's plan with black lines and legends, and colored background areas. The graphic shall be made of 7-mil photographic film, having all accent colors applied to the backside of the film. Important areas such as elevator shafts, stairwells, and main air ducts shall be highlighted for easy identification. The panel supplier shall furnish a color chart with a minimum of 22 accent colors for architect selection.

C. Graphic Surface:

1. The working surface (polyester film) shall be bonded to the aluminum substrate with an adhesive that has been proven not to delaminate in similar applications. The adhesive shall achieve 100% bonding without any creases, bumps, or blemishes in the working surface (face) of the graphic. The working surface (face) of the graphic. The working surface of the graphic shall be textured and non-glare. Translucent areas shall be made in the overlay for backlighted indicators. LEDs shall not protrude through the polyester film overlay. Backlit areas shall be subdued until the LED is illuminated. The illumination of any indicator shall be clearly visible from any viewing angle in front of the working surface of the graphic.

D. Substrate:

1. The aluminum substrate shall have holes for LEDs and switches. The substrate shall have holes drilled and tapped for mounting the printed circuit

boards. The aluminum substrate shall have a clear irradiated finish to prevent oxidation.

E. Indicators:

1. The indicators shall be high intensity LEDs, T-1 ¾ in size, and rated for normal operation at a current of 20 mA. The LEDs shall have an operating life of a minimum of 170,000 hours of continuous or pulsed operation. The LED lens body shall be constructed of high impact plastic. All LEDs shall be mounted on .062" printed circuit boards constructed of epoxy glass material, NEMA Type FR-4, Grade 10. Resistors and diodes for current limiting and LED test shall also be mounted on the printed circuit boards. Solder type, pressed in turrets shall be provided for electrical connections to the LEDs. All field wiring shall terminate on modular screw clamp type terminals or connectors located in the rear of the enclosure.

F. Switches:

1. Rotary switches shall be used for specific panel operations unless other switch types are specified. A key switch shall be used for panel enable operation when specified. Switches shall be rated for the load served. A momentary pushbutton shall be provided for simultaneous testing of all LEDs. All switch wiring shall be terminated on modular screw clamp type terminal strips or connectors mounted in the rear of the enclosure.

G. Enclosure:

1. The enclosure shall be made from cold rolled steel and be assembled using all welded and formed steel construction. The enclosure shall be primed and painted with a baked enamel and have a textured finish. A security door with viewing window may be supplied to prevent unauthorized operation of the control panel switches. All enclosures shall be constructed according to UL 864 Section 7 specifications.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install software in control units and operator workstation(s). Implement all features of programs to specified requirements and as appropriate to sequence of operation.

B. Connect and configure equipment and software to achieve sequence of operation specified.

C. All control components including automatic control valves, dampers, instruments, sensors, etc shall be tagged for identification. Acceptable methods of tagging are: laminated plastic, stamped metal and engraved plastic.

D. Install equipment level and plumb.

E. Verify location of temperature sensors, humidity sensors and other exposed control sensors with plans and room details before installation. Locate all 60" above the floor or as otherwise required by ADA.

1. Install averaging elements in ducts and plenums in crossing or zigzag pattern.

F. Install guards on thermostats in the following locations:

1. Entrances.
2. Public areas.
3. Where indicated.

G. Install damper motors on outside of duct in warm areas, not in locations exposed to outdoor temperatures.

H. Install automatic dampers according to Division 23 Section.

I. Install hydronic instrument wells, valves and other accessories according to Division 23.

J. Install refrigerant instrument wells, valves and other accessories according to Division 23.

K. Install duct volume-control dampers according to Division 23.

L. Install electronic cables according to Division 26.

M. Water line mounted sensors shall be removable without shutting down the system in which they are installed.

N. For duct static pressure sensors, the high pressure port shall be connected to a metal static pressure probe inserted into the duct pointing upstream. The low pressure port shall be left open to the plenum area at the point that the high pressure port is tapped into the ductwork.

O. Averaging temperature sensors (i.e. freezestats, mixed air temperature sensor, etc.) shall be provided with fasteners or mounting clips to prevent shearing due to vibrations in the ductwork.

3.2 ELECTRICAL WIRING AND CONNECTION INSTALLATION

A. Install, connect and wire the items included under this Section. This work includes providing required conduit, wire, fittings and related wiring accessories.

B. All exposed wiring and wiring in mechanical equipment rooms shall be installed in conduit.

C. All control wiring inside an AHU shall be in conduit.

D. Plenum rated cable shall be acceptable in hung ceilings, walls and raised floors.

E. All wiring located outside shall be installed in rigid conduit, seal tite or EMT with compression fittings.

F. Conceal cable, except in mechanical rooms and areas where other conduit and piping are exposed.

G. Install cable in raceway.

H. Bundle and harness multiconductor instrument cable in place of single cables where several cables follow a common path.

I. Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.

J. Number-code or color-code conductors for future identification and service of control system, except local individual room control cables.

K. Wires and cables shall be as follows:

1. Single Conductor (120 VAC): Type THWN 12AWG stranded copper with 600V insulation.

L. Primary and Secondary Communications Network Cabling

1. Primary network shall be Ethernet based and shall utilize CAT5, CAT6 or fiber optic cable. All wiring runs longer than 300' shall utilize fiber optic cable.

2. Cable shall be of type recommend by the DDC System Manufacturer and 20AWG at a minimum.

3. Cable shall be shielded.

4. Multimode OM4, 50/125-micrometer, 12-fiber at a minimum (or per design), armored, tight buffer, laser-optimized optical fiber cable. Shall comply with TIA/EIA-568-B.3 for performance specifications. Shall be listed by NRTL as compliant with UL 444, UL 1651, and NFPA 70 as OFNR or OFNP. Maximum attenuation 3.5 dB/km at 850 nm; 1.5 dB/km at 1300 nm. Minimal modal bandwidth 160 MHz-km at 850 nm; 500 MHz-km at 1300 nm. Aqua colored jacket. Provide 100% spare capacity. Industry standard ST style connectors shall be used, with a hot melt or glue and polish termination. Use of mechanical crimp type connectors is not acceptable.

M. Room Sensor Cabling

1. Cable shall consist of copper conductors not less than No. 24 AWG.

N. Cables for 120 VAC wiring and low level signal wiring (i.e., 4 – 20 mA analog) shall always be run in separate raceways.

3.3 CONNECTIONS

A. Connect manual-reset limit controls independent of manual-control switch positions. Automatic duct heater resets may be connected in interlock circuit of power controllers.

B. Connect HOA selector switches to override automatic interlock controls when switch is in hand position.

C. Ground equipment.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including piping and electrical connections. Report results in writing.

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove malfunctioning units, replace with new units and retest.

2. Test and adjust controls and safeties.

B. Engage a factory-authorized service representative to perform startup service.

C. Replace damaged or malfunctioning controls and equipment.

1. Start, test and adjust control systems.

2. Demonstrate compliance with requirements, including calibration and testing and control sequences.

3. Adjust, calibrate and fine tune circuits and equipment to achieve sequence of operation specified.

D. Verification

1. Verify that instruments are installed before calibration, testing and loop or leak checks.
2. Check instruments for proper location and accessibility.
3. Check instrument installation for direction of flow, elevation, orientation, insertion depth and other applicable considerations.
4. Check instrument tubing for proper fittings, slope, material and support.
5. Check installation of air supply for each instrument.
6. Check flow instruments. Inspect tag number and line and bore size and verify that inlet side is identified and that meters are installed correctly.
7. Check pressure instruments, piping slope, installation of valve manifold and self-contained pressure regulators.
8. Check temperature instruments and material and length of sensing elements.
9. Check control valves. Verify that they are in correct direction.
10. Check air-operated dampers. Verify that pressure gages are provided and that proper blade alignment, either parallel or opposed, has been provided.
11. Check DDC system as follows:
    a. Verify that DDC controller power supply is from emergency power supply, if applicable.
    b. Verify that wires at control panels are tagged with their service designation and approved tagging system.
    c. Verify that spare I/O capacity has been provided.
    d. Verify that DDC controllers are protected from power supply surges.

3.5 COMMISSIONING

A. Refer to the MEP CX specification for all CX requirements.

B. Prior to full operation, the contractor in the presence of the owner’s representative and engineer shall perform a complete demonstration and testing of the system operating functions and alarms. This testing shall take place after having satisfactorily met the requirements of shop drawing acceptance. Upon successful completion of system operation, the contractor shall submit a statement in writing stating that the full operation of all systems, functions and alarms has been demonstrated and are operational as well as a listing of all systems, alarms and functions that have been commissioned. All items shall be submitted for review and acceptance to the owner, owner’s representative and engineer before final acceptance can take place.

3.6 DEMONSTRATION

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

Refer to Division 1 Section "Closeout Procedures" and "Demonstration and Training."

3.7 TRAINING

A. The BMS contractor shall provide competent instructors to give full instruction to designated personnel in the adjustment, operation and maintenance of the system installed rather than a general training course. Instructors shall be thoroughly familiar with all aspects of the subject matter they are to teach. All training shall be held during normal work hours of 8:00 a.m. to 4:30 p.m. weekdays.

B. Provide forty (40) hrs of training for Owner's operating and maintenance personnel. All training shall be on-site training. Videotape all sessions and edit each session to 1-hour DVDs. Turn over two (2) copies each unedited and edited DVD to the Owner. Training shall include:

1. Explanation of drawings, operators and maintenance manuals.
2. Walk-through of the job to locate all control components.
3. Operator workstation and peripherals.
4. DDC Controller operation/function.
5. Operator control functions including graphic generation, if design includes color graphics and field panel programming.
6. Explanation of adjustment, calibration and replacement procedures.

C. The BMS contractor shall also create a color PDF reference guide for the use of the Owner and the operating staff which provide graphical step-by-step instructions on how to perform basic tasks at the BMS that are part of the owner's operating staff's daily duties. This shall include, but not be limited to, navigating the BMS screens, setpoint adjustment, turning units on/off, turning systems on/off, overriding commands, acknowledging alarms, adjusting time schedules, etc. Coordinate with the Owner's operating staff as required.

D. Since the Owner may require personnel to have more comprehensive understanding of the hardware and software, additional training must be available from the Contractor. If the Owner requires such training, it will be contracted at a later date. Provide description of available local and factory customer training. Provide costs associated with performing training at an off-site classroom facility and detail what is included in the manufacturer's standard pricing such as transportation, meals, etc.

E. The BMS Contractor shall provide phase training to ensure that when the new BMS workstation is installed, the facility staff are able to utilize the new workstation/software as equipment is switched over from the existing BMS to the new BMS. Below is a timeline of how to phase the training schedule:

1. After cut-over of first system to the new BMS:
   a. Familiarize the owner and their operating staff with the new BMS workstation, BMS software and how an overview of operator control functions including but not limited to:
      1) Navigating the new BMS software screens
      2) Setpoint adjustment
      3) Alarm notifications and acknowledgment

4) Adjusting the occupancy schedule

5) Overriding commands and setpoints

b. Familiarize the Owner and the Owner's operating staff with the new DDC controllers and their functions

c. Provide a simple navigation and basic operator control function tutorial in color in PDF for easy reference for the owner and the operating staff. The tutorial shall include how to access data and complete all operator control functions required for the owner's operating staff to perform their duties.

2. After the major hydronic systems (chiller plant, hot water system) have been cut over:

a. Provide a more detailed version of the training that occurred after the cut-over of the first system.

b. Familiarize the Owner and the Owner's operating staff with the new DDC controllers and their functions

c. Update the navigation and basic operator control function as necessary

3. At the conclusion of the project, the BMS contractor shall provide a formal training that includes all items listed in this section along with any items recommended by the manufacturer of the BMS software/hardware. Update the navigation and basic operator control function as necessary.

4. The BMS Contractor shall also include training to be provided before the first heating season and before the first cooling season to assist the Owner's operating staff with switch-over of equipment and systems. This training shall be scheduled with the owner.

3.8 ON-SITE ASSISTANCE

A. Occupancy Adjustments: Within 1 year of date of Substantial Completion, provide up to three (3) Project-site visits, when requested by Owner, to adjust and calibrate components and to assist Owner's personnel in making program changes and in adjusting sensors and controls to suit actual conditions.

3.9 RECORD DOCUMENTATION

A. Operation and Maintenance Manuals

1. Three (3) copies of the Operation and Maintenance Manuals shall be provided to the Owner's Representative upon completion of the project. The entire Operation and Maintenance Manual shall be furnished on Compact Disc media and include the following for the BMS provided:

a. Table of contents.

b. As-built system record drawings. Record drawings shall represent the as-built condition of the system and incorporate all information supplied with the approved submittal.

1) BMS network riser diagram

2) Wiring diagrams

3) Electrical drawings

4) Flow diagrams and device locations

5) Hardware and software points list

6) Bill of materials

7) Sequence of operations.

8) I/O point lists

9) Cut sheets of all equipment installed

c. Manufacturer's product data sheets or catalog pages for all products including software.

d. System Operator's manuals.

e. Archive copy of all site-specific databases and sequences.

f. BMS network diagrams.

g. Interfaces to all third-party products and work by other trades.

h. Training course list.

B. The Operation and Maintenance Manual CD shall be self-contained and include all necessary software required to access the product data sheets. A logically organized table of contents shall provide dynamic links to view and print all product data sheets. Viewer software shall provide the ability to display, zoom and search all documents.

3.10 WARRANTY

A. The BMS shall include a one (1) year parts and labor warranty to begin upon system acceptance that covers the entire system to correct any operational issues at no additional cost to the Owner. The warranty shall cover adjustment and calibration of components and assistance to building personnel in making program changes and in adjusting sensors and controls to suit actual conditions. System acceptance shall be determined by the Owner.

B. During the warranty period, the Contractor shall guarantee the following in a form satisfactory to the Owner:

1. All work installed will be free from any and all defects in workmanship and or materials.

2. All devices will operate as per the capacities and performance characteristics specified.

3. The systems shall operate without malfunction.

C. Maintain an adequate supply of materials within 100 miles of the Project site

D. The BMS contractor shall provide alternate yearly costs for an on-going service contract for years 2 through 5 from the date the original warranty ends. This shall include spare parts, board repairs and software revisions.

E. Provide specific warranty details as part of the proposal and submittal.

3.11 BUILDING MANAGEMENT SYSTEM MAINTENANCE AGREEMENT

A. Qualifications

1. A maintained service organization consisting of at least eight (8) competent servicemen, within 60 miles of the project site, for a period of not less than 5-years.

2. The Bidder shall not be considered qualified to bid this project unless they can provide a list of 10 projects, similar in size and scope to this project, completed within the last five years.

B. Services

1. Basic Maintenance

a. The Contractor shall maintain the System for proper functioning through preventive maintenance, repair, examination, analysis, adjustment, cleaning, and calibration of all covered System components.

b. The Owner's Agent recommended frequency of 12 site visits (monthly increments) per Year. Preventive maintenance schedules will be determined and provided by the Contractor. 50% of the time shall be allocated for normal hours and 50% of the time shall be allocated for after hours.

c. NOTE: If the Owner's Agent's frequency of visitation requirements are less than those recommended by the Contractor, the Contractor will maintain the system to the best of its ability for the prescribed frequency of visitations required by the Owner's Agent.

2. Component Replacement

a. The Contractor shall repair or replace all covered failed or worn System components.

b. Replacement components will be new. Reconditioned components shall be approved by the Owner's Agent prior to installation.

c. The Contractor to provide the same warranty for reconditioned components as the manufacturer would provide for such components.

3. Scheduled Maintenance Hours

a. The Contractor shall perform all scheduled or non-emergency maintenance service during regular business hours, defined as 8:00 a.m. to 5:00 p.m., Monday - Friday, the Contractor's holidays excepted.

4. Emergency Service

a. Emergency service, defined as service or maintenance provided during other than regular business hours in the event of a critical System failure rendering the System inoperative.

b. If emergency service is included in this Contract, upon the Owner's Agent's request, the Contractor shall provide emergency service required to restore the System to operation at any time, 24 hours a day, 7 days a week, with a 4 hour response time to the location above.

5. Service Reports

a. After each repair or maintenance visit, the Contractor shall provide the Owner's Agent with a work order concerning work performed on the System, setting forth each maintenance task and listing, by name and part number, all System components replaced during that repair or maintenance visit.

6. Training

a. Customer Training is included in this Contract. The training is described as follows: Training is in lieu of scheduled monthly visit. Additional training can be provided at billable rates.

7. Fire/Life Safety Certification Testing

a. Fire/Life Safety Certification Testing is not included in this Contract.

8. Smoke Detector Testing

a. Smoke detector testing is not included in this contract.

C. Access

1. The Owner's Agent shall provide the Contractor, at no charge, with such access to the System at the Owner's Agent's premises, facilities, and equipment.

2. Following consultation with the Owner's Agent or the Owner's Agent's representative, the Contractor shall be free to start, stop, and adjust any of the Owner's Agent's equipment related to the operation of the System.

D. Limitations of Contract

1. Services Not Covered

a. Scheduled or emergency service necessitated by any act of God (including without limitation, earthquake, storm, fire, and flood), war, riot, vandalism, or any damage caused by third parties or by the Owner's Agent or its employees or agents or any damage resulting from the negligence of such third parties, the Owner's Agent, or its employees or agents.

b. Repair or replacement of any non-maintainable parts of the System such as (but not limited to) ductwork, boiler shells and tubes, electrical wiring, unit cabinets, boiler refractory material, piping, and structural supports.

c. Repair or replacement of any obsolete, discontinued, or out-of-manufacture equipment.

d. Repair or replacement of electrical wiring and/or pneumatic piping or tubing.

e. Removal or reinstallation of automatic temperature control valves and dampers or any valve rebuilding or repacking. Where automatic temperature control valves and dampers are included in the scope of this agreement (Equipment To Be Maintained), the Contractor will provide both scheduled maintenance and replacement components, but removal and replacement of these components are the sole responsibility of the Owner's Agent.

E. Maintenance Agreement Pricing

1. The Contractor shall provide yearly and multi-year pricing (1-5) for the services listed in their agreement. Each bidder shall put together a 5 year service maintenance plan as required.

END OF SECTION

SECTION 230993

SEQUENCE OF OPERATIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Section 01 81 13 "Sustainable Design Requirements – LEED v4 for Building Design & Construction – New Construction" for sustainable design requirements and detailed sustainable design submittal requirements.

C. Section 01 74 19 "Construction and Demolition Waste Management and Disposal" for disposal of construction, demolition and packaging waste disposal requirements.

1.2 SUMMARY

A. This Section includes control sequences for HVAC systems, subsystems and equipment.

B. Sustainable Building Requirements:
   1. The Owner requires the Contractor to implement practices and procedures to meet the project's environmental performance goals, which include achieving LEED version 4 Certified level Certification. Specific project goals that may impact this area of work include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; construction waste recycling; and the implementation of a construction indoor air quality management plan. The Contractor shall ensure that the requirements related to these goals, as defined in the Articles below, are implemented to the fullest extent. Substitutions, or other changes to the work proposed by the Contractor or their Subcontractors, shall not be allowed if such changes compromise the aforementioned environmental goals and LEED certification.

1.3 DEFINITIONS

A. AHU: Air Handling Unit.

B. AI: Analog Input.

C. AO: Analog output.

D. ATC: Automatic Temperature Control.

E. BMS: Building Management System.

F. CFM: Cubic Feet per Minute.

G. DDC: Direct-digital controls.

H. DI: Digital Input.

I. DO: Digital Output.

J. FAS: Fire Alarm System.

K. HVAC: Heating, Ventilating and Air Conditioning.

L. LAN: Local area network.

M. LCD: Liquid Crystal Display

N. MER: Mechanical Equipment Room.

O. PID: Proportional Integral Derivative.

P. POT: Portable Operators Terminal.

Q. RTU: Rooftop Air Handling unit.

R. VAV: Variable air volume.

S. VFD: Variable Frequency Drive.

1.4 GENERAL

A. All safety devices shall be hardwired to the starter and shall have a second contact for monitoring via the BMS.

B. A failure alarm, as included in the point list, shall indicate the type of equipment that has failed (pump, fan, valve, etc.) including the specific designation of the piece of equipment (e.g., supply fan SF-1). It is not acceptable to generate a general failure alarm.

C. Alarming devices such as pressure safeties, etc. shall be wired so the contacts open in the alarm condition. All alarm points shall be annunciated at the BMS audibly and visually. All alarm points associated with varying values shall be provided with adjustable limits.

D. Air pressure switches shall be manual reset type and a manual reset at the switch shall be required to allow the system to restart.

E. All setpoints including setpoints internal to control algorithms shall be adjustable from all BMS operator interfaces. All commands shall be overrideable from all BMS operator interfaces. All control points shall be adjustable or overrideable from the same graphic page that displays the points.

F. All points for a specific mechanical system shall be connected to and controlled by the same DDC controller unless otherwise specified. For example, it is not acceptable to control a supply fan with one (1) DDC controller located at a motor control center and to control the rest of the air-handling unit points with a DDC controller located at the air-handling unit.

G. All points required by the sequence of operation including, but not limited to, the points listed in the sequences of operation below, as well as all of the points' associated values, shall be connected to the BMS and available to the BMS operators on all operator workstations and all operator interface devices as part of a graphical display that depicts the mechanical system controlled.

H. The BMS shall utilize the MMC campus LAN (MMC IT backbone) as the primary network. Ethernet drops shall be provided by others as required. Coordinate exact locations of all Ethernet drops. The BMS contractor is responsible for all other

wiring, devices, etc. required to connect to the LAN. The BMS contractor shall coordinate with MMC IT for all network tie-in requirements.

I. All valves, dampers, controllers, control devices, etc. exposed to outside air conditions shall be specifically designed for outside air conditions including, but not limited to, NEMA 4X enclosures, weatherproof enclosures and all other weather precautions recommended by the manufacturer.

J. No part of the programming specified herein shall be programmed into operator priority.

K. All alarms associated with equipment that is disabled shall be inhibited.

L. All initial field settings applied shall be saved as the default values. These values shall be downloaded to the controller such that they are the default value if the controller loses power. A printed copy shall also be provided to the owner as part of the O & M manuals.

M. When the motor controller is equipped with an HOA, the motors shall only be controlled by the BMS when the HOA switch is in the auto position.

N. Freezestats, pressure safeties, interlocked dampers, etc. shall be wired to shutdown motors when the HOA switch is in both the hand and auto positions. It shall not be possible to override these or any other safety devices or any fire alarm system control functions, except in the case of an engineered smoke control system in which case freeze protection safeties shall be overridden.

O. Where fans and dampers are to be hardwire interlocked, provide hardwire interlocks between the motor terminal strip and dampers such that the damper shall be driven open then the motor is required to start. Motor start-up shall not occur until the damper end switch indicates the damper is in the full open position. Where fans and dampers are hardwire interlocked, the interlocks shall apply in both the "hand" and "auto" positions of the HOA switch at the motor controller.

P. The point lists are provided for convenience and are not intended to be all-inclusive. All points required to provide the Sequence of Operation shall be included as if listed.

1.5 VARIABLE AIR VOLUME RECIRCULATING AHU FOR OR (AHU-152 & AHU-154)

A. Please refer to the MMC OPR-REV-5 for more detail on the AHU sequences shown below.

B. AHU-152 and AHU-154 are part of headed together pair serving operating rooms on the C1 level.

C. Each AHU consists of a supply fan array with four (4) fans and four (4) VFDs. There shall be one (1) common return fan array with four (4) return fans and four (4) return fan VFDs serving both AHUs.

D. Safeties

1. The supply and/or return smoke detector shall stop the supply and return fans upon the presence of smoke through the FAS.

2. A low suction air pressure switch located upstream of the supply fan array and downstream of the closest damper shall stop the supply and return fans when duct pressure decreases below an adjustable setpoint. A high discharge

air pressure switch located downstream of the supply fan array and upstream of the closest damper shall stop the supply and return fans when duct pressure exceeds an adjustable setpoint. The supply and return fans shall remain off until the air pressure switch is manually reset.

3. A low suction air pressure switch located upstream of the return fan array and downstream of the closest damper shall stop the supply and return fans when duct pressure decreases below an adjustable setpoint. A high discharge air pressure switch located downstream of the return fan array and upstream of the closest damper shall stop the supply and return fans when duct pressure an adjustable setpoint. The supply and return fans shall remain off until the air pressure switch is manually reset.

4. Furnish, install and wire one (1) supply static pressure sensor for each supply fan array for high limit control.

E. Enabled Mode (Typical for each AHU)

1. The unit shall be started based upon a time of day schedule or manual command and run continuously. The units shall be programmed to run 24 hours a day, 7 days a week.

2. All associated VAV boxes shall be enabled prior to the supply fan array starting.

3. Upon a command to start, the BMS shall send a signal to the fire alarm system to open associated fire/smoke dampers at the shafts. Once the FAS confirms the associated fire/smoke dampers open, the AHU shall be allowed to start. Hardwired damper end switches on all 2-position dampers at the unit shall energize the supply and return fan array VFDs when all associated dampers are in their fully open position.

4. Totalize current airflow rate from VAV boxes and display on AHU graphic at discharge duct. Display the AFMS airflow rate adjacent to the sum-of-zone airflow rate. The airflow measurement stations are to be used for control.

5. The AHU shall poll the VAVs it serves over the controls network to obtain each of its VAVs damper positions.

6. Air Handling Unit Damper Control

   a. During occupied mode, the return air damper and exhaust air damper shall modulate open and the maximum outside air damper shall remain closed. The exhaust air damper shall modulate open to maintain a differential pressure of +0.05”w.c. (adj.) across the damper. The minimum outside air damper shall modulate to maintain minimum outdoor air setpoint as sensed by the minimum outdoor air flow monitoring station. If the minimum outside air damper is open 100% and the minimum outside air CFM requirement is not met, the return air dampers shall modulate closed as necessary to maintain the minimum outdoor air CFM setpoint.

   b. During economizer mode, the exhaust air damper shall stay open, the maximum outside air damper shall modulate open, the return air damper shall modulate closed after the maximum outside air damper is commanded open, and the minimum outside air CFM control loop shall be disabled.

7. Supply Fan Control

   a. The controls shall be programmed to maintain the minimal fan speed required to satisfy the boxes under the following criteria:

      1) Note: there may exist a few rouge boxes in a system. These are boxes that, given normal building operating conditions, may consistently stay unsatisfied due to the upstream AHU reaching a stabilized state required to satisfy the majority of the VAVs.

         a) Rouge zones shall be given an importance multiplier of zero (0).

      2) If any VAV dampers are less than 80% (adj.) open, then the duct static pressure setpoint shall be reduced by 0.05 inches every 5 minutes. This reduction shall occur until at least one of the boxes has opened its damper greater than the aforementioned 80% (adj.) variable.

      3) If a minimum of 2(adj.) VAV dampers have modulated to a position of 95% (adj.) or greater, then the duct static pressure set point shall be increased by 0.1 inches Every 2 minutes.

      4) Alternatively, the static pressure setpoint may be reset with a properly tuned PID control algorithm.

      5) If the supply fan VFD has been at full speed (100% or 60hz) for more than 5 minutes (adj.) and any VAV included in the calculation is at 100% open during the same 5 Minutes, an alarm shall be issued.

      6) Upon a total loss of communications between the VFD and the VAVs, the supply fan speed shall operate at the current value until communications are restored.

   b. Upon a command to enable, all the supply fan VFDs (eight (8) total) shall start unloaded and slowly ramp up to minimum speed. In the occupied mode, the supply fans shall run continuously at matching speed. The supply fans shall be controlled in unison to maintain the common supply riser static pressure setpoint, as sensed by the static pressure sensor.

   c. A new static pressure transmitter (one for each supply fan array) in the discharge duct 3/4 downstream of each supply fan array shall provide a signal (proportional to the fan discharge static pressure) to software based two mode pressure controller with reverse action, acting as a high limit. If the fan discharge static pressure exceeds its setpoint, the high limit controller shall, through a software low selector, override the output of the system static pressure controller to proportionally reduce the capacity of the supply fan array to maintain the fan discharge pressure high limit setpoint.

8. Return Fan Control

   a. The return fans in the return fan array shall each modulate in unison. The return fan array variable frequency drives shall be controlled to maintain the return CFM, as sensed by a return airflow measuring

station, at the return CFM setpoint. The return CFM setpoint shall be calculated by subtracting [exhaust air and air flow required for pressurization)] from the supply CFM, as sensed by a supply airflow measuring station.

b. RA = SA – (EA + Qp) where,

1) RA = Return airflow setpoint.

2) SA = Supply airflow as measured by airflow measuring station.

3) EA = Total exhaust airflow from the area served by the RTU. (Coordinate with the air balancer and mechanical plans).

4) Qp = Outdoor air required to maintain building pressurization. (use 10% of the RTU design CFM if this valve is not given).

9. Valve and Damper Sequencing for Discharge Air Control

a. Refer to the OPR_REV5 drawing AHU-1.02 for more details on economizer control.

b. Refer to the OPR_REV5 drawing AHU-1.03 for more details on supply air temperature control.

c. Supply air temperature shall be controlled to setpoint using a control loop whose output is mapped to sequence the preheat valve, outdoor air damper (while economizer is enabled), return air damper (while economizer is enabled), and chilled water valve as in the valve sequencing for discharge air control graph above valve and damper sequencing for discharge air control. The PID shall be direct acting so that as temperature rises above setpoint, the output of the PID rises as well.

1) As the PID for supply air temperature control increases from an output of 0% toward 33% (adj), the heating control valve shall modulate from 100% open toward fully closed.

2) If economizer is enabled, as the PID for supply air temperature control continues to increase from an output of 33% toward 45% the outdoor air damper shall modulate from its minimum position (min OA-p) towards its maximum position (max OA-p).

3) If economizer is enabled, as the PID for supply air temperature control continues to increase from an output of 45% toward 66% the return air damper shall modulate from its maximum position (max RA-p) towards 0% open.

4) As the PID for supply air temperature control continues to increase from an output of 66% (adj) toward 100% the chilled water valve shall modulate from 0% open toward 100% open.

5) Note: the PID output % that is associated with the heating valve being fully closed shall always be less than the PID output % that is associated with the chilled water valve being fully closed.

d. When AHU is proven off, there shall be no modulation of the valves or dampers. The exception being the heating valve being modulated for freeze protection.

e. Economizer Lockout

1) The normal temperature control sequencing of the economizer dampers (above) shall be disabled whenever the outdoor air conditions exceed either of the economizer lockout conditions below:

a) Outside air humidity > 28 BTU/LB (disable at 28 BTU / LB, enable at 26 BTU / LB)

b) Outside air temperature > 70°f (disable at 70 DEG F, enable at 68 DEG F)

2) Once the economizer is disabled, it shall not be re-enabled within 10 minutes, and vice versa.

F. Supply Air Temperature Setpoint Control

1. Coordinate all temperature reset sequences with MMC Controls standards.

2. Control loop shall enable only when the supply air fan is proven on.

3. Supply air temperature set point

a. Setpoint shall be reset between supply air temperature setpoint minimum (sat-min) and supply air temperature setpoint maximum (sat-max) based on heating and cooling calls from the downstream VAVs.

1) Sat-min shall be a user adjustable value, limited to a maximum of 60ºF. Initial value for all AHUs shall be 53°F.

2) Sat-max shall be a user adjustable value limited to a minimum of 70ºF and a maximum of 85ºF. Initial value for all AHUs shall be 75ºF.

3) Supply air temperature shall be reset using ~~heating and~~ cooling requests and responses. A PID shall handle the response portion to the summed ~~heating and~~ cooling requests where:

a) Only cooling requests shall be summed up and used to reset the supply temperature setpoint due to the criticality of the associated zones.

b) The result of the summation shall then be used as the input of a PID with a fixed setpoint of zero. This result may be multiplied by 10 or 100 if required by the specific PID being used. The PID shall be configured in such a way that the loop shall output 50% when its input is equal to set point (or PID bias shall equal 50%).

c) The result of the PID shall then be used as the input of a linear reset. This reset shall use the PIDs output range (0-100) to reset the supply air temperature set point between sat-min and sat-max. The calculated supply air temperature set point shall be able to be overridden at the user interface.

G. Humidification

1. When the outdoor air temperature is less than 65°F (adj.), the associated humidifier seasonal isolation valve shall open, and the humidifier shall be enabled (for each AHU). The humidifier control valves shall modulate in unison as necessary to maintain the return air relative humidity setpoint of 35% RH (adj.). As the return air relative humidity drops below setpoint, the humidifier valves shall modulate open in unison. As the return air relative humidity rises above the setpoint, the humidifier valves shall modulate close in unison.

2. A supply air humidity high limit control algorithm in each AHU shall override the individual humidifier valve closed to maintain a high limit of 75% RH (adj.) as sensed by a humidity sensor located downstream of the humidifier. The humidifier valve shall not be fully closed upon reaching the high limit setpoint. A humidity high limit switch shall shut down the humidifier if the supply air humidity rises above the high limit setpoint (adj.). The humidity high limit switch shall be provided by the humidifier manufacturer.

3. When the outdoor air temperature is greater than 65°F (adj.), the associated humidifier seasonal isolation valve shall close.

H. Dehumidification

1. If any OR space RH goes above 55% (adj.) the associated AHU shall enter a dehumidification mode.

2. When active, dehumidification mode shall be indicated on the graphics.

3. SAT setpoint shall be reset down to dehumidify. The setpoint shall slowly modulate down towards a low limit of 47°F (adj.) and hold there until all spaces are satisfied.

4. Upon all of the OR space RH becoming satisfied at 50% RH (adj.), the supply setpoint shall be released and allowed to slowly modulate back to its previous set point.

I. Mixed air temperature low limit control: The outside air, return air, and exhaust air dampers shall be overridden as necessary to maintain the mixed air low limit setpoint of 45°F (adj.).

1. This control shall only override economizer operation and shall not close OA (or minimum OA) damper below minimum OA flow setpoint.

J. Preheat Valve Control and Freeze Protection

1. If the heating coil condensate temperature sensor drops below 45°F (adj.), the steam control valve shall modulate open to maintain the steam condensate temperature at 45°F (adj.).

2. Upon a freezestat sensing a temperature below 40°F (adj.), the supply and return fans shall disable and the outside air dampers shall close. The steam control valve shall modulate to maintain the preheat discharge air temperature of 90°F, and set an alarm to the BMS indicating the unit is shut down by freeze protection.
    a. If a freeze protection shutdown is triggered, it shall remain in effect until it is reset by a physical reset switch. There shall be no software reset switches allowed.

K. Disabled Mode

1. The supply and return fans shall remain off and the variable frequency drives shall be set to 0%. The return air damper shall open and the outside air and exhaust air dampers shall close. All isolation dampers shall close and the BMS shall send a signal to the fire alarm system to close the associated fire/smoke dampers at the shafts. The chilled water valve shall close and the steam valve shall modulate as necessary to maintain the steam condensate temperature of 45°F (adj.). The humidifier control valve shall remain closed.

L. Provide the following points hardwired to the BMS:

1. All points available via integration (BACNet, Modbus) to each VFD
2. AI – Chilled water valve position feedback (0-100%).
3. AI – Common duct static pressure.
4. AI – Exhaust air damper position feedback (0-100%).
5. AI – Final-filter differential pressure (via differential pressure transmitter).
6. AI – Humidifier valve position feedback (0-100%).
7. AI – Mixed air temperature.
8. AI – Outside air CFM.
9. AI – Outside air damper position feedback (0-100%).
10. AI – Pre-filter differential pressure (via differential pressure transmitter).
11. AI – Preheat coil discharge air temperature.
12. AI – Preheat coil valve position feedback (0-100%).
13. AI – Return air CFM.
14. AI – Return air damper position feedback (0-100%).
15. AI – Return air humidity.
16. AI – Return air temperature.
17. AI – Return fan VFD speed feedback (0-100%; one (1) per VFD).
18. AI – Steam Condensate temperature.
19. AI – Supply air CFM.
20. AI – Supply air humidity.
21. AI – Supply air static pressure.
22. AI – Supply air temperature.

23. AI – Supply fan VFD speed feedback (0-100%; one (1) per VFD).
24. AO – Chilled water valve control (0-100%).
25. AO – Exhaust air damper control (0-100%).
26. AO – Humidifier valve control (0-100%).
27. AO – Outside air damper control (0-100%).
28. AO – Preheat coil valve control (0-100%; per coil section).
29. AO – Return air damper control (0-100%).
30. AO – Return fan VFD speed control (0-100%; one (1) per VFD).
31. AO – Supply fan VFD speed control (0-100%; one (1) per VFD).
32. DI – Freezestat status (one (1) per each).
33. DI – Return fan array high discharge pressure switch status.
34. DI – Return fan array low intake pressure switch status.
35. DI – Return fan status (via current sensing relay; one (1) per fan).
36. DI – Return fan VFD common alarm (one (1) per VFD).
37. DI – Supply fan array high discharge pressure switch status.
38. DI – Supply fan array low intake pressure switch status.
39. DI – Supply fan status (via current sensing relay; one (1) per fan).
40. DI – Supply fan VFD common alarm (one (1) per VFD).
41. DI – UV light status.
42. DO – Return fan VFD command (enable/disable; one (1) per VFD).
43. DO – Supply fan VFD command (enable/disable; one (1) per VFD).

M. Provide the following points on the associated equipment graphic in addition to the hardwired points indicated above:

1. AHU command (enable/disable).
2. AHU mode (economizer, normal, etc.)
3. Dirty filter alarm (indicated if filter differential pressure exceeds 0.6” for pre-filter and 1.2” for final-filter (adj.)).
4. Economizer available.
5. Freezestat alarm.
6. High and low preheat coil discharge air temperature alarms.
7. High and low return air CFM alarms.
8. High and low return air humidity alarms.
9. High and low supply air static pressure alarms.
10. High and low supply air temperature alarms.
11. High supply air humidity alarm.

12. Humidification mode (on/off).
13. Low condensate temperature alarm.
14. Low Outside air CFM alarm (below setpoint for 10 min (adj.) when economizer is disabled).
15. Mixed air low limit setpoint.
16. Outside air CFM setpoint.
17. Outside air enthalpy.
18. Outside air humidity (global point).
19. Outside air minimum CFM setpoint.
20. Outside air temperature (global point).
21. Preheat discharge low limit setpoint.
22. Return air CFM setpoint.
23. Return air enthalpy.
24. Return air humidity setpoint.
25. Return fan failure.
26. Return fan high discharge pressure alarm.
27. Return fan KW (via integration).
28. Return fan low intake pressure alarm.
29. Setback and setup temperature setpoints.
30. Supply air static pressure reset parameters.
31. Supply air static pressure setpoint.
32. Supply air temperature reset parameters.
33. Supply air temperature setpoint.
34. Supply fan failure.
35. Supply fan high discharge pressure alarm.
36. Supply fan KW (via integration).
37. Supply fan low intake pressure alarm.

1.6 VARIABLE AIR VOLUME RECIRCULATING AHU FOR ICU (AHU-151)

A. Please refer to the MMC OPR-REV-5 for more detail on the AHU sequences shown below.

B. AHU-151 has a cross tie between the supply and return mains with AHU-153 (PACU) which will be used to back up the PACU unit should it have a failure. Refer to cross connect mode below for sequence.

C. ~~Each~~ AHU consists of a supply fan array with six (6) fans and six (6) VFDs. There shall be one (1) common return fan array with four (4) return fans and four (4) return fan VFDs serving both AHUs.

D. Safeties

1. The supply and/or return smoke detector shall stop the supply and return fans upon the presence of smoke through the FAS.

2. A low suction air pressure switch located upstream of the supply fan array and downstream of the closest damper shall stop the supply and return fans when duct pressure decreases below an adjustable setpoint. A high discharge air pressure switch located downstream of the supply fan array and upstream of the closest damper shall stop the supply and return fans when duct pressure exceeds an adjustable setpoint. The supply and return fans shall remain off until the air pressure switch is manually reset.

3. A low suction air pressure switch located upstream of the return fan array and downstream of the closest damper shall stop the supply and return fans when duct pressure decreases below an adjustable setpoint. A high discharge air pressure switch located downstream of the return fan array and upstream of the closest damper shall stop the supply and return fans when duct pressure an adjustable setpoint. The supply and return fans shall remain off until the air pressure switch is manually reset.

4. Furnish, install and wire one (1) supply static pressure sensor for each supply fan array for high limit control.

E. Enabled Mode (Typical for each AHU)

1. The unit shall be started based upon a time of day schedule or manual command and run continuously. The units shall be programmed to run 24 hours a day, 7 days a week.

2. All associated VAV boxes shall be enabled prior to the supply fan array starting.

3. Upon a command to start, the BMS shall send a signal to the fire alarm system to open associated fire/smoke dampers at the shafts. Once the FAS confirms the associated fire/smoke dampers open, the AHU shall be allowed to start. Hardwired damper end switches on all 2-position dampers at the unit shall energize the supply and return fan array VFDs when all associated dampers are in their fully open position.

4. Totalize current airflow rate from VAV boxes and display on AHU graphic at discharge duct. Display the AFMS airflow rate adjacent to the sum-of-zone airflow rate. The airflow measurement stations are to be used for control.

5. The AHU shall poll the VAVs it serves over the controls network to obtain each of its VAVs damper positions.

6. Air Handling Unit Damper Control

   a. During occupied mode, the return air damper and exhaust air damper shall modulate open and the maximum outside air damper shall remain closed. The exhaust air damper shall modulate open to maintain a differential pressure of +0.05”w.c. (adj.) across the damper. The minimum outside air damper shall modulate to maintain minimum outdoor air setpoint as sensed by the minimum outdoor air flow monitoring station. If the minimum outside air damper is open 100% and the minimum outside air CFM requirement is not met, the return air

dampers shall modulate closed as necessary to maintain the minimum outdoor air CFM setpoint.

b. During economizer mode, the exhaust air damper shall stay open, the maximum outside air damper shall modulate open, the return air damper shall modulate closed after the maximum outside air damper is commanded open, and the minimum outside air CFM control loop shall be disabled.

7. Supply Fan Control

a. The controls shall be programmed to maintain the minimal fan speed required to satisfy the boxes under the following criteria:

1) Note: there may exist a few rouge boxes in a system. These are boxes that, given normal building operating conditions, may consistently stay unsatisfied due to the upstream AHU reaching a stabilized state required to satisfy the majority of the VAVs.

a) Rouge zones shall be given an importance multiplier of zero (0).

2) If any VAV dampers are less than 80% (adj.) open, then the duct static pressure setpoint shall be reduced by 0.05 inches every 5 minutes. This reduction shall occur until at least one of the boxes has opened its damper greater than the aforementioned 80% (adj.) variable.

3) If a minimum of 2(adj.) VAV dampers have modulated to a position of 95% (adj.) or greater, then the duct static pressure set point shall be increased by 0.1 inches Every 2 minutes.

4) Alternatively, the static pressure setpoint may be reset with a properly tuned PID control algorithm.

5) If the supply fan VFD has been at full speed (100% or 60hz) for more than 5 minutes (adj.) and any VAV included in the calculation is at 100% open during the same 5 Minutes, an alarm shall be issued.

6) Upon a total loss of communications between the VFD and the VAVs, the supply fan speed shall operate at the current value until communications are restored.

b. Upon a command to enable, all the supply fan VFDs (six (6) total) shall start unloaded and slowly ramp up to minimum speed. In the occupied mode, the supply fans shall run continuously at matching speed. The supply fans shall be controlled in unison to maintain the common supply riser static pressure setpoint, as sensed by the static pressure sensor.

c. A new static pressure transmitter (one for each supply fan array) in the discharge duct 3/4 downstream of each supply fan array shall provide a signal (proportional to the fan discharge static pressure) to software based two mode pressure controller with reverse action, acting as a high limit. If the fan discharge static pressure exceeds its setpoint, the high limit controller shall, through a software low selector, override the output of the system static pressure controller to proportionally reduce

the capacity of the supply fan array to maintain the fan discharge pressure high limit setpoint.

8. Return Fan Control

   a. The return fans in the return fan array shall each modulate in unison. The return fan array variable frequency drives shall be controlled to maintain the return CFM, as sensed by a return airflow measuring station, at the return CFM setpoint. The return CFM setpoint shall be calculated by subtracting [exhaust air and air flow required for pressurization)] from the supply CFM, as sensed by a supply airflow measuring station.

   b. RA = SA – (EA + Qp) where,

      1) RA = Return airflow setpoint.

      2) SA = Supply airflow as measured by airflow measuring station.

      3) EA = Total exhaust airflow from the area served by the RTU. (Coordinate with the air balancer and mechanical plans).

      4) Qp = Outdoor air required to maintain building pressurization. (use 10% of the RTU design CFM if this valve is not given).

9. Valve and Damper Sequencing for Discharge Air Control

   a. Refer to the OPR_REV5 drawing AHU-1.02 for more details on economizer control.

   b. Refer to the OPR_REV5 drawing AHU-1.03 for more details on supply air temperature control.

   c. Supply air temperature shall be controlled to setpoint using a control loop whose output is mapped to sequence the preheat valve, outdoor air damper (while economizer is enabled), return air damper (while economizer is enabled), and chilled water valve as in the valve sequencing for discharge air control graph above valve and damper sequencing for discharge air control. The PID shall be direct acting so that as temperature rises above setpoint, the output of the PID rises as well.

      1) As the PID for supply air temperature control increases from an output of 0% toward 33% (adj), the heating control valve shall modulate from 100% open toward fully closed.

      2) If economizer is enabled, as the PID for supply air temperature control continues to increase from an output of 33% toward 45% the outdoor air damper shall modulate from its minimum position (min OA-p) towards its maximum position (max OA-p).

      3) If economizer is enabled, as the PID for supply air temperature control continues to increase from an output of 45% toward 66%

the return air damper shall modulate from its maximum position (max RA-p) towards 0% open.

4) As the PID for supply air temperature control continues to increase from an output of 66% (adj) toward 100% the chilled water valve shall modulate from 0% open toward 100% open.

5) Note: the PID output % that is associated with the heating valve being fully closed shall always be less than the PID output % that is associated with the chilled water valve being fully closed.

d. When AHU is proven off, there shall be no modulation of the valves or dampers. The exception being the heating valve being modulated for freeze protection.

e. Economizer Lockout

1) The normal temperature control sequencing of the economizer dampers (above) shall be disabled whenever the outdoor air conditions exceed either of the economizer lockout conditions below:

a) Outside air humidity > 28 BTU/LB (disable at 28 BTU / LB, enable at 26 BTU / LB)

b) Outside air temperature > 70°f (disable at 70 DEG F, enable at 68 DEG F)

2) Once the economizer is disabled, it shall not be re-enabled within 10 minutes, and vice versa.

F. Supply Air Temperature Setpoint Control

1. Coordinate all temperature reset sequences with MMC Controls standards.

2. Control loop shall enable only when the supply air fan is proven on.

3. Supply air temperature set point

a. Setpoint shall be reset between supply air temperature setpoint minimum (sat-min) and supply air temperature setpoint maximum (sat-max) based on heating and cooling calls from the downstream VAVs.

1) Sat-min shall be a user adjustable value, limited to a maximum of 60ºF. Initial value for all AHUs shall be 53°F.

2) Sat-max shall be a user adjustable value limited to a minimum of 70ºF and a maximum of 85ºF. Initial value for all AHUs shall be 75ºF.

3) Supply air temperature shall be reset using heating and cooling request and response. A PID shall handle the response portion to the summed heating and cooling requests where:

a) Heating and cooling requests cancel each other out. For example, all heating requests shall be negative and all cooling requests shall be positive.

b) Heating and cooling requests shall be summed from all associated zones.

c) The result of the summation shall then be used as the input of a PID with a fixed setpoint of zero. This result may be multiplied by 10 or 100 if required by the specific PID being used. The PID shall be configured in such a way that the loop shall output 50% when its input is equal to set point (or PID bias shall equal 50%).

d) The result of the PID shall then be used as the input of a linear reset. This reset shall use the PIDs output range (0-100) to reset the supply air temperature set point between sat-min and sat-max. The calculated supply air temperature set point shall be able to be overridden at the user interface.

G. Humidification

1. When the outdoor air temperature is less than 65°F (adj.), the associated humidifier seasonal isolation valve shall open, and the humidifier shall be enabled (for each AHU). The humidifier control valves shall modulate in unison as necessary to maintain the return air relative humidity setpoint of 35% RH (adj.). As the return air relative humidity drops below setpoint, the humidifier valves shall modulate open in unison. As the return air relative humidity rises above the setpoint, the humidifier valves shall modulate close in unison.

2. A supply air humidity high limit control algorithm in each AHU shall override the individual humidifier valve closed to maintain a high limit of 75% RH (adj.) as sensed by a humidity sensor located downstream of the humidifier. The humidifier valve shall not be fully closed upon reaching the high limit setpoint. A humidity high limit switch shall shut down the humidifier if the supply air humidity rises above the high limit setpoint (adj.). The humidity high limit switch shall be provided by the humidifier manufacturer.

3. When the outdoor air temperature is greater than 65°F (adj.), the associated humidifier seasonal isolation valve shall close.

H. Dehumidification

1. If unit return RH goes above 55% (adj.) the associated AHU shall enter a dehumidification mode.

2. When active, dehumidification mode shall be indicated on the graphics.

3. SAT setpoint shall be reset down to dehumidify. The setpoint shall slowly modulate down towards a low limit of 50°F (adj.) and hold there until all spaces are satisfied.

4. Upon the unit return RH becoming satisfied at 45% RH (adj.), the supply setpoint shall be released and allowed to slowly modulate back to its previous set point.

I. Mixed air temperature low limit control: The outside air, return air, and exhaust air dampers shall be overridden as necessary to maintain the mixed air low limit setpoint of 45°F (adj.).

1. This control shall only override economizer operation and shall not close OA (or minimum OA) damper below minimum OA flow setpoint.

J. Preheat Valve Control and Freeze Protection

1. If the heating coil condensate temperature sensor drops below 45°F (adj.), the steam control valve shall modulate open to maintain the steam condensate temperature at 45°F (adj.).

2. Upon a freezestat sensing a temperature below 40°F (adj.), the supply and return fans shall disable and the outside air dampers shall close. The steam control valve shall modulate to maintain the preheat discharge air temperature of 90°F, and set an alarm to the BMS indicating the unit is shut down by freeze protection.

a. If a freeze protection shutdown is triggered, it shall remain in effect until it is reset by a physical reset switch. There shall be no software reset switches allowed.

K. Disabled Mode

1. The supply and return fans shall remain off and the variable frequency drives shall be set to 0%. The return air damper shall open and the outside air and exhaust air dampers shall close. All isolation dampers shall close and the BMS shall send a signal to the fire alarm system to close the associated fire/smoke dampers at the shafts. The chilled water valve shall close and the steam valve shall modulate as necessary to maintain the steam condensate temperature of 45°F (adj.). The humidifier control valve shall remain closed.

2. All VAV boxes on bed floors shall go to open to allow floor Fan powered boxes serving positive pressure rooms to draw air from the floor.

L. Cross Connect Mode

1. There are two (2) cross connect dampers (1 supply, 1 return), located in between the supply and return ducts of AHU 151, and 153. Cross connect mode will allow the bed units (151) airflow/static to supplement AHU-153 should there be a failure with 153, at a reduced capacity. When the DDC operator turns on cross connect mode, the DDC will send a signal to FAS which shall be used to open the appropriate floor level FSD's (AHU-153's main supply and return SD's to remain closed on AHU-153). The cross connect dampers will modulate open and provide open status feedback signals to the DDC via damper mounted end switches. When cross connect mode is turned off, the opposite sequence will occur.

M. Provide the following points hardwired to the BMS:

1. All points available via integration (BACNet, Modbus) to each VFD

2. AI – Chilled water valve position feedback (0-100%).

3. AI – Common duct static pressure.

4. AI – Exhaust air damper position feedback (0-100%).

5. AI – Final-filter differential pressure (via differential pressure transmitter).
6. AI – Humidifier valve position feedback (0-100%).
7. AI – Mixed air temperature.
8. AI – Outside air CFM.
9. AI – Outside air damper position feedback (0-100%).
10. AI – Pre-filter differential pressure (via differential pressure transmitter).
11. AI – Preheat coil discharge air temperature.
12. AI – Preheat coil valve position feedback (0-100%).
13. AI – Return air CFM.
14. AI – Return air damper position feedback (0-100%).
15. AI – Return air humidity.
16. AI – Return air temperature.
17. AI – Return fan VFD speed feedback (0-100%; one (1) per VFD).
18. AI – Steam Condensate temperature.
19. AI – Supply air CFM.
20. AI – Supply air humidity.
21. AI – Supply air static pressure.
22. AI – Supply air temperature.
23. AI – Supply fan VFD speed feedback (0-100%; one (1) per VFD).
24. AO – Chilled water valve control (0-100%).
25. AO – Exhaust air damper control (0-100%).
26. AO – Humidifier valve control (0-100%).
27. AO – Outside air damper control (0-100%).
28. AO – Preheat coil valve control (0-100%; per coil section).
29. AO – Return air damper control (0-100%).
30. AO – Return fan VFD speed control (0-100%; one (1) per VFD).
31. AO – Supply fan VFD speed control (0-100%; one (1) per VFD).
32. DI – Freezestat status (one (1) per each).
33. DI – Return fan array high discharge pressure switch status.
34. DI – Return fan array low intake pressure switch status.
35. DI – Return fan status (via current sensing relay; one (1) per fan).
36. DI – Return fan VFD common alarm (one (1) per VFD).
37. DI – Supply fan array high discharge pressure switch status.
38. DI – Supply fan array low intake pressure switch status.
39. DI – Supply fan status (via current sensing relay; one (1) per fan).

40. DI – Supply fan VFD common alarm (one (1) per VFD).
41. DI – UV light status.
42. DO – Return fan VFD command (enable/disable; one (1) per VFD).
43. DO – Supply fan VFD command (enable/disable; one (1) per VFD).

N. Provide the following points on the associated equipment graphic in addition to the hardwired points indicated above:

1. AHU command (enable/disable).
2. AHU mode (economizer, normal, etc.)
3. Dehumidification mode (on/off).
4. Humidification mode (on/off).
5. Dirty filter alarm (indicated if filter differential pressure exceeds 1″ (adj.)).
6. Economizer available.
7. Freezestat alarm.
8. High and low preheat coil discharge air temperature alarms.
9. High and low return air CFM alarms.
10. High and low return air humidity alarms.
11. High and low supply air static pressure alarms.
12. High and low supply air temperature alarms.
13. High supply air humidity alarm.
14. Low condensate temperature alarm.
15. Mixed air low limit setpoint.
16. Outside air CFM setpoint.
17. Outside air enthalpy.
18. Outside air humidity (global point).
19. Outside air minimum CFM setpoint.
20. Outside air temperature (global point).
21. Preheat discharge low limit setpoint.
22. Return air CFM setpoint.
23. Return air enthalpy.
24. Return air humidity setpoint.
25. Return fan failure.
26. Return fan high discharge pressure alarm.
27. Return fan KW (via integration).
28. Return fan low intake pressure alarm.
29. Setback and setup temperature setpoints.

30. Supply air static pressure reset parameters.
31. Supply air static pressure setpoint.
32. Supply air temperature reset parameters.
33. Supply air temperature setpoint.
34. Supply fan failure.
35. Supply fan high discharge pressure alarm.
36. Supply fan KW (via integration).
37. Supply fan low intake pressure alarm.

1.7 VARIABLE AIR VOLUME RECIRCULATING AIR HANDLING UNITS (AHU-153 & AHU-155)

A. Please refer to the MMC OPR-REV-5 for more detail on the AHU sequences shown below.

B. Safeties

1. The supply and/or return smoke detector shall stop the supply and return fans upon the presence of smoke through the FAS.
2. A low suction air pressure switch located upstream of the supply fan and downstream of the closest damper shall stop the supply and return fans when duct pressure decreases below an adjustable setpoint. A high discharge air pressure switch located downstream of the supply fan and upstream of the closest damper shall stop the supply and return fans when duct pressure exceeds an adjustable setpoint. The supply and return fans shall remain off until the air pressure switch is manually reset.
3. A low suction air pressure switch located upstream of the return fan and downstream of the closest damper shall stop the supply and return fans when duct pressure decreases below an adjustable setpoint. A high discharge air pressure switch located downstream of the return fan and upstream of the closest damper shall stop the supply and return fans when duct pressure an adjustable setpoint. The supply and return fans shall remain off until the air pressure switch is manually reset.

C. Enabled Mode

1. The unit shall be started based upon a time of day schedule or manual command and run continuously. The unit shall be programmed to run 24 hours a day, 7 days a week.
2. All associated VAV boxes shall be enabled prior to the supply fan starting.
3. Upon a command to start, the BMS shall send a signal to the fire alarm system to open associated fire/smoke dampers at the shafts. Once the FAS confirms the associated fire/smoke dampers open, the AHU shall be allowed to start. Hardwired damper end switches on all 2-position dampers at the unit shall energize the supply and return fan VFDs when all associated dampers are in their fully open position.

4. Totalize current airflow rate from VAV boxes and display on AHU graphic at discharge duct. Display the AFMS airflow rate adjacent to the sum-of-zone airflow rate. The airflow measurement stations are to be used for control.

5. The AHU shall poll the VAVs it serves over the controls network to obtain each of its VAVs damper positions.

6. AHU Damper Control

   a. During occupied mode, the return air damper and exhaust air damper shall modulate open and the maximum outside air damper shall remain closed. The minimum outside air damper shall modulate to maintain minimum outdoor air setpoint as sensed by the minimum outdoor air flow monitoring station. If the minimum outside air damper is open 100% and the minimum outside air CFM requirement is not met, the return air dampers shall modulate close as necessary to maintain the minimum outdoor air CFM setpoint.

   b. During economizer mode, the exhaust air damper shall stay open, the maximum outside air damper shall modulate open, the return air damper shall modulate closed after the maximum outside air damper is commanded open, and the minimum outside air CFM control loop shall be disabled.

7. Supply Fan Control

   a. The controls shall be programmed to maintain the minimal fan speed required to satisfy the boxes under the following criteria:

      1) Note: there may exist a few rouge boxes in a system. These are boxes that, given normal building operating conditions, may consistently stay unsatisfied due to the upstream AHU reaching a stabilized state required to satisfy the majority of the VAVs.

         a) Rouge zones shall be given an importance multiplier of zero (0).

      2) If any VAV dampers are less than 80% (adj.) open, then the duct static pressure setpoint shall be reduced by 0.05 inches every 5 minutes. This reduction shall occur until at least one of the boxes has opened its damper greater than the aforementioned 80% (adj.) variable.

      3) If a minimum of 2(adj.) VAV dampers have modulated to a position of 95% (adj.) or greater, then the duct static pressure set point shall be increased by 0.1 inches Every 2 minutes.

      4) Alternatively, the static pressure setpoint may be reset with a properly tuned PID control algorithm.

      5) If the supply fan VFD has been at full speed (100% or 60hz) for more than 5 minutes (adj.) and any VAV included in the calculation is at 100% open during the same 5 Minutes, an alarm shall be issued.

      6) Upon a total loss of communications between the VFD and the VAVs, the supply fan speed shall operate at the current value until communications are restored.

b. Supply and return fan variable frequency drives shall start unloaded and slowly ramp up to speed as required. In the occupied mode, the supply and return fans run continuously. The supply fan variable frequency drive shall be controlled to maintain the supply static pressure setpoint, as sensed at a point 3/4 downstream of the supply fan.

8. Return Fan Control

a. The return fan variable frequency drive shall be controlled to maintain the return CFM, as sensed by a return airflow measuring station, at the return CFM setpoint. The return CFM setpoint shall be calculated by subtracting [exhaust air and air flow required for pressurization)] from the supply CFM, as sensed by a supply airflow measuring station.

RA = SA – (EA + Qp) where,

1) RA = Return airflow setpoint.

2) SA = Supply airflow as measured by airflow measuring station.

3) EA = Total exhaust airflow from the area served by the RTU. (Coordinate with the air balancer and mechanical plans).

4) Qp = Outdoor air required to maintain building pressurization. (use 10% of the RTU design CFM if this valve is not given).

9. Valve and Damper Sequencing for Discharge Air Control

a. Refer to the OPR_REV5 drawing AHU-1.02 for more details on economizer control.

b. Refer to the OPR_REV5 drawing AHU-1.03 for more details on supply air temperature control.

c. Supply air temperature shall be controlled to setpoint using a control loop whose output is mapped to sequence the preheat valve, outdoor air damper (while economizer is enabled), return air damper (while economizer is enabled), and chilled water valve as in the valve sequencing for discharge air control graph above valve and damper sequencing for discharge air control. The PID shall be direct acting so that as temperature rises above setpoint, the output of the PID rises as well.

1) As the PID for supply air temperature control increases from an output of 0% toward 33% (adj), the heating control valve shall modulate from 100% open toward fully closed.

2) If economizer is enabled, as the PID for supply air temperature control continues to increase from an output of 33% toward 45% the outdoor air damper shall modulate from its minimum position (min OA-p) towards its maximum position (max OA-p).

3) If economizer is enabled, as the PID for supply air temperature control continues to increase from an output of 45% toward 66% the return air damper shall modulate from its maximum position (max RA-p) towards 0% open.

4) As the PID for supply air temperature control continues to increase from an output of 66% (adj) toward 100% the chilled water valve shall modulate from 0% open toward 100% open.

5) Note: the PID output % that is associated with the heating valve being fully closed shall always be less than the PID output % that is associated with the chilled water valve being fully closed.

d. When AHU is proven off, there shall be no modulation of the valves or dampers. The exception being the heating valve being modulated for freeze protection.

e. Economizer Lockout

1) The normal temperature control sequencing of the economizer dampers (above) shall be disabled whenever the outdoor air conditions exceed either of the economizer lockout conditions below:

a) Outside air humidity > 28 BTU/LB (disable at 28 BTU / LB, enable at 26 BTU / LB)

b) Outside air temperature > 70°f (disable at 70 DEG F, enable at 68 DEG F)

2) Once the economizer is disabled, it shall not be re-enabled within 10 minutes, and vice versa.

D. Supply Air Temperature Setpoint Control

1. Coordinate all temperature reset sequences with MMC Controls standards.

2. Control loop shall enable only when the supply air fan is proven on.

3. Supply air temperature set point

a. Setpoint shall be reset between supply air temperature setpoint minimum (sat-min) and supply air temperature setpoint maximum (sat-max) based on heating and cooling calls from the downstream VAVs.

1) Sat-min shall be a user adjustable value, limited to a maximum of 60ºF. Initial value for all AHUs shall be 53°F.

2) Sat-max shall be a user adjustable value limited to a minimum of 70ºF and a maximum of 85ºF. Initial value for all AHUs shall be 75ºF.

3) Supply air temperature shall be reset using heating and cooling request and response. A PID shall handle the response portion to the summed heating and cooling requests where:

a) Heating and cooling requests cancel each other out. For example, all heating requests shall be negative and all cooling requests shall be positive.

b) Heating and cooling requests shall be summed from all associated zones.

c) The result of the summation shall then be used as the input of a PID with a fixed setpoint of zero. This result may be multiplied by 10 or 100 if required by the specific PID being used. The PID shall be configured in such a way that the loop shall output 50% when its input is equal to set point (or PID bias shall equal 50%).

d) The result of the PID shall then be used as the input of a linear reset. This reset shall use the PIDs output range (0-100) to reset the supply air temperature set point between sat-min and sat-max. The calculated supply air temperature set point shall be able to be overridden at the user interface.

E. Humidification

1. When the outdoor air temperature is less than 65°F (adj.), the associated humidifier seasonal isolation valve shall open, and the humidifier shall be enabled. The humidifier control valve shall modulate as necessary to maintain the return air relative humidity setpoint of 35% RH (adj.). As the return air relative humidity drops below setpoint, the humidifier valve shall modulate open. As the return air relative humidity rises above the setpoint, the humidifier valve shall modulate close.

2. A supply air humidity high limit control algorithm shall override the humidifier valve close to maintain a high limit of 75% RH (adj.) as sensed by a humidity sensor located downstream of the humidifier. The humidifier valve shall not be fully closed upon reaching the high limit setpoint. A humidity high limit switch shall shut down the humidifier if the supply air humidity rises above the high limit setpoint (adj.). The humidity high limit switch shall be provided by the humidifier manufacturer.

3. When the outdoor air temperature is greater than 65°F (adj.), the associated humidifier seasonal isolation valve shall close.

F. Dehumidification

1. If unit return RH goes above 55% (adj.) the associated AHU shall enter a dehumidification mode.

2. When active, dehumidification mode shall be indicated on the graphics.

3. SAT setpoint shall be reset down to dehumidify. The setpoint shall slowly modulate down towards a low limit of 50°F (adj.) and hold there until all spaces are satisfied.

4. Upon the unit return RH becoming satisfied at 45% RH (adj.), the supply setpoint shall be released and allowed to slowly modulate back to its previous set point.

G. Mixed air temperature low limit control: The outside air, return air, and exhaust air dampers shall be overridden as necessary to maintain the mixed air low limit setpoint of 45°F (adj.).

1. This control shall only override economizer operation and shall not close OA (or minimum OA) damper below minimum OA flow setpoint.

H. Preheat Valve Control and Freeze Protection

1. If the heating coil condensate temperature sensor drops below 45°F (adj.), the steam control valve shall modulate open to maintain the steam condensate temperature at 45°F (adj.).

2. Upon a freezestat sensing a temperature below 40°F (adj.), the supply and return fans shall disable and the outside air dampers shall close. The steam control valve shall modulate to maintain the preheat discharge air temperature of 90°F, and set an alarm to the BMS indicating the unit is shut down by freeze protection.

   a. If a freeze protection shutdown is triggered, it shall remain in effect until it is reset by a physical reset switch. There shall be no software reset switches allowed.

I. Disabled Mode

1. The supply and return fans shall remain off and the variable frequency drives shall be set to 0%. The return air damper shall open and the outside air and exhaust air dampers shall close. All isolation dampers shall close and the BMS shall send a signal to the fire alarm system to close the associated fire/smoke dampers at the shafts. The chilled water valve shall close and the steam valve shall modulate as necessary to maintain the steam condensate temperature of 45°F (adj.). The humidifier control valve shall remain closed.

J. Provide the following points hardwired to the BMS:

1. All points available via integration (BACNet, Modbus) to each VFD
2. AI – Chilled water valve position feedback (0-100%).
3. AI – Common duct static pressure.
4. AI – Exhaust air damper position feedback (0-100%).
5. AI – Final-filter differential pressure (via differential pressure transmitter).
6. AI – Humidifier valve position feedback (0-100%).
7. AI – Mixed air temperature.
8. AI – Outside air CFM.
9. AI – Outside air damper position feedback (0-100%).
10. AI – Pre-filter differential pressure (via differential pressure transmitter).
11. AI – Preheat coil discharge air temperature.
12. AI – Preheat coil valve position feedback (0-100%).
13. AI – Return air CFM.
14. AI – Return air damper position feedback (0-100%).
15. AI – Return air humidity.
16. AI – Return air temperature.
17. AI – Return fan VFD speed feedback (0-100%).
18. AI – Steam Condensate temperature.

19. AI – Supply air CFM.
20. AI – Supply air humidity.
21. AI – Supply air static pressure.
22. AI – Supply air temperature.
23. AI – Supply fan VFD speed feedback (0-100%).
24. AO – Chilled water valve control (0-100%).
25. AO – Exhaust air damper control (0-100%).
26. AO – Humidifier valve control (0-100%).
27. AO – Outside air damper control (0-100%).
28. AO – Preheat coil valve control (0-100%; per coil section).
29. AO – Return air damper control (0-100%).
30. AO – Return fan VFD speed control (0-100%).
31. AO – Supply fan VFD speed control (0-100%).
32. DI – Freezestat status (one (1) per each).
33. DI – Return fan high discharge pressure switch status.
34. DI – Return fan low intake pressure switch status.
35. DI – Return fan status (via current sensing relay).
36. DI – Return fan VFD common alarm.
37. DI – Supply fan high discharge pressure switch status.
38. DI – Supply fan low intake pressure switch status.
39. DI – Supply fan status (via current sensing relay).
40. DI – Supply fan VFD common alarm.
41. DI – UV light status.
42. DO – Return fan VFD command (enable/disable).
43. DO – Supply fan VFD command (enable/disable).

K. Provide the following points on the associated equipment graphic in addition to the hardwired points indicated above:

1. AHU command (enable/disable).
2. AHU mode (economizer, normal, etc.)
3. Dehumidification mode (on/off).
4. Humidification mode (on/off).
5. Dirty filter alarm (indicated if filter differential pressure exceeds 1” (adj.)).
6. Economizer available.
7. Freezestat alarm.
8. High and low preheat coil discharge air temperature alarms.

9. High and low return air CFM alarms.
10. High and low return air humidity alarms.
11. High and low supply air static pressure alarms.
12. High and low supply air temperature alarms.
13. High supply air humidity alarm.
14. Low condensate temperature alarm.
15. Mixed air low limit setpoint.
16. Outside air CFM setpoint.
17. Outside air enthalpy.
18. Outside air humidity (global point).
19. Outside air minimum CFM setpoint.
20. Outside air temperature (global point).
21. Preheat discharge low limit setpoint.
22. Return air CFM setpoint.
23. Return air enthalpy.
24. Return air humidity setpoint.
25. Return fan failure.
26. Return fan high discharge pressure alarm.
27. Return fan KW (via integration).
28. Return fan low intake pressure alarm.
29. Setback and setup temperature setpoints.
30. Supply air static pressure reset parameters.
31. Supply air static pressure setpoint.
32. Supply air temperature reset parameters.
33. Supply air temperature setpoint.
34. Supply fan failure.
35. Supply fan high discharge pressure alarm.
36. Supply fan KW (via integration).
37. Supply fan low intake pressure alarm.

1.8 HOT WATER SYSTEM SERVING TERMINAL EQUIPMENT (P-198, P-199, HXT-2, HTX-3)

A. This system shall serve hot water to the reheat loop in the building.

B. This system shall consist of two (2) steam to hot water heat exchangers. One (1) heat exchanger shall be operational and the other heat exchanger shall be standby.

C. Provide two (2) control valves to control the steam input to each heat exchanger. The two (2) control valves (for each heat exchanger) shall be sized for 1/3 and 2/3 capacity. Provide an individual control output to each control valve.

D. The heat exchanger control algorithm shall be enabled via time schedule or manual command. The system shall be programmed to run 24 hours a day, 7 days a week.

E. Upon a command to enable the heat exchanger, the lead hot water pump shall be energized. The VFD shall start at 0% and slowly ramp up to speed as required by the differential pressure sensor. The sensor shall be wired to the same controller that modulates the speed of the VFD. The VFD shall modulate as necessary to maintain the system differential pressure setpoint.

F. When the lead hot water pump is on, the heat exchanger's 1/3 and 2/3 steam valves shall be allowed to operate. The staged 1/3 and 2/3 heat exchanger steam control valves shall modulate as necessary to maintain the hot water supply temperature setpoint of 180ºF (adj.).

G. Hot water supply temperature reset

1. All the associated VAV box terminal loads shall be polled to reset the hot water supply temperature.

2. Terminal load is measured in terms of deviation between space temperature and space temperature setpoint. For example, -175 means the space temperature is 1.75 ºF below setpoint. If the average of all the associated VAV terminal loads are above their respective setpoints, that means "AVG terminal load" > 0.

3. If AVG terminal load < 0 and any VAV terminal load is < -175, the hot water supply temperature shall be increased by 5 ºF (adj.) every 10 min (adj.) until the max temperature is 180 ºF.

4. If AVG terminal load > 0 and no VAV terminal load is < -175, the hot water supply temperature shall be decreased by 1 ºF (adj.) every 10 min (adj.) until the minimum temperature is 140 ºF.

H. Hot water differential pressure reset

1. The reheat valve position of each associated VAV box and radiant panel shall be polled.

1. The differential pressure setpoint shall be reset based on the hot water control valve position of the terminal units and radiant panels. If a control valve is greater than 90% (adj.) open, gradually increase the differential pressure setpoint until all control valves are below 95% (adj.) open. If no control valve is greater than 85% (adj.) open, decrease the differential pressure setpoint until at least one (1) control valve is greater than 85% (adj.) open.

2. The differential pressure setpoint shall have a high limit setpoint of 10 psi (adj.) and a low limit setpoint of 6 psi (adj.).

I. At any time a pump command does not equal a pump status, except immediately after startup, a pump failure alarm shall be generated on the BMS and that pump shall be commanded off. The BMS shall wait 30 seconds to see the pump status change before indicating a pump failure alarm. An automatic lead/lag program shall

start the lag pump in the event of a lead pump failure. The lead and lag pumps shall rotate on a weekly basis based on runtime.

J. When the heat exchanger is disabled, the steam control valve shall close. The hot water pumps shall be de-energized.

K. Provide the following points hardwired to the BMS:

1. All points available via integration (BACNet, Modbus) to each VFD
2. AI – Hot water supply temperature.
3. AI – Hot water system differential pressure.
4. AI – Hot water return temperature.
5. AI – Hot water pump VFD speed feedback ((0-100%); one (1) for each pump).
6. DI – Hot water pump VFD common alarm (one (1) for each pump).
7. DI – Hot water pump status (via current sensing relay; one (1) for each pump).
8. DO – Hot water pump VFD command (enable/disable; one (1) for each pump).
9. AO – Hot water pump VFD control (0-100%; one (1) for each pump).
10. AO – 1/3 steam valve control (0-100%).
11. AO – 2/3 steam valve control (0-100%).

L. Provide the following points on the associated equipment graphic in addition to the hardwired points indicated above:

1. Heat exchanger command (on/off).
2. Hot water supply temperature setpoint.
3. Hot water supply temperature reset parameters.
4. Heat exchanger enable/disable outside air interlock setpoint.
5. Heat exchanger priority.
6. High and low hot water supply temperature alarms.
7. Hot water pump failure.
8. Hot water pump priority.
9. Pump KW (via integration).

1.9 SNOW MELTING SYSTEM (P-196, P-197, HTX-1)

A. The snow melting system consists of one (1) steam to glycol heat exchanger, two (2) snow melting pumps and manufacturer provided snow melting manifold system with controls.

B. The BMS Contractor shall:

1. Provide a DDC control panel for the snow melt system and all sensors and devices described below.

2. Mount and wire all control components that are shipped with the snow melting manifold system that are not factory installed. Coordinate with the manufacturer for all field installation requirements.

3. Furnish, mount and wire any additional components not provided by the snow melting manifold system manufacturer to achieve a completely operational system.

4. Furnish, mount and wire one (1) steam control valve on the inlet of the heat exchanger for controlling the heat exchanger discharge temperature.

C. The snowmelt system is enabled to operate when the outside air temperature is below 38ºF (adj.)

D. The heat exchanger control algorithm shall be enabled by the snow melting system or manual command. Upon a command to enable the heat exchanger, the lead snow melt pump shall be energized. The pump self-sensing VFD shall operate in "Constant Curve mode", as per the pump's packaged controls.

E. When the snow melt system is enabled, the associated lead snow melt pump shall be commanded on and the heat exchanger steam control valve shall modulate as required to maintain the heat exchanger discharge temperature setpoint (adj.). The discharge temperature shall be limited by the slab return temperature, plus 20ºF, (adj.), and the discharge setpoint shall be limited to a maximum temperature of 150ºF (adj.) to prevent thermal cracking.

F. When there is no moisture present at any of the associated snow sensors, then the system shall enter idle mode. In this mode the discharge temperature is reset to maintain the lowest slab temperature of 30ºF (adj.).

G. When the snow melt system is enabled and there is moisture present at any of the associated snow sensors, then the system shall enter snow melt mode. In this mode, the discharge temperature is reset to maintain the lowest slab temperature at 38ºF (adj.).

H. Disabled Mode

1. When the snow melt system is disabled, the associated lead snow melt pump shall be commanded off and the heat exchanger steam control valve shall close.

2. At any time a pump command does not equal a pump status, except immediately after startup, a pump failure alarm shall be generated on the BMS and that pump shall be commanded off. The BMS shall wait 30 seconds to see the pump status change before indicating a pump failure alarm. An automatic lead/standby program shall start the standby pump in the event of a lead pump failure. The lead pump shall be the pump with the lower runtime hours. The standby pump shall be the pump with the higher runtime hours.

I. Provide the following points hardwired to the BMS:

1. All points available via a BACnet or Modbus communication interface to the VFDs, snowmelt packaged controls, and heat trace system.

2. AI – Concrete Slab temperature (one (1) for each sensor).

3. AI – Heat exchanger control valve position feedback (0-100%; one (1) per valve).

4. AI – Heat exchanger discharge temperature.
5. AI – Snow melt pump VFD speed feedback (0-100%; one (1) for each pump).
6. AO – Heat exchanger control valve control (0-100%).
7. AO – Snow melt pump VFD control (0-100%; one (1) for each pump).
8. DI – Common alarm (if available from heat trace manufacturer provided controls).
9. DI – Glycol tank high pressure alarm.
10. DI – Glycol tank low pressure alarm.
11. DI – Glycol tank low level alarm.
12. DI – Heat tracing on/off status (as sensed by a current sensing relay; install one (1) per heat tracing circuit and each current sensing relay shall be an individual input to the BMS).
13. DI – Snow melt pump status (via current sensing relay; one (1) for each pump).
14. DI – Snow pump VFD common alarm (one (1) for each pump).
15. DO – Snow melt pump VFD command (enable/disable; one (1) for each pump).
16. DO – Snow melt system enable.

J. Provide the following points on the associated equipment graphic in addition to the hardwired points indicated above:

1. Failure alarm (indicated if no moisture is present, outside air temperature is less 38°F (adj.), and heat tracing status is off).
2. Heat exchanger discharge temperature reset parameters.
3. Heat exchanger discharge temperature setpoint.
4. High and low concrete slab temperature alarms.
5. High and low heat exchanger discharge temperature alarms.
6. Outside air temperature (global point).
7. Pump KW (via integration).
8. Snow melt pump failure.
9. Snow melting system command (on/off).

1.10 OVERHANG HOT WATER SYSTEM (P-205, P-206, HTX-5)

A. This system shall consist of two (2) hot water pumps and one (1) steam to glycol heat exchanger serving the overhang radiant system.

B. Furnish, install and wire one (1) control valve to control the steam input to the heat exchanger.

C. Furnish, install and wire six (6) space temperature sensors in the cavity above the overhang.

D. The heat exchanger control algorithm shall be enabled to operate when the outside air temperature drops below 40ºF (adj.).

E. Upon a command to enable the heat exchanger, the lead pump shall be energized. The pump self-sensing VFD shall operate in "Constant Curve mode", as per the pump's packaged controls.

F. When the lead pump is on, the heat exchanger's steam control valve shall modulate as necessary to maintain the heat exchanger supply temperature setpoint of 120ºF (adj.).

G. The heat exchanger supply temperature setpoint shall be reset linearly from 120ºF (adj.) to 180ºF (adj.) as the outside air temperature falls from 40ºF (adj.) to 0ºF (adj.).

H. At any time a pump command does not equal a pump status, except immediately after startup, a pump failure alarm shall be generated on the BMS and that pump shall be commanded off. The BMS shall wait 30 seconds to see the pump status change before indicating a pump failure alarm. An automatic lead/lag program shall start the lag pump in the event of a lead pump failure. The lead and lag pumps shall rotate on a weekly basis based on runtime.

I. When the heat exchanger is disabled, the steam control valve shall close. The pumps shall be de-energized.

J. Provide the following points hardwired to the BMS:

1. All points available via integration (BACNet, Modbus) to each VFD
2. AI – Heat exchanger return temperature.
3. AI – Heat exchanger supply temperature.
4. AI – Overhang cavity space temperature (one (1) per sensor).
5. AI – Pump VFD speed feedback ((0-100%); one (1) for each pump).
6. AO – Heat exchanger control valve control (0-100%).
7. AO – Pump VFD control (0-100%; one (1) for each pump).
8. DI – Glycol tank high pressure alarm.
9. DI – Glycol tank low pressure alarm.
10. DI – Glycol tank low level alarm.
11. DI – Pump status (via current sensing relay; one (1) for each pump).
12. DI – Pump VFD common alarm (one (1) for each pump).
13. DO – Pump VFD command (enable/disable; one (1) for each pump).

K. Provide the following points on the associated equipment graphic in addition to the hardwired points indicated above:

1. Heat exchanger command (on/off).
2. High and low space temperature alarms.
3. Hot water supply temperature setpoint.
4. Hot water supply temperature reset parameters.
5. Heat exchanger enable/disable outside air interlock setpoint.
6. High and low hot water supply temperature alarms.

7. Hot water pump failure.
8. Hot water pump priority.
9. Pump KW (via integration).

1.11 INFLOOR RADIANT HOT WATER SYSTEM (P-201, P-202, HX-4)

A. This system shall consist of two (2) hot water pumps and one (1) steam to hot water heat exchanger serving the radiant floor system which shall come with manufacturer provided controls.

B. The BMS contractor shall:

1. Provide field wiring for all control devices shipped loose. This shall include and not be limited to manufacturer provided radiant terminal load thermostats.

2. Coordinate with the manufacturer for all field installation requirements.

3. Furnish, install and wire any devices not provided by the manufacturer to ensure a completely operations system.

4. Furnish, install and wire one (1) control valve to control the steam input to the heat exchanger.

C. The heat exchanger control algorithm shall be enabled when outdoor air temperature falls below 50°F (adj.).

D. Upon a command to enable the heat exchanger, the lead pump shall be energized. The VFD shall start at 0% and slowly ramp up to speed as required. The pump VFD shall operate at preset speed. The actual speed setting shall be determined by the water balancer during water balancing.

E. When the lead pump is on, the heat exchanger's steam control valve shall modulate as necessary to maintain the supply temperature setpoint.

F. The supply temperature setpoint shall be reset linearly from 80°F (adj.) to 128°F (adj.) as the outside air temperature falls from 50ºF (adj.) to 20°F (adj.).

G. At any time a pump command does not equal a pump status, except immediately after startup, a pump failure alarm shall be generated on the BMS and that pump shall be commanded off. The BMS shall wait 30 seconds to see the pump status change before indicating a pump failure alarm. An automatic lead/lag program shall start the lag pump in the event of a lead pump failure. The lead and lag pumps shall rotate on a weekly basis based on runtime.

H. When the heat exchanger is disabled, the steam control valve shall close. The pumps shall be de-energized.

I. Provide the following points hardwired to the BMS:

1. All points available via integration (BACNet, Modbus) to each VFD
2. AI – Heat exchanger supply temperature.
3. AI – Heat exchanger return temperature.
4. AI – Pump VFD speed feedback ((0-100%); one (1) for each pump).
5. DI – Pump VFD common alarm (one (1) for each pump).

6. DI – Pump status (via current sensing relay; one (1) for each pump).
7. DO – Pump VFD command (enable/disable; one (1) for each pump).
8. AO – Heat exchanger control valve control (0-100%).
9. AO – Pump VFD control (0-100%; one (1) for each pump).

J. Provide the following points on the associated equipment graphic in addition to the hardwired points indicated above:

1. Heat exchanger command (on/off).
2. Heat exchanger supply temperature setpoint.
3. Heat exchanger supply temperature reset parameters.
4. Heat exchanger enable/disable outside air interlock setpoint.
5. High and low heat exchanger supply temperature alarms.
6. Hot water pump VFD speed setting.
7. Pump failure.
8. Pump priority.
9. Pump KW (via integration).

1.12 AIR COOLED CHILLER – (CH-24, P-202, P-203)

A. General

1. This system shall consist of one (1) new modular air cooled chiller, two (2) new variable speed chilled water pumps, and one (1) new chilled water system bypass valve.
2. The BMS shall monitor runtime for each piece of equipment associated with the chiller plant (i.e., chillers, pumps, etc.).
3. This contractor shall coordinate with the chiller manufacturer as required to ensure a completely operable system. This contractor shall be present with the associated chiller manufacturer during startup testing of the chiller. This contractor shall coordinate with the water balancer as required to confirm the new system bypass valve sizing and system differential pressure setpoints.

B. The BMS contractor shall:

1. Furnish all field wiring required for chiller operation, including but not limited to individual flow switch interlock wiring to the chiller manufacturer's control panel. The new chillers shall be furnished with packaged controls. The BMS shall interface to the packaged chiller controls via a BACnet gateway. Program all points available via the interface at the BMS.
2. Provide all necessary gateways (Modbus or BACnet MS/TP), etc. for each chiller and pump VFDs as required.
3. Furnish, install, and wire one (1) new differential pressure transmitters across the evaporator of the new chiller.
4. Furnish, wire, and install one (1) new system differential pressure transmitter located at the new system bypass valve.
5. Furnish and wire one (1) new DDC electric system differential bypass valve.

C. Chiller Control

1. The air cooled chiller shall be indexed on via a time schedule or manual command. The chiller shall be programmed to operate 24 hours a day, 7 days a week.

2. Upon a command to enable the chiller, the BMS shall energize the associated lead chilled water pump. When pump status is proven via a current sensing relay, the BMS shall enable the chiller packaged controls. The packaged chiller controls shall operate as required to maintain the chilled water supply temperature setpoint (adj.).

D. Chilled Water Pump Control

1. The two (2) new chilled water pumps shall operate on a lead/standby program via the BMS. The load of the system shall never exceed that of the lead chilled water pump; therefore, only one (1) chilled water pump shall be enabled during chilled water system operation.

2. Upon a command to enable the lead chilled water pump, the pump VFD shall start unloaded at 0% and slowly ramp up to speed as required by the associated differential pressure transmitter. The lead chilled water pump VFD shall modulate as necessary to maintain the constant differential pressure setpoint across the lead chiller evaporator (adj.). The differential pressure transmitter shall be wired to the same controller that modulates the speed of the VFD.

3. The speed of the chilled water pump VFD shall not be allowed to change at a rate quicker than that allowed by the chiller manufacturer. Coordinate the maximum rate of change of chilled water flow with the chiller manufacturer.

E. Chilled Water Pump Failure and Priority

1. At any time a pump command does not equal a pump status, except immediately after startup, a pump failure alarm shall be generated on the BMS that notifies the BMS operator of the specific pump that has failed and that pump shall be commanded off. The BMS shall wait 30 seconds to see the pump status change before indicating a pump failure alarm. An automatic lead/standby program shall start the next pump in sequence in the event of a pump failure.

2. The lead chilled water pump shall be the pump with the lowest runtime hours. The standby chilled water pump shall be the pump with the highest runtime hours. The lead and standby pumps shall be indexed on a weekly basis at a minimum. BMS operators shall have the ability to override each pump's priority level.

F. System Differential Pressure Control

1. The new system differential bypass valve shall modulate open/close as required to maintain the system differential pressure setpoint (adj.).

2. If the system differential pressure exceeds the high or low pressure limit, an alarm shall be annunciated at the BMS.

G. Chiller Disabled Mode

1. When the chiller is disabled, the following sequence of operation shall occur:

2. The packaged chiller controls shall be disabled manually via the BMS. Water shall circulate through the chiller until the BMS receives a signal from the chiller control panel indicating that the dilution process has ended. Once the BMS has received this signal, the chilled water pumps shall be disabled.

H. Provide the following points hardwired to the BMS:

1. All points available via integration (BACNet, Modbus) to each chiller control panel and pump VFD
2. AI – Chilled water pump VFD feedback (0-100%; one (1) for each pump).
3. AI – Chilled water return temperature.
4. AI – Chilled water supply temperature.
5. AI – Chilled water system differential pressure bypass valve feedback (0-100%).
6. AI – System differential pressure.
7. AO – Chilled water pump VFD control (0-100%; one (1) for each pump).
8. AO – Chilled water supply temperature setpoint.
9. AO – Chilled water system differential pressure bypass valve control (0-100%).
10. DI – Chilled water pump status (via current sensing relay; one (1) for each pump).
11. DI – Chilled water pump VFD common alarm (one (1) for each pump).
12. DI – Chiller common alarm.
13. DI – Chiller module common alarm (one (1) per chiller module; if available).
14. DI – Chiller status.
15. DI – Chiller module status (one (1) per chiller module).
16. DO – Chilled water pump command (one (1) for each pump).
17. DO – Chiller command.

I. Provide the following points on the associated equipment graphic in addition to the hardwired points indicated above:

1. Chilled water bypass valve failure.
2. Chilled water pump failure.
3. Chilled water supply temperature setpoint.
4. Chilled water tonnage (calculated by BMS).
5. Chiller failure.
6. Differential pressure setpoint.
7. High and low chilled water supply temperature alarms.
8. High and low differential pressure alarms.
9. Individual chilled water pump priority (lead/standby).
10. Individual chiller priority (lead/standby).
11. Outside air humidity (global point).

12. Outside air temperature (global point).

1.13 CHILLED WATER CRAC UNITS

A. The CRAC units shall come with manufacturer provided temperature controls and operate as per the manufacturer provided sequence of operations.

B. For CRAC units in the basement (with humidification) only, please furnish, wire, install one (1) space humidity sensor and a low space humidity alarm on the BMS.

C. The BMS contractor shall:

1. Mount and wire all control components that are shipped with the CRAC unit that are not factory installed. This shall include, but not be limited to, the manufacturer provided point leak detector, manufacturer provided chilled water valve, etc.

2. Furnish, mount and wire any additional components not provided by the CRAC unit manufacturer to achieve a completely operational system. This shall include, but not be limited to, chilled water isolation valves on the chilled water supply of each unit.

3. Coordinate with the unit manufacturer for all field installation requirements.

4. Wire a communication interface to each CRAC unit such as (Modbus, BACnet, etc.) to monitor all points available via the interface.

5. Coordinate the unit customizable alarms with the owner.

D. Safeties

1. Upon detection of water in the drain pan, an alarm shall be sent to the BMS, the associated isolation valve shall close via hardwire interlock, and the unit shall disable.

2. Coordinate all unit safeties with the unit manufacturer.

E. Enabled mode

1. The CRAC unit shall be enabled 24 hours a day, 7 days a week.

2. The CRAC unit supply fan shall run continuously.

3. Upon a command to enable the CRAC unit, the CRAC unit's associated isolation damper shall be hardwired open.

4. The unit shall operate as per its manufacturer packaged controls. The unit manufacturer provided chilled water valve shall modulate as necessary to maintain the space temperature setpoint (adj.).

5. For MDF CRAC Units (CRAC-0-1, CRAC-0-2, CRAC-0-3)

a. Each CRAC shall be provided with supply and return isolation dampers.

b. The MDF CRAC units shall operate on a lead, second, standby rotational program via the BMS. The lead CRAC unit shall be the unit with the

lowest run time hours and the standby CRAC unit shall be the unit with the highest run time hours. The lead, second, and standby CRAC unit shall be indexed on a weekly basis at a minimum. The priority of each CRAC unit shall be overrideable via the BMS.

c. Only the lead and second CRAC unit shall operate and one (1) standby CRAC unit shall remain idle.

d. Upon failure of the lead or second CRAC unit (fault alarm), the standby CRAC unit shall be enabled and operate per the enabled mode sequence above and an alarm shall be sent to the BMS.

e. When a CRAC unit enables, the associated isolation dampers shall open. When a CRAC unit disables, the associated isolation dampers shall close.

6. IDF CRAC Units (CRAC-0-4, CRAC-0-5)

a. Each CRAC shall be provided with supply and return isolation dampers.

b. The IDF CRAC units shall operate on a lead/standby rotational program via the BMS. The lead CRAC unit shall be the unit with the lowest run time hours and the standby CRAC unit shall be the unit with the highest run time hours. The lead and standby CRAC unit shall be indexed on a weekly basis at a minimum. The priority of each CRAC unit shall be overrideable via the BMS.

c. Only the lead CRAC unit shall operate and one (1) standby CRAC unit shall remain idle.

d. Upon failure of the lead or second CRAC unit (fault alarm), the standby CRAC unit shall be enabled and operate per the enabled mode sequence above and an alarm shall be sent to the BMS.

e. When a CRAC unit enables, the associated isolation dampers shall open. When a CRAC unit disables, the associated isolation dampers shall close.

F. Disabled mode

1. If the unit is commanded off, the supply fan shall disable and the chilled water valve shall close.

2. Upon a command to disable the CRAC unit, the associated isolation damper shall be hardwired closed.

G. Provide the following points hardwired to the BMS for each unit:

1. All points available via a high level communication interface (Modbus, BACnet, etc.) For each unit.

2. AI – Space humidity.

3. DI – CRAC unit common alarm.

4. DI – CRAC unit status.

5. DI – Isolation valve position.

6. DI – Leak detector status.

H. Provide the following points on the associated equipment graphic in addition to the hardwired points indicated above:

1. AC unit failure.

2. CRAC unit priority.

3. Fan failure alarm (when command does not equal status).

4. High and low space temperature alarms.

5. High space humidity alarm.

6. Leak detected alarm.

7. Space/area served.

1.14 2-PIPE FAN COIL UNITS

A. The BMS contractor shall:

1. Mount and wire all control components that are shipped with the fan coil unit that are not factory installed. Coordinate with the unit manufacturer as required for all field installation requirements.

2. Furnish, mount and wire any additional components not provided by the unit manufacturer to achieve a completely operational system.

3. Furnish, mount, and wire one (1) space temperature sensor per fan coil unit.

4. Provide one (1) secondary DDC controller per fan coil unit.

B. Safeties

1. A leak detector located in the drain pan below the unit shall disable the unit, close the chilled water valve, and sound an alarm at the BMS upon sensing water.

C. Occupied mode:

1. The fan coil unit shall be started/stopped by the BMS based upon a time of day schedule or manual command.

2. Upon a command to start the fan coil unit, the supply fan EC motor shall energize and the chilled water valve shall modulate as required to maintain the space temperature setpoint (adj.).

D. Unoccupied mode:

1. The supply fan shall remain off and the chilled water and valve shall close.

2. If the space temperature rises above the unoccupied setup temperature setpoint of 80°f (adj.), the fan coil unit shall be indexed to occupied mode until the space temperature falls below 76°f (adj.) Or until the unit runs for a minimum of 1/2 hour (adj.).

E. Provide the following points hardwired to the BMS:

1. AI – Discharge air temperature.

2. AI – Space temperature.

3. AO – Chilled water valve control (0-100%).

4. AO – Supply fan speed control (0-100%).

5. DI – Leak detected.

6. DI – Supply fan status (via current sensing relay).

7. DO – Supply fan command.

F. Provide the following points on the associated equipment graphic in addition to the hardwired points indicated above:

1. Fan coil unit enable/disable.

2. High or low discharge air temperature alarms.

3. High or low space temperature alarms.

4. Space temperature setpoint.

5. Space/area served.

6. Supply fan failure.

1.15 4-PIPE FAN COIL UNITS

A. The BMS contractor shall:

1. Mount and wire all control components that are shipped with the fan coil unit that are not factory installed. Coordinate with the unit manufacturer as required for all field installation requirements.

2. Furnish, mount and wire any additional components not provided by the unit manufacturer to achieve a completely operational system.

3. Furnish, mount, and wire one (1) space temperature sensor per fan coil unit.

4. Provide one (1) secondary DDC controller per fan coil unit.

B. Safeties

1. A leak detector located in the drain pan below the unit shall disable the unit, close the chilled water and hot water valve, and sound an alarm at the BMS upon sensing water.

C. Occupied mode:

1. The fan coil unit shall be started/stopped by the BMS based upon a time of day schedule or manual command.

2. Upon a command to start the fan coil unit, the supply fan EC motor shall energize and the chilled water and hot water valves shall modulate in sequence as necessary to maintain modulate to maintain the space temperature setpoint (adj.).

3. Heating and cooling shall not occur simultaneously.

D. Unoccupied mode:

1. The supply fan shall remain off and the chilled water and hot water valves shall close.

2. If the space temperature falls below the unoccupied setback temperature setpoint of 60°f (adj.), the fan coil unit shall be indexed to occupied mode until the space temperature exceeds 64°f (adj.) Or until the unit runs for a minimum of 1/2 hour (adj.).

3. If the space temperature rises above the unoccupied setup temperature setpoint of 80°f (adj.), the fan coil unit shall be indexed to occupied mode until the space temperature falls below 76°f (adj.) Or until the unit runs for a minimum of 1/2 hour (adj.).

E. Provide the following points hardwired to the BMS:

1. AI – Discharge air temperature.

2. AI – Space temperature.

3. AO – Chilled water valve control (0-100%).

4. AO – Hot water valve control (0-100%).

5. AO – Supply fan speed control (0-100%).

6. DI – Leak detected.

7. DI – Supply fan status (via current sensing relay).

8. DO – Supply fan command.

F. Provide the following points on the associated equipment graphic in addition to the hardwired points indicated above:

1. Fan coil unit enable/disable.

2. High or low discharge air temperature alarms.

3. High or low space temperature alarms.

4. Space temperature setpoint.

5. Space/area served.

6. Supply fan failure.

1.16 VARIABLE AIR VOLUME (VAV) BOXES WITH HOT WATER REHEAT

A. Coordinate factory mounting and wiring of Control Panel, actuator, transformer and hot water valve with the VAV box manufacturer. The BMS contractor shall be responsible for furnishing, installing and wiring of controls not furnished, installed, or wired by others that are required for an operational system.

B. Two separate PID control loops shall operate to maintain space temperature at setpoint cooling loop and the heating loop

1. The heating loop shall be enabled whenever the space temperature is below the current zone heating setpoint temperature, and disabled when space temperature is above the current zone heating setpoint temperature and the loop output is zero for 30 seconds

2. The cooling loop shall be enabled whenever the space temperature is above the current zone cooling setpoint temperature, and disabled when space temperature is below the current zone cooling setpoint temperature and the loop output is zero for 30 seconds

C. The cooling loop shall maintain the space temperature at the active cooling setpoint. The output of the loop shall be a software point ranging from 0% (no cooling) to 100% (full cooling).

D. The heating loop shall maintain the space temperature at the active heating setpoint. The output of the loop shall be a software point ranging from 0% (no heating) to 100% (full heating).

1. When the zone state is cooling, the cooling loop output shall be mapped to the airflow setpoint from the cooling minimum (vmin) to the cooling maximum airflow setpoints (vcool- max). The hot water valve shall close unless the discharge air temperature is below the minimum setpoint.

a. If supply air temperature from the air handler is greater than room temperature, cooling supply airflow setpoint shall be no higher than the minimum airflow setpoint (vmin).

2. When the zone state is deadband, the active airflow setpoint shall be the minimum airflow setpoint (vmin). The hot water valve is closed unless the discharge air temperature is below the minimum setpoint.

3. When the zone state is heating, the heating loop shall maintain space temperature at the heating setpoint as follows:

a. From 0-50%, the heating loop output shall reset the discharge temperature setpoint from the current AHU supply air temperature setpoint to a maximum of max ΔT above space temperature setpoint. The airflow setpoint shall be the heating minimum.

1) Max ΔT = The lesser of 90°F or (Space Temp + 15°F)

b. From 51%-100%, if the discharge air temperature is greater than room temperature plus (5°F), the heating loop output shall reset the airflow setpoint from the minimum airflow setpoint to the heating maximum airflow (vheat-max) setpoint.

4. The hot water valve shall be modulated to maintain the discharge temperature at setpoint. (directly controlling heating off the zone temperature control loop is not acceptable)

5. In occupied mode, the hot water valve shall be modulated to maintain a discharge air temperature no lower than 50°F (adj.).

E. Unoccupied Mode

1. When the primary fan system serving the VAV box is not running, the VAV box damper shall close.

2. Unoccupied mode: the VAV shall be in unoccupied mode when the VAV is scheduled unoccupied and not triggered by optimal start/stop algorithms.

3. Unoccupied heating request:

a. When the space temperature falls below the unoccupied space heating set point, the VAV shall call the parent ahu to run.

b. The VAV shall then modulate to maintain the vheat-max flow set point.

c. The VAV shall open its reheat 100%.

4. Unoccupied cooling request:

a. When the space temperature rises above the unoccupied space cooling set point, the VAV shall call the parent ahu to run.

b. The VAV shall then modulate to maintain the vcool-max flow set point.

c. The VAV shall keep its reheat fully closed.

F. The VAV box shall not open beyond the maximum CFM setting. Provide one (1) DDC controller and one (1) temperature sensor for each VAV box.

G. Provide the following points hardwired to the BMS:

1. AI – Discharge air temperature.

2. AI – Space temperature.

3. AI – Supply air CFM.

4. AO – Damper control (0-100%).

5. AO – Reheat valve control (0-100%).

H. Provide the following points on the associated equipment graphic in addition to the hardwired points indicated above:

1. Box enable/disable.

2. Box k factor.

3. Force damper full open/close.
4. Force zone airflow setpoint to vcool-max.
5. Force zone airflow setpoint to vmin.
6. Force zone airflow setpoint to zero.
7. Heating/cooling temperature setpoints.
8. High and low space temperature alarms.
9. Minimum/maximum/heating CFM settings.
10. Operating Mode (Mode 1 and Mode 2).
11. Space/area served.
12. Supply air CFM setpoint.

1.17 VARIABLE AIR VOLUME (VAV) BOXES WITH REHEAT INTERLOCKED WITH PERIMETER RADIANT PANEL VALVES

A. Coordinate factory mounting and wiring of secondary control panel and actuator with the VAV box manufacturer. The BMS contractor shall be responsible for furnishing, installing and wiring of controls not furnished, installed or wired by others that are required for an operational system.

B. The sequence above shall apply to all VAV boxes unless otherwise specified. Please see the VAV box staged with perimeter heating sequence shown below.

C. The VAV shall follow the same sequence as outlined in VAV
DAT reset with the followig amendments as shown in VAV with reheat and radiant panel graph in OPR-REV-5

1. When the zone is in heating, the heating loop shall maintain space temperature at the heating setpoint as follows:

   a. The heating loop from 0% to 50% output shall open the radiant panel valve.

   b. The heating loop from 50% to 75% output shall reset the discharge tem perature from the current AHU sat setpoint to the lesser of 90°F or 15°F above space temperature.

   c. From 75% to 100%, if the supply air temperature from the AHU is greater than room temperature plus 5°F, the heating loop output shall reset the active airflow setpoint from the minimum airflow setpoint to the maximum heating airflow setpoint.

D. The VAV box shall not open beyond the maximum CFM setting. Provide one (1) DDC controller and one (1) space temperature sensor with setpoint adjustment for each VAV box.

E. Provide the following points hardwired to the BMS:

1. AI – Discharge air temperature (at the VAV box).
2. AI – Space temperature.
3. AI – Supply air CFM.

4. AO – Damper control (0-100%).
5. AO – Radiation valve control (0-100%).
6. AO – Reheat valve control (0-100%).

F. Provide the following points on the associated equipment graphic in addition to the hardwired points indicated above:

1. Box enable/disable.
2. Box k factor.
3. Force damper full open/close.
4. Force zone airflow setpoint to vcool-max.
5. Force zone airflow setpoint to vmin.
6. Force zone airflow setpoint to zero.
7. Heating/cooling temperature setpoints.
8. High and low space temperature alarms.
9. Minimum/maximum/heating CFM settings.
10. Operating Mode (Mode 1 and Mode 2).
11. Space/area served.
12. Supply air CFM setpoint.

1.18 FAN-POWERED BOX (FPB) WITH HOT WATER REHEAT (series)

A. Coordinate factory mounting and wiring of secondary control panel, actuator, transformer, relays and controller with the FPB box manufacturer. The BMS contractor shall be responsible for furnishing, installing and wiring of controls not furnished, installed or wired by others that are required for an operational system.

B. Provide one (1) TSI RPM10 or RPM20 room pressure monitor as required depending on number of differential pressure inputs required per each Protective Environment Room.

1. Sensors to incorporate a bladder-style pressure sensing element. Thermal measuring elements or other similar designs requiring air to pass over them for proper operation are not acceptable.

2. Provide a door switch on every door into the or, including the small door leaf.

a. All door switches shall be DPDT switches.

b. One pole of every door switch shall be electrically wired in series to the TSI pressure monitor and the other poles to the ISO VAV controller.

c. Any open door shall suppress the local TSI pressure alarm for 3 minutes (as configured on the TSI monitor).

d. Any open door shall hold the associated or supply VAV box at its last position until the door is closed. Once doors are confirmed closed via door switch input, revert supply VAV box to pressure control.

C. Enabled Mode

1. The FPB ECM motor shall run at a constant preset speed determined during balancing at all times.

2. Two separate PID control loops shall operate to maintain space temperature at setpoint cooling loop and the heating loop.

   a. The heating loop shall be enabled whenever the space temperature is below the current zone heating setpoint temperature, and disabled when space temperature is above the current zone heating setpoint temperature and the loop output is zero for 30 seconds.

   b. The cooling loop shall be enabled whenever the space temperature is above the current zone cooling setpoint temperature, and disabled when space temperature is below the current zone cooling setpoint temperature and the loop output is zero for 30 seconds.

3. The cooling loop shall maintain the space temperature at the active cooling setpoint. The output of the loop shall be a software point ranging from 0% (no cooling) to 100% (full cooling).

4. The heating loop shall maintain the space temperature at the active heating setpoint. The output of the loop shall be a software point ranging from 0% (no heating) to 100% (full heating).

   a. When the zone state is cooling, the cooling loop output shall be mapped to the airflow setpoint from the cooling minimum (vmin) to the cooling maximum airflow setpoints (vcool- max). The hot water valve shall close unless the discharge air temperature is below the minimum setpoint.

      1) If supply air temperature from the air handler is greater than room temperature, cooling supply airflow setpoint shall be no higher than the minimum airflow setpoint (vmin).

   b. When the zone state is deadband, the active airflow setpoint shall be the minimum airflow setpoint (vmin). The hot water valve is closed unless the discharge air temperature is below the minimum setpoint.

   c. When the zone state is heating, the heating loop shall maintain space temperature at the heating setpoint as follows:

      1) From 0 to 50%, the heating loop output will open the radiant panel valve.

      2) From 51 to 100%, the heating loop output shall reset the discharge temperature setpoint from the current AHU supply air temperature setpoint to a maximum of max ΔT above space temperature setpoint. The airflow setpoint shall be the heating minimum.

         a) Max ΔT = The lesser of 90°F or (Space Temp + 15°F)

d. The hot water valve shall be modulated to maintain a discharge air temperature no lower than 50°F (adj.).

D. Disabled Mode

1. The FPB damper shall close to its minimum position.
2. The FPB fan shall disable.

E. The FPB box damper shall not open beyond the maximum CFM setting. Provide one (1) DDC controller and one (1) temperature sensor for each FPB box.

F. The minimum and maximum CFM settings shall be those scheduled on the mechanical drawings.

G. Provide the following points hardwired to the BMS:

1. AI – Discharge air temperature (at the FPB).
2. AI – Space temperature.
3. AI – Supply air CFM.
4. AO – Damper control (0-100%).
5. AO – FPB ECM speed control (0-100%).
6. AO – Hot water reheat control (0-100%).
7. DI – Door switch status (open/closed, per door).
8. DI – Room pressure monitor common alarm.
9. DI – Fan powered box fan status.
10. DO – Fan command.

H. Provide the following points on the associated equipment graphic in addition to the hardwired points indicated above:

1. Box enable/disable.
2. Box K factor.
3. Door open alarm (per door).
4. High and low room pressure alarm limits.
5. High and low room pressure alarms.
6. High and low space temperature alarms.
7. Minimum/maximum/heating CFM settings.
8. Occupied/unoccupied command.
9. Occupied/unoccupied, heating/cooling temperature setpoints.
10. Room pressure critical alarm.
11. Space/area served.
12. Supply air CFM setpoint.

1.19 OPERATING ROOM SUPPLY AND RETURN VARIABLE AIR VOLUME (VAV) BOXES

A. Provide an independent occupancy schedule for each OR. Default occupied hours shall be 05:00 AM to 7:00 PM and shall be graphically adjustable on an individual or basis.

B. In each OR, provide a dual-technology (IR and Ultrasonic) room occupancy sensor or sensors as required to achieve complete room coverage considering all equipment in the OR.

1. The sensor shall not employ any predictive or learning algorithms.

C. After 60 minutes of vacancy (30 minutes on the occupancy sensor and an additional 30 minute bas delay) reduce the supply airflow to 1/2 of the occupied flow setpoint. No other setpoint changes shall occur.

1. Immediately upon detection of occupancy at the occupancy sensor, revert to occupied supply CFM setpoint.

D. Thermostat adjustment wheel shall be limited in normal mode as follows:

1. Normal high limit temp to be 75 F less than .5 dead band (actual setpoint no more than 75.5)

2. Normal low limit temp to be 68 F less than .5 dead band (actual setpoint no less than 67.5)

E. Provide thermostat functionality, including led illumination, to implement bypass mode. Thermostat shall utilize an adjustable knob for temperature adjustment and shall have an onboard led and onboard occupancy override push button.

1. When the thermostat occupancy override button is pressed, enter bypass mode.

2. Bypass mode immediately puts the or into occupied mode.

3. Bypass mode extends the range of the thermostat wheel as follows:

a. Bypass high limit temp to be 85 F

b. Bypass low limit temp to be 60 F

4. When in bypass mode, illuminate the thermostat led and the graphical led on the bas graphic page.

5. Bypass mode default time limit shall be 2 hours (graphically adjustable with password).

a. After (nominal time limit), revert to normal temperature setpoint range.

b. Occupancy mode shall have priority over bypass mode

6. Include in reports and activate trends for each or to indicate whether the OR is in bypass or normal thermostat mode based on COV.

F. Modulate supply VAV to maintain specified airflows

1. All cfm setpoints to be graphically adjustable.

G. Modulate the VAV reheat coil to maintain a VAV supply air temperature.

1. VAV SAT to be reset between 52 and 100, based on space heating demand.

2. VAV SAT high/low limits shall be graphically adjustable.

H. Modulate the return VAV box to maintain return cfm setpoint.

1. Max cfm setpoint based on tab requirements to achieve positive 0.020 inches DP.

2. Reset the return box cfm setpoint to maintain room DP setpoint. DP setpoint shall be 0.020 inches, graphically adjustable.

3. Min cfm setpoint shall be zero.

I. Provide a TSI RPM10 or RPM20 room pressure monitor as required depending on number of differential pressure inputs required.

1. Sensors to incorporate a bladder-style pressure sensing element. Thermal measuring elements or other similar designs requiring air to pass over them for proper operation are not acceptable.

J. Provide a door switch on every door into the or, including the small door leaf.

1. All door switches shall be DPDT switches.

2. One pole of every door switch shall be electrically wired in series to the TSI pressure monitor and the other poles to the OR VAV controller.

3. Any open door shall suppress the local TSI pressure alarm for 3 minutes (as configured on the TSI monitor).

4. Any open door shall hold the associated or return box at its last position until the door is closed. Once doors are confirmed closed via door switch input, revert return VAV box to pressure control.

K. Provide a TSI bladder style pressure sensor where an OR is connected to a sub-sterile room, as well as between the Sub-sterile room and the corridor. Sensor(s) to be wired back to or s RPM-20 for monitoring.

1. These pressure sensor(s) shall not be used for active control, only for pressure monitoring and alarming.

L. Alarms

1. Pressure alarms shall be via BACnet integration to the TSI monitor. Alarm stpt are set at the TSI monitor. Pressure alarms after 3min delay (as configured on the TSI monitor).

a. High OR pressure alarm, stpt = 0.030 in wc

b. Low OR pressure alarm, stpt = 0.010 in wc

c. Sub-sterile high pressure alarm, stpt = 0.020 in wc

d. Sub-sterile low pressure alarm, stpt = 0.000 in wc

2. OR temp alarms – not active in bypass mode.

a. Alarm if space temp is more than 2 degrees above or below space setpoint for more than 5 continuous minutes.

3. If a door switch is open for more than 10 minutes provide a BMS alarm.

M. Provide the following points hardwired to the BMS:

1. All points available via a BACnet or Modbus communication interface to each room pressurization monitor.

2. AI – Discharge air temperature.

3. AI – Room differential pressure (per monitor).

4. AI – Space temperature.

5. AI – Supply air CFM.

6. AO – Damper control (0-100%).

7. AO – Reheat valve control (0-100%).

8. DI – Door switch status (open/closed, per door).

9. DI – Room pressure monitor common alarm.

N. Provide the following points on the associated equipment graphic in addition to the hardwired points indicated above:

1. Box enable/disable.

2. Box K factor.

3. Door open alarm (per door).

4. High and low discharge air temperature alarms.

5. High and low room pressure alarm limits.

6. High and low room pressure alarms.

7. High and low space temperature alarms.

8. Minimum/maximum/heating CFM settings.

9. Occupied/unoccupied command.

10. Occupied/unoccupied, heating/cooling temperature setpoints.

11. Space/area served.

12. Supply air CFM setpoint.

1.20 ISOLATION ROOM SUPPLY AND EXHAUST VARIABLE AIR VOLUME (VAV) BOXES

A. Coordinate factory mounting and wiring of secondary control panel, actuator and hot water valve with the box manufacturer. The BMS contractor shall be responsible for furnishing, installing and wiring of controls not furnished, installed or wired by others that are required for an operational system.

B. Provide a TSI RPM10 or RPM20 room pressure monitor as required depending on number of differential pressure inputs required.

1. Sensors to incorporate a bladder-style pressure sensing element. Thermal measuring elements or other similar designs requiring air to pass over them for proper operation are not acceptable.

C. Provide a door switch on every door into the or, including the small door leaf.

1. All door switches shall be DPDT switches.

2. One pole of every door switch shall be electrically wired in series to the TSI pressure monitor and the other poles to the ISO VAV controller.

3. Any open door shall suppress the local TSI pressure alarm for 3 minutes (as configured on the TSI monitor).

4. Any open door shall hold the associated or supply VAV box at its last position until the door is closed. Once doors are confirmed closed via door switch input, revert supply VAV box to pressure control.

D. VAV Temperature Control

1. Two separate pid control loops shall operate to maintain space temperature at setpoint, the cooling loop and the heating loop.

2. The heating loop shall be enabled whenever the space temperature is below the current zone heating setpoint temperature using a PID algorithm to calculate loop demand signal.

3. The cooling loop shall be enabled whenever the space temperature is above the current zone cooling setpoint temperature using a PID algorithm to calculate loop demand signal.

4. The cooling loop shall maintain the space temperature at the active cooling setpoint. The output of the loop shall be a software point ranging from 0% (no cooling) to 100% (full cooling).

5. The heating loop shall maintain the space temperature at the active heating setpoint. The output of the loop shall be a software point ranging from 0% (no heating) to 100% (full heating).

6. When the zone is in heating, the heating loop will maintain the space temperature at the heating setpoint as follows:

   a. The heating loop from 0% to 50% output will open the radiant panel valve.

   b. The heating loop from 50% to 100% output will reset the discharge temperature from the current AHU SAT setpoint to the lesser of 90F or 15F above space temperature.

7. The hot water valve shall be modulated to maintain the discharge temperature at setpoint. (Directly controlling heating off the zone temperature control loop is not acceptable).

8. In occupied mode, the hot water valve shall be modulated to maintain a discharge air temperature no lower than 50°F.

E. VAV Pressure Control

1. The supply air VAV shall maintain the room pressure using a cascading control loop:

2. The TSI room pressure monitor shall send a signal to the supply VAV controller proportional to the room pressure.

3. The supply VAV controller shall generate a room pressure control PID signal in response to the room pressure signal from the tsi room pressure monitor.

4. The room pressure control PID signal shall be "cascaded" to an airflow control PID.

5. The airflow control PID signal shall be used to calculate an airflow setpoint within the VAV's design min and max design airflow setpoints.

F. Alarms

1. Pressure alarms shall be via BACnet integration to the TSI monitor. Alarm stpt are set at the TSI monitor. Pressure alarms after 3min delay (as configured on the TSI monitor).

   a. Low ISO pressure alarm, stpt = - 0.030 in wc

   b. High ISO pressure alarm, stpt = - 0.010 in wc

2. If a door switch is open for more than 10 minutes provide a BMS alarm.

G. Provide the following points hardwired to the BMS:

1. All points available via a BACnet or Modbus communication interface to each room pressurization monitor.

2. AI – Discharge air temperature.

3. AI – Room differential pressure (per monitor).

4. AI – Space temperature.

5. AI – Supply air CFM.

6. AO – Damper control (0-100%).

7. AO – Reheat valve control (0-100%).

8. DI – Door switch status (open/closed, per door).

9. DI – Room pressure monitor common alarm.

H. Provide the following points on the associated equipment graphic in addition to the hardwired points indicated above:

1. Box enable/disable.

2. Box K factor.

3. Door open alarm (per door).

4. High and low discharge air temperature alarms.

5. High and low room pressure alarm limits.

6. High and low room pressure alarms.

7. High and low space temperature alarms.

8. Minimum/maximum/heating CFM settings.

9. Occupied/unoccupied command.

10. Occupied/unoccupied, heating/cooling temperature setpoints.

11. Space/area served.

12. Supply air CFM setpoint.

1.21 ELECTRIC UNIT HEATERS

A. The BMS contractor shall:

1. Provide field wiring for all control devices shipped loose.

2. Coordinate with the manufacturer for all field installation requirements.

3. Furnish, install and wire any devices not provided by the manufacturer to ensure a completely operations system.

B. On a fall in space temperature below setpoint, the manufacturer provided thermostat shall energize the unit fan and electric heating coil to maintain the space temperature setpoint (adj.). On a rise in space temperature, the electric heating coil and the fan shall be de-energized. The heaters shall operate independent of the BMS.

C. Provide one (1) DDC space temperature sensor per each zone associated with each unit heater for monitoring on the BMS.

D. Provide the following points hardwired to the BMS:

1. AI – Space temperature.

E. Provide the following points on the associated equipment graphic in addition to the hardwired points indicated above:

1. Low space temperature alarm.

1.22 HOT WATER UNIT HEATERS

A. The BMS contractor shall install and wire a manufacturer provided space thermostat to control the unit heater. On a fall in space temperature below setpoint, the thermostat shall energize the unit fan and open the manufacturer provided control valve to maintain the space temperature setpoint. On a rise in space temperature, the fan shall be de-energized and the control valve shall remain closed. The units shall operate independent of the BMS.

B. A pipe-mounted electric aquastat shall lock out the fan if hot water is not available.

C. Provide one (1) DDC space temperature sensor per each zone associated with each unit heater for monitoring on the BMS.

D. Provide the following points hardwired to the BMS:

1. AI – Space temperature.

E. Provide the following points on the associated equipment graphic in addition to the hardwired points indicated above:

1. Low space temperature alarm.

1.23 STEAM UNIT HEATERS

A. The BMS contractor shall install and wire a manufacturer provided space thermostat to control the unit heater. On a fall in space temperature below setpoint, the thermostat shall energize the unit fan and open the manufacturer provided steam control valve to maintain the space temperature setpoint. On a rise in space temperature, the fan shall be de-energized and the steam control valve shall remain closed. The units shall operate independent of the BMS.

B. A pipe-mounted electric aquastat shall lock out the fan if steam is not available.

C. Provide one (1) DDC space temperature sensor per each zone associated with each unit heater for monitoring on the BMS.

D. Provide the following points hardwired to the BMS:

1. AI – Space temperature.

E. Provide the following points on the associated equipment graphic in addition to the hardwired points indicated above:

1. Low space temperature alarm.

1.24 HOT CONDENSATE PUMPS

A. General

1. The hot condensate pumps shall be provided with manufacturer provided controls. Coordinate with the pump package manufacturer for all field installation requirements.

B. The BMS contractor shall:

1. Mount and wire all control components that are shipped with the pump package that are not factory installed. This shall include, but not be limited to float switch, temperature sensor, etc.

2. Furnish, mount and wire any additional components not provided by the pump package manufacturer to achieve a completely operational system.

C. The hot condensate pumps shall operate as per the manufacturer provided sequence of operation. Each pump shall be enabled by a float switch.

D. Provide the following points hardwired to the BMS:

1. DI – Condensate pump status (one (1) for each condensate pump).

E. Provide the following points on the associated equipment graphic in addition to the hardwired points indicated above:

1. Space/area served.

1.25 ISOLATION ROOM EXHAUST FANS

A. The isolation room exhaust fan system shall be started/stopped based upon a time of day schedule or manual command and run continuously.

B. At any time a fan command does not equal a fan status, except immediately after startup, a fan failure alarm shall be generated on the BMS and that fan shall be commanded off. The BMS shall wait 30 seconds to see the fan status change before indicating a fan failure alarm. An automatic lead/lag program shall start the lag fan in the event of a lead fan failure. The lead and lag fans shall rotate on a weekly basis based on runtime.

C. Upon a command to start the lead fan, the fan discharge damper shall open. When the damper is open, as sensed by a damper end switch, the fan shall energize.

D. The fan's VFD shall start unloaded and slowly ramp up to maintain the duct static pressure setpoint (adj.) as sensed by a static pressure sensor 3/4 downstream of the fan.

E. Upon a command to start the lag fan while the lead fan is operating, the lag fan shall start with its VFD at minimum speed and after 15 seconds the discharge damper shall open while the lag fan slowly ramps up and the lead fan slowly ramps down and its isolation damper closes. The timing delays to open the lag fans isolation damper and close the lead fans isolation damper shall be adjusted during start up to maintain a constant system static pressure.

F. Upon a command to de-energize the fan, the discharge damper shall have an adjustable time delay to keep the damper open up to 30 seconds after the fan VFD is de-energized.

G. Provide the following points hardwired to the BMS:

1. All points available via integration (BACNet, Modbus) to each VFD.

2. AI – Duct static pressure level.

3. AI – Exhaust fan VFD speed feedback (0-100%).
4. AO – Exhaust fan VFD speed control (0-100%).
5. DI – Exhaust fan status (via current sensing relay).
6. DI – Exhaust fan VFD common alarm.
7. DO – Exhaust fan VFD command (on/off).

H. Provide the following points on the associated equipment graphic in addition to the hardwired points indicated above:

1. Duct static pressure setpoint.
2. Fan failure alarm.
3. Fan KW (via integration).
4. High / low duct static pressure alarms.
5. Occupied/unoccupied command.
6. Space/area served.

1.26 MISCELLANEOUS EXHAUST FANS (FR PUMP ROOM, UPS BATTERY EXHAUST)

A. The fan shall be started/stopped based upon a time of day schedule or manual command and run continuously. The fan shall be programmed to operate 24 hours a day, 7 days a week.

B. Upon a command to start the fan, the fan discharge damper shall open (if applicable). When the damper is open, as sensed by a damper end switch, the fan shall energize.

C. Upon a command to de-energize the fan, the discharge damper shall have an adjustable time delay to keep the damper open up to 30 seconds after the fan is de-energized (if applicable).

D. Provide the following points hardwired to the BMS:

1. DI – Individual fan status (via current sensing relay).
2. DO – Individual fan command (on/off).

E. Provide the following points on the associated equipment graphic in addition to the hardwired points indicated above:

1. Fan failure alarm.
2. Occupied/unoccupied command.
3. Space/area served.

1.27 MISCELLANEOUS EXHAUST FANS (MDF SOILED EXHAUST EAST, SOILED EXHAUST WEST, GENERAL EXHAUST EAST, GENERAL EXHAUST WEST)

A. The fan shall be started/stopped based upon a time of day schedule or manual command and run continuously. The fan shall be programmed to operate 24 hours a day, 7 days a week.

B. Upon a command to start the fan, the fan discharge damper shall open (if applicable). When the damper is open, as sensed by a damper end switch, the fan shall VFD shall energize and slowly ramp up to a preset speed determined during balancing.

C. Upon a command to de-energize the fan, the discharge damper shall have an adjustable time delay to keep the damper open up to 30 seconds after the fan is de-energized (if applicable).

D. Provide the following points hardwired to the BMS:

1. All points available via integration (BACNet, Modbus) to each VFD.
2. AI – Exhaust fan VFD speed feedback (0-100%).
3. AO – Exhaust fan VFD speed control (0-100%).
4. DI – Exhaust fan status (via current sensing relay).
5. DI – Exhaust fan VFD common alarm.
6. DO – Exhaust fan VFD command (on/off).

E. Provide the following points on the associated equipment graphic in addition to the hardwired points indicated above:

1. Fan failure alarm.
2. Fan KW (via integration).
3. Occupied/unoccupied command.
4. Space/area served.

1.28 MER EXHAUST AND MAKEUP AIR FANS

A. There shall be four (4) fans associated with exhausting the MERs and there shall be two (2) fans and two (2) HV supply units associated with providing makeup air to the MERs.

B. Each MER exhaust fan shall have a VFD and each MER makeup air fan and supply HV unit shall have a VFD.

C. Each HV unit shall consist of a filter, steam preheat coil, supply fan, etc.

D. The HV unit's temperature control shall be as follows:

1. When the outside air is below 39 F, the steam coil control valve shall go to full open and the face and bypass damper shall modulate to maintain 50°F (adj) discharge air temperature.

2. When the outside air is above 39 F, the face and bypass damper shall go to full face, and the steam coil control valve shall modulate to maintain 50°F (adj) discharge air temperature.

E. When outside air is greater than 50ºF (adj.) the following equipment shall enable:

1. Two (2) HV supply units (MAU-1 and MAU-2)

2. Two (2) supply makeup air fans (MAF-1 and MAF-2)

3. Four (4) exhaust fans (EX-227, EX-228, EX-229, EX-230)

F. The associated VFDs for each unit and fan shall start unloaded and slowly ramp up to a preset speed determined during balancing.

G. When outside air is less than 50ºF (adj.) the following equipment shall enable:

1. Two (2) HV supply units (MAU-1, MAU-2)

2. Two (2) exhaust fans (EX-227 and EX-228)

H. The associated VFDs for each unit and fan shall start unloaded and slowly ramp up to a preset speed determined during balancing.

I. The BMS operator shall have the ability to select which pairs of fans fall into the aforementioned program.

J. Provide the following points hardwired to the BMS:

1. All points available via integration (BACNet, Modbus) to each VFD.

2. AI – HV supply unit filter differential pressure (via differential pressure transmitter).

3. AI – Individual fan VFD speed feedback (0-100%).

4. AO – Individual fan VFD speed control (0-100%).

5. AO – HV unit steam valve control (0-100%).

6. AI – HV discharge air temperature

7. DI – Individual fan status (via current sensing relay).

8. DI – Individual fan VFD common alarm.

9. DO – Individual fan command (on/off).

K. Provide the following points on the associated equipment graphic in addition to the hardwired points indicated above:

1. Dirty filter alarm (indicated if filter differential pressure exceeds 0.6” for pre-filter and 1.2” for final-filter (adj.)).

2. Fan failure alarm.

3. Fan KW (via integration).

4. Individual exhaust fan priority

5. Occupied/unoccupied command.

6. Space/area served.

7. Summer Mode or Winter Mode

1.29 STEAM PRESSURE REDUCING STATION ALARM MONITORING

A. The BMS contractor shall monitor the steam PRV stations. Refer to the mechanical plans for location.

B. The BMS contractor shall furnish, install, wire and commission a pressure transmitters at the steam inlet line and steam outlet line of the steam PRV station.

C. The BMS contractor shall furnish, install, and wire any additional control components required for a fully operational system.

D. Provide the following points hardwired to the BMS:

1. AI – Steam pressure reducing station inlet pressure.
2. AI – Steam pressure reducing station outlet pressure.

E. Provide the following points on the associated equipment graphic in addition to the hardwired points indicated above:

1. Steam pressure reducing station high and low entering pressure alarms.
2. Steam pressure reducing station high and low discharge pressure alarms.

1.30 UNFIRED CLEAN STEAM GENERATOR MONITORING

A. The BMS contractor shall monitor the clean steam generator.

B. The BMS contractor shall furnish, install, and wire any additional control components required for a fully operational system.

C. Provide the following points hardwired to the BMS:

1. AI – Main air pressure.
2. AI – Steam inlet pressure.
3. AI – Steam outlet pressure.
4. AO – Steam inlet valve control (0-100%).
5. DI – Steam generator common alarm.
6. DO – Steam generator command.

1.31 ENERGY (BTU) METERING

A. The BMS contractor shall furnish, install, wire, and commission an insertion magnetic BTU meter and a steam inline vortex meter for the following systems. Refer to the mechanical plans for locations.

1. Chilled water supply line from CH-24.
2. Chilled water supply line from the existing plant.
3. Steam condensate return line (flow meter only, not BTU).
4. High pressure steam – from the plant (flow meter only, not BTU).

B. Provide the following points hardwired to the BMS:

1. All points available via integration (BACNet, Modbus) to each meter.
2. AI – Chilled water BTU.
3. AI – Chilled water flow.
4. AI – Steam flow.

1.32 SMOKE PURGE

A. Smoke Condition

1. Upon detection of smoke from either the respective AHU supply or return mounted smoke detector the system supply and return fans shall disengage via the FAS. The following shall also occur:

   a. The outside and exhaust air dampers shall close.

   b. The cooling coil control valve shall close.

   c. A signal shall be received by the BMS indicating smoke shutdown (from the F.A.C.P.).

   d. The system smoke and/fire smoke dampers shall close.

2. Fire Smoke Dampers

   a. The Fire/Smoke Dampers (other than those indicated to be hardwire interlocked with a fan) shall remain open until de-energized by the Fire Alarm System.

   b. The BMS shall monitor the status of the floor fire/smoke dampers by wiring the normally open end switch back to the BMS.

3. Operation and/or activation of any alarm device shall automatically operate control relay contacts to shutdown all air handling systems. The fan shutdown relays shall not be permitted to be reset from the simple operation of the system reset switch. A separate fan systems restart switch shall be provided at the fire alarm control panel to permit the resetting of the fan shutdown relays after the fire detection and alarm system has been reset to normal. Work described above is by electrical contractor. Refer to Electrical drawings.

4. The BMS shall receive notification from the fire alarm system that the building is in alarm. Coordinate inputs/outputs and termination with the fire alarm contractor.

B. Smoke Purge Mode

1. Smoke purge shall be activated on a floor-by-floor basis from the Smoke Purge Control Panel.

2. The Smoke Purge Control Panel, provided by the BMS contractor, shall be supplied with Fire Department approved key switches. Upon activation, the Smoke Purge Control Panel shall send a signal to the BMS to initiate the smoke purge mode.

3. The purge control panel shall start the associated floor AHU return fan and ~~open fire smoke dampers which are located in the return air system associated with the floor to be purged. A signal from the smoke purge control panel~~ shall signal the return fan to go into the purge mode. The exhaust air dampers and fire/smoke dampers in the return air system shall open~~,~~ and the return damper at the AHU shall close prior to sending the signal for the return fan to go into the purge mode. The end switch at each damper shall provide proof each damper is fully open before the signal to start the return fan is sent.

~~4. Each floor served by an associated AHU return fan shall be capable of being purged independent of the other floors. Each floor shall have a switch on the~~

~~smoke purge panel that initiates smoke purge for that floor only. This includes which floors shall be purged by which AHU return fan.~~

5. **Provide the panel with a graphical chart showing which fan controls which area of the building that will be exhausted when the fan is switched to purge mode.**

6. Coordinate all F/SD, FAS, and Smoke Purge requirements with the FAS contractor.

1.33 STAIRWELL PRESSURIZATION FANS

A. These fans shall be controlled by the FAS. The BMS contractor shall coordinate with the FAS contractor as required.

1.34 ATRIUM SMOKE CONTROL

A. These fans shall be controlled by the FAS. The BMS contractor shall coordinate with the FAS contractor as required.

1.35 MISCELLANEOUS PLUMBING POINTS

A. Provide the following points hardwired/via software to the BMS:

1. AI – CW temp into each mixing valve
2. AI – DHW temp into each mixing valve
3. AI – Mixed HW temp after each mixing valve
4. AI – Recirc DHW return temp
5. AI – Steam inlet pressure on LPS to DHW heaters
6. DI – Backflow preventer flood protection solenoid shutdown valve
7. DI – Domestic pressure booster pump status and alarm
8. DI – Domestic water filtration alarm
9. DI – Domestic water filtration system status
10. DI – Fire pump status
11. DI – Jockey pump status
12. DI – Med air compressor trouble
13. DI – Sewage ejector pit high level
14. DI – Sewage ejector pump status
15. DI – Sump pit high level
16. DI – Vacuum Pump Trouble Alarm

17. DI – Water meter readings

18. DI –DHW recirc pump status (one (1) per pump)

END OF SECTION

This page is intentionally left blank.

SECTION 230993

SEQUENCE OF OPERATIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Section 01 81 13 "Sustainable Design Requirements – LEED v4 for Building Design & Construction – New Construction" for sustainable design requirements and detailed sustainable design submittal requirements.

C. Section 01 74 19 "Construction and Demolition Waste Management and Disposal" for disposal of construction, demolition and packaging waste disposal requirements.

1.2 SUMMARY

A. This Section includes control sequences for HVAC systems, subsystems and equipment.

B. Sustainable Building Requirements:
   1. The Owner requires the Contractor to implement practices and procedures to meet the project's environmental performance goals, which include achieving LEED version 4 Certified level Certification. Specific project goals that may impact this area of work include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; construction waste recycling; and the implementation of a construction indoor air quality management plan. The Contractor shall ensure that the requirements related to these goals, as defined in the Articles below, are implemented to the fullest extent. Substitutions, or other changes to the work proposed by the Contractor or their Subcontractors, shall not be allowed if such changes compromise the aforementioned environmental goals and LEED certification.

1.3 DEFINITIONS

A. AHU: Air Handling Unit.

B. AI: Analog Input.

C. AO: Analog output.

D. ATC: Automatic Temperature Control.

E. BMS: Building Management System.

F. CFM: Cubic Feet per Minute.

G. DDC: Direct-digital controls.

H. DI: Digital Input.

SECTION 23 21 13

HYDRONIC PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes pipe and fitting materials, joining methods, special-duty valves, and specialties for the following:
1. Hot-water heating piping.
2. Chilled-water piping.
3. Makeup-water piping.
4. Condensate-drain piping.
5. Blowdown-drain piping.
6. Air-vent piping.
7. Air control devices
8. Strainers
9. Vacuum Breakers
10. Drain coolers

B. Related Sections include the following:
1. Division 23 Section "Hydronic Pumps" for pumps, motors, and accessories for hydronic piping.

1.3 DEFINITIONS

A. PTFE: Polytetrafluoroethylene.

1.4 PERFORMANCE REQUIREMENTS

A. Hydronic piping components and installation shall be capable of withstanding the minimum working pressure and temperature of the systems listed in the PIPING APPLICATIONS section in Part 3 and as follows:
1. Hot-Water Heating Piping: 150 psig at 200 deg F
2. Chilled-Water Piping: 150 psigat 200 deg F
3. Condensate-Drain Piping: 150 deg F.
4. Blowdown-Drain Piping: 200 deg F
5. Air-Vent Piping: 200 deg F.
6. Make-up water piping: 80 psig at 150 deg. F.

1.5 SUBMITTALS

A. Product Data: For each type of the following:
   1. Submit a schedule indicating the following:
      a. System Service, Operating temperature, Operating pressure, Pipe material, Fittings, Methods of joining, Gaskets, Specialties, Test pressure, Flange gaskets, , Fittings., Unions, , Suction diffusers, Ring spacers and test blanks.
   2. Valves. Include flow and pressure drop curves based on manufacturer's testing for calibrated-orifice balancing valves and automatic flow-control valves.
   3. Strainers
   4. Air control devices.
   5. Hydronic specialties.

B. Shop Drawings: Detail, at 3/8 inch scale piping layout with fittings, valves and equipment, use single line for pipe sizes 3 inches and smaller, and double line for pipe sizes 4 inches and greater. fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to the building structure. Detail location of anchors, alignment guides, and expansion joints and loops
   1. Minimum 3/8 inch scale double line layout and sections where required or coordination drawings

C. Grooved joint couplings and fittings shall be shown on drawings and product submittals, and be specifically identified with the applicable Victaulic style or series number

D. Welding certificates

E. Qualification Data: For Installer

F. Field quality-control test reports, Written reports of tests specified in Part 3 of this Section. Include the following:
   1. Test procedures used.
   2. Test results that comply with requirements
   3. Failed test results and corrective action taken to achieve requirements

G. Operation and Maintenance Data: For air control devices, hydronic specialties, and special-duty valves to include in emergency, operation, and maintenance manuals

1.6 QUALITY ASSURANCE

A. Installer Qualifications:

B. Steel Support Welding: Qualify processes and operators according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

C. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current

D. Welding: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX.
   1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."

2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

E. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 01.

F. To assure uniformity and compatibility of piping components in grooved piping systems, all grooved products utilized shall be supplied by Victaulic. Grooving tools shall be supplied by the same manufacturer as the grooved components.

G. Steel Pipe Welding:
1. Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, “Welding and Brazing Qualifications.”
2. Welders shall be qualified for all required pipe sizes, material, wall thickness, and position in accordance with the American Society of Mechanical Engineering (ASME) Section IX, boiler and pressure Vessel Code
3. Copies of the certified welder qualification reports shall be maintained by the responsible welding agency and the company performing the welding, and shall be submitted to the owner and/or Inspector upon request.
4. All defective welds shall be chipped out and repaired at no cost to the Owner, based on procedure to be specified at the time.
5. The contractor shall bear the cost of reinspection of the repaired welds and the inspection of two (2) additional welds, as selected by the owner, for each failed weld.
6. Field Procedures:
   a. Clean pipe free from rust, scale and oxide.
   b. Bevel pipe on each end per acceptable procedures.
   c. Contractor is responsible for preparation of pipe in accordance with ASME B 31.1, Chapter V and for visual inspection during the welding operation and for all required welding examinations with certified welding inspector(s), in accordance with ANSI/AWS B.1.10-86 or latest issue section 3.1, 3.1.1, 3.1.2, and 3.1.3.

H. Copper Tube Brazing
1. Qualify process and operators in accordance with ASME Boiler and Pressure Vessel Code, Section IX, “Welding and Brazing Qualifications”
2. Brazers shall be qualified for all required tube sizes, material, wall thickness, and position in accordance with the American Society of Mechanical Engineering (ASME), Section IX, boiler and Pressure Vessel Code.
3. Brazing qualification testing shall be performed an agency/laboratory certified by ASME.
4. Copies of the certified brazer qualification reports shall be maintained by the responsible brazing agency and the company performing the brazing, and shall be submitted to the owner and/or Inspector.
5. All defective brazements shall be chipped out and repaired at no cost to the Owner, based on procedure to be specified at the time.
6. The contractor shall bear the cost of re-inspection of the repaired brazements and the inspection of two (2) additional brazements, as selected by the owner, for each failed brazement.
7. Field Procedures:

a. Clean tubing free from surface oxidation on the O.D.
b. Ream all tubes and remove burrs created by the cutting operation, on each end per acceptable procedures.
c. Contractor is responsible for preparation of tubes and for visual inspection during the brazing operation in accordance with all applicable ASME, ANSI and AWS standards.

1.7 COORDINATION

A. Coordinate layout and installation of hydronic piping and suspension system components with other construction, including light fixtures, HVAC equipment, fire-suppression-system components, structure and partition assemblies.

B. Coordinate pipe sleeve installations for foundation wall penetrations.

C. Coordinate piping installation with roof curbs, equipment supports, and roof penetrations. Roof specialties are specified in Division 7 Sections.

D. Coordinate pipe fitting pressure classes with products specified in related Sections.

E. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into base. Concrete, reinforcement, and formwork requirements are specified in Division 3 Sections.

F. Coordinate installation of pipe sleeves for penetrations through exterior walls and floor assemblies. Coordinate with requirements for firestopping for fire and smoke wall and floor assemblies.

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

A. Drawn-Temper Copper Tubing: ASTM B 88, Type L

B. Annealed-Temper Copper Tubing: ASTM B 88, Type L

C. Wrought-Copper Fittings: ASME B16.22
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Anvil International, Inc.
b. S.P. Fittings; a division of Star Pipe Products

D. Wrought-Copper Unions: ASME B16.22

2.2 STEEL PIPE AND FITTINGS

A. Steel Pipe: ASTM A 106 Seamless, black steel with plain ends; type, grade, and wall thickness as indicated in Part 3 "Piping Applications" Article.

B. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125 and 250 as indicated in Part 3 "Piping Applications" Article.

C. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300 as indicated in Part 3 "Piping Applications" Article.

D. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in Part 3 "Piping Applications" Article.

E. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Classes 25, 125, and 250; raised ground face, and bolt holes spot faced as indicated in Part 3 "Piping Applications" Article.

F. Wrought-Steel Fittings: ASTM A 234/A 234M, wall thickness to match adjoining pipe.

G. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
   1. Material Group: 1.1.
   2. End Connections: Butt welding.
   3. Facings: Raised face.

H. Steel Pipe Nipples: ASTM A 733, made of same materials and wall thicknesses as pipe in which they are installed

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 thickness or specific material is indicated.
      a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
      b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
      c. For chilled water systems – Klinger suitable for glycol use.
      d. For hot water – Klinger C4500
      e. For joints of dissimilar metals, provide isolating gaskets, sleeves and washers between flanges, bolts and nuts. Gaskets shall be similar to Dupont Teflon

B. Flange Bolts, Studs, Nuts and Washers:
   1. Bolts and studs shall be chrome-molybdenum bolt stud in accordance with ASTM A 193 grade B7 with full-length threads in accordance ANSI B 31.1. Length shall be sufficient to project beyond nuts three complete threads when joint is made.
   2. Nuts shall be carbon-steel in accordance with ASTM A 194 Grade 2H. Nuts shall be hexagon heavy series type. Threads shall the same as for bolts.
   3. Washers shall be flat, plain, stamped, in accordance with ANSI/ASME B18.22.1.

C. Ring Spacers and Test Blanks:
   1. Provide between flanges where shown on drawing or where necessary to isolate equipment from the piping system, in accordance with B3.1.1, Chapter VI, section 137.2.4. Ring spacers to be replaced by test blanks during hydrostatic testing and/or during chemical cleaning for equipment isolation.
   2. Size and rating to match companion flanges.

D. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813

E. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel

F. 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
   1. Comply with Section II, Part C of the ASME Boiler and Pressure Vessel Code for welding materials appropriate for wall thickness and for chemical analysis of pipe being welded

2.4 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper-alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

B. In lieu of dielectric fittings, use brass unions to join piping of dissimilar materials.

2.5 VALVES

A. Gate, Globe, Check, Ball, Butterfly, safety relief and balancing Valves,: Comply with requirements specified in Division 23 Section "General-Duty Valves for HVAC Piping."

B. Automatic Temperature-Control Valves, Actuators, and Sensors: Comply with requirements specified in Division 23 Section "Instrumentation and Control for HVAC."

2.6 AIR CONTROL DEVICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Amtrol, Inc.
   2. Bell & Gossett Domestic Pump; a division of ITT Industries
   3. TACO

B. Manual Air Vents:
   1. Body: Bronze.
   2. Internal Parts: Nonferrous.
   3. Operator: Screwdriver or thumbscrew.
   4. Inlet Connection: NPS 1/2.
   5. Discharge Connection: NPS 1/8.
   6. CWP Rating: 150 psig.
   7. Maximum Operating Temperature: 225 deg F

C. Automatic Air Vents:
   1. Body: Bronze or cast iron.
   2. Internal Parts: Nonferrous.
   3. Operator: Noncorrosive metal float.
   4. Inlet Connection: NPS 1/2.
   5. Discharge Connection: NPS 1/4.
   6. CWP Rating: 150 psig.
   7. Maximum Operating Temperature: 240 deg F

D. Expansion Tanks:

1. General:
   a. Provide as shown on the drawings, a pressurization and air elimination system to accommodate the expanded water generated by the increase in temperature in the water system and to control the increase in pressure at all critical components in the system to the maximum allowable for those components.
   b. The pressurization and air elimination system shall ensure that all entrained air bubbles in the system shall be eliminated. The only air in the system shall be the permanent sealed in air cushion contained in the pressurization controller component of the system, a diaphragm type extension tank, pre-charged to the minimum operating pressure at the location indicated on the drawing.
   c. All free air originally contained in the system, and all entrained air bubbles carried by the system water shall be eliminated at all points in the piping system where the capability of water to hold air in solution is lowest (the point of lowest solubility), and as indicated on the drawings. The air separating and elimination component shall separate entrained free air from flowing system water by the creation of a vortex which will allow free air to rise in the center, the point of lowest velocity, to an air elimination valve
2. Diaphragm or Bladder- Type Extension Tanks:.
   a. Tank: Welded steel, rated for 125 psig (860-kPa_ working pressure and 375 deg F (191 deg c)maximum operating temperature. Factory test with taps fabricated and supports installed and labeled according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
   b. Diaphragm or Bladder: Securely sealed into tank to separate air change from system water to maintain required expansion capacity.
   c. Air-Changed Fittings: Schrader valve, stainless steel with EPDM seats.
   d. Orientation: Vertical
   e. Size and capacity as scheduled on drawings
   f. Features:
      1. Integral structural steel supports
      2. Base for vertical tanks
      3. Gasketed handhole
      4. Gasketed manhole
      5. All tappings for gauge glass, instrumentation, drain, fill and connections to system: Refer to detail on the drawing
      6. Pre-Charged with air to pressure scheduled on drawings

E. Air Separators:
1. Furnish and install air removal device of the size and type shown on the plans. Air and dirt separation devices shall be Taco 4900 series or approved equal, by Spirotherm or Armstrong
2. Air removal devices shall be constructed of steel. It shall be designed, fabricated and stamped per ASME Section VIII Division I with a maximum working pressure of 125 psi at 270 degrees F° Units up to three 3-inch in size shall be provided with threaded connections as standard. Units 4-inch and larger shall be provided with flanged system connections as standard.
3. Each air removal device shall be equipped with a brass conical shaped air venting chamber designed to minimize system fluid from fouling the venting assembly. A brass flushing cock shall be located on the side of each separator to facilitate system fast-fill and removal of the floating impurities fro the air

system interface within the separator. A blown down valve shall be provided by the unit manufacture on the bottom of each unit to allow blow down and cleaning. On units 2 ½" and smaller the valve and all of its fitting shall be I". On units 3" and larger the valve and all openings shall be 2".

4. The air removal device shall remove air down to 18 microns. The unit manufacture shall provide owner and design engineer third party independent test data certifying that their unit perform to the above standards. Suppliers not providing these independent performance test results will not be acceptable.
5. The air separator shall employ the use of high surface area pall rings to achieve optimal separation of air with minimal pressure drop. The pall rings shall be made of stainless steel. Stainless steel will be there only acceptable material used for suppressing turbulence and increasing surface area for high efficiency air.
6. The unit shall be manufactured with a removable upper head to facilitate removal, inspection, and cleaning of the pall ring basket.

2.7 CHEMICAL TREATMENT

A. The HVAC Contractor shall hire the services of the building water treatment contractor and provide all required labor and materials. Provide temporary metering and mixing devices as required. The HVAC contractor shall obtain and provide all requirements from the Owner/ water treatment vendor.

2.8 HYDRONIC PIPING SPECIALTIES

A. Y-Pattern Strainers:
   1. Chilled Water and Hot Water Systems of Steel Construction:
      a. Working pressure: To 250 psig, non-shock.
         1. Sizes 1/4 inch to 2 inch: ANSI 250 lb. Class.
            a) Connections: Threaded.
            b) Body: Cast iron, ASTM A126, Class B. With machined seat for screen retention. Galvanized as required to match connecting piping.
            c) Cap: Bronze, gasketed.
            d) Screen: 20 mesh. 304 stainless steel, ASTM 240. Free area not less than 2-1/2 times inlet area.
            e) Blowoff outlet: With female NPT tapping.
            f) Manufactured by Keckley
         2. Sizes 2-1/2 inch to 24 inch: Class 250.
            a) Connections: Flanged.
            b) Body: Cast iron, ASTM A126, Class B. With machined seat for screen retention. Galvanized as required to match connecting piping.
            c) Cover flange: Cast iron, ASTM A126, Class B. With machined seat for screen retention. With female tapped NPT blowoff connection. With EPDM O-ring seal.
            d) Screen to 8 inch: 1/8 inch perforations. 304 stainless steel, ASTM 240. Free area not less than 2-1/2 times inlet area.

e) Screen 10 inch and larger: 5/32 inch perforations. 304 stainless steel, ASTM 240. Free area not less than 2-1/2 times inlet area.
f) Magnets: Provide magnets for strainers. All 8 inch and larger. At each pump suction. With continuous magnetic field around entire circumference of screen. With removable cast Alnico No. 5 channel magnets with acceptable baskets constructed of magnetic alloy. Secured with stainless steel retaining lugs and threaded rods.
g) Blowoff outlet: With female NPT tapping.
h) Manufactured by Keckley

2. Chilled Water and Hot Water Systems of Copper Construction:
   a. Working pressure: To 250 psig, non-shock.
      1. Sizes 1/4 inch to 2 inch: Class 250
         a) Connections: Threaded.
         b) Body: Bronze, ASTM B62. With machined seat for screen retention.
         c) Cap: Bronze, ASTM B62. With machined seat for screen retention.
         d) Screen: 20 mesh. 304 stainless steel, ASTM 240. Free area not less than 2-1/2 time inlet area.
         e) Blowoff outlet: With female NPT tapping.
         f) Manufactured by Keckley
   b. Working pressure to 225 psig Class 150; to 400 psig Class 300:
      1. Sizes 2-1/2 inch to 4 inch:
         a) Connections: Flanged.
         b) Body: Bronze, ASTM B62 (85-5-5-5) or bronze ASTM B61. Aluminum bronze ASTM A148-90 for sizes 8 inch and larger. With machined seat for screen retention.
         c) Cover: Material to match body. With machined seat for screen retention.
         d) Screen to 8 inch: 1/8 inch perforations. 304 stainless steel, ASTM 240. Free area not less than 2-1/2 times inlet area.
         e) Screen 10 inch and larger: 5/32 inch perforations. 304 stainless steel, ASTM 240. Free area not less than 2-1/2 times inlet area.
         f) Blowoff outlet: With female NPT tapping.
         g) Manufactured by Keckley

B. Vacuum Breakers
   1. For service to 300 psig wsp, similar to Sarco VB 12:
      a. Size: 1/2 inch.
      b. Features:
         1. All internals renewable without disturbing piping.
      c. Construction:
         1. Cap: Stainless steel, Type 303.
         2. Valve: VB 12 stainless steel, Type 303.
         3. Valve seat: VB 12 stainless steel, Type 303.
         4. Body: VB 12 stainless steel, Type 303.
         5. Gasket: VB 12 stainless steel, Type 304.
         6. Connections:
            a) System: 1/2 inch screwed NPT.

b) Air inlet: 1/8 inch screwed NPT.

C. Expansion fittings are specified in Division 23 Section "Expansion Fittings and Loops for HVAC Piping."

D. Drain Coolers:
1. Provide, where indicated on drawings, drain coolers to cool hot blowdown water from humidifiers, using city water
2. Drain coolers shall be equipped with temperature activated cold water valve, vacuum breaker and stainless steel mixing chamber.
3. Provide with appropriate wall mount, floor mount or suspension mount assemblies as required.
4. Drain coolers to be equal to Drane-Kooler by Dri-Steem

PART 3 - EXECUTION

3.1 PIPING APPLICATIONS

A. Low Temperature Water System, IN EXCESS of 100 psig up to 300 PSIG, except as noted and 40 to 220 deg F supply temperature for hot water and chilled water systems:
1. Material shall be seamless steel in accordance with ASTM A 106, Grades A or B. Pipe material shall not be manufactured in China or Taiwan.
2. Wall thickness shall be:
   a. To 2 inch: Schedule 80 with threaded ends or Schedule 40 with socket weld ends.
   b. 2-1/2 inch to 10 inch: Schedule 40, butt weld ends only.
3. 4 inch and smaller up to 300 PSIG and 100 deg F or 150 PSIG and 250 deg F, Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints
4. No threaded joints are allowed in glycol systems.

B. Makeup-water piping installed aboveground shall be either of the following:
1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.

C. Condensate-Drain Piping: Type , L drawn-temper copper tubing, wrought-copper fittings, and soldered joints.

D. Blowdown-Drain Piping: Same materials and joining methods as for piping specified for the service in which blowdown drain is installed.

E. Air-Vent Piping:
1. Inlet: Same as service where installed
2. Outlet: Same as service where installed.

F. Provide brass unions for connection of dissimilar metals. Use of bronze valves is not acceptable as a dielectric

3.2 VALVE APPLICATIONS

A. Install shutoff-duty valves at each branch connection to supply and return mains, and at supply connection to each piece of equipment.

B. Install 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.

3.3 PIPING INSTALLATIONS

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicate piping locations and arrangements if such were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

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 3/4ball 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 branch connections to mains using tee fittings in main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.

P. Install valves according to Division 23 Section "General-Duty Valves for HVAC Piping."

Q. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.

R. Install flanges or grooved joints on applicable systems, in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated. Slip-on flanges shall be back welded.

S. Install strainers on inlet side of each control valve, pressure-reducing valve, solenoid valve, in-line pump, and elsewhere as indicated. Install NPS 3/4 nipple and ball valve in blowdown connection of strainers NPS 2 and larger. Match size of strainer blowoff connection for strainers smaller than NPS 2.

T. Install expansion loops, expansion joints, anchors, and pipe alignment guides as specified in Division 23 Section "Expansion Fittings and Loops for HVAC Piping."

U. Identify piping as specified in Division 23 Section "Identification for HVAC Piping and Equipment."

3.4 HANGERS AND SUPPORTS

A. Hanger, support, and anchor devices are specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment." Comply with the following requirements for maximum spacing of supports.

B. Seismic restraints are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

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, 6 feet; minimum rod size, 3/8inch.
2. NPS 1: Maximum span, 6 feet; minimum rod size, 3/8inch.
3. NPS 1-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
4. NPS 2: Maximum span, 10 feet; minimum rod size, 3/8 inch.
5. NPS 2-1/2: Maximum span, 11 feet; minimum rod size, 1/2inch.
6. NPS 3: Maximum span, 12 feet; minimum rod size, 1/2inch.
7. NPS 4: Maximum span, 14 feet; minimum rod size, 5/8inch.
8. NPS 6: Maximum span, 17 feet; minimum rod size, 3/4inch.
9. NPS 8 (DN 200): Maximum span, 19 feet ; minimum rod size, 3/4 inch
10. NPS 10 (DN 250): Maximum span, 22 feet ; minimum rod size, 7/8 inch .
11. NPS 12 (DN 300): Maximum span, 23 feet ; minimum rod size, 7/8 inch (22 mm).

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, 3/8inch.
2. NPS 1: Maximum span, 6 feet; minimum rod size, 3/8inch.
3. NPS 1-1/2: Maximum span, 8 feet; minimum rod size, 3/8 inch.

4. NPS 2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
5. NPS 2-1/2: Maximum span, 9 feet; minimum rod size, 1/2inch.
6. NPS 3: Maximum span, 10 feet; minimum rod size, 1/2inch.

F. Support vertical runs at roof, at each floor, and at 10-foot intervals between floors.

G. Provide additional support at changes in direction, branch piping and runouts over 5 feet and concentrated loads due to valves, strainers and other similar items.

H. Vertical piping:
1. Base elbow support: Provide bearing plate on structural support, similar to F&S Manufacturing Co. Fig. 720 or 721.
2. Provide guides at every third floor but not exceed:
   a. 25 ft for piping to 2 inch.
   b. 36 ft for piping 2-1/2 inch to 12 inch.
   c. 50 ft for piping 14 inch and larger.
3. Top support: Provide special hanger or saddle in horizontal connection and make provisions for expansion.
4. Intermediate supports: Steel pipe clamp at floor. Bolt and weld to pipe with extension ends bearing on structural steel or bearing plates.
5. For multiple pipes, coordinate guides, bearing plates and accessory steel.

3.5 PIPE JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. 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.

E. 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.

F. 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.

G. Welded Joints: Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

H. 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 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. Manual vents at heat-transfer coils and elsewhere as required for air venting.

3.7 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 according to Division 23 Section "Meters and Gages for HVAC Piping."

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 "SE" value in Appendix A in ASME B31.9, "Building Services Piping." Systems less than 100 psig, hydrostatically test to 150 psig.

5. After hydrostatic test pressure has been applied for at least 4 hours, 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.

END OF SECTION

This page is intentionally left blank.

SECTION 23 21 23

HYDRONIC PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:
   1. Close-coupled, in-line centrifugal pumps.
   2. Separately coupled, horizontal, end suction centrifugal pumps.
   3. Separately coupled, vertical, in-line centrifugal pumps.
   4. Automatic condensate pump units.

1.3 DEFINITIONS

A. Buna-N: Nitrile rubber.

B. EPT: Ethylene propylene terpolymer.

1.4 SUBMITTALS

A. Product Data: 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: Show pump layout and connections. Include setting drawings with templates for installing foundation and anchor bolts and other anchorages.
   1. Wiring Diagrams: Power, signal, and control wiring.

C. Operation and Maintenance Data: For pumps to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain hydronic pumps through one source from a single manufacturer.

B. Product Options: Drawings indicate size, profiles, and dimensional requirements of hydronic pumps and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. UL Compliance: Comply with UL 778 for motor-operated water pumps.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Manufacturer's Preparation for Shipping: Clean flanges and exposed machined metal surfaces and treat with anticorrosion compound after assembly and testing. Protect flanges, pipe openings, and nozzles with wooden flange covers or with screwed-in plugs.

B. Store pumps in dry location.

C. Retain protective covers for flanges and protective coatings during storage.

D. Protect bearings and couplings against damage from sand, grit, and other foreign matter.

E. Comply with pump manufacturer's written rigging instructions.

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 Division 03.

1.8 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Mechanical Seals: One mechanical seal for each pump.

PART 2 - PRODUCTS

2.1 GENERAL PUMP REQUIREMENTS

A. Pump Units: factory assembled and tested, package pump and motor, single-stage except as noted, and suitable for scheduled conditions of service.

B. Pump and motor capacities: Minimum as scheduled, suitable for parallel operation. Each motor shall be non-overloading and shall operate over entire head capacity range of pump without exceeding nameplate horsepower rating.

C. Pump characteristics: Pump curve shall rise continuously from maximum capacity to shutoff. Shut off head shall be approximately 10 percent greater than design head. Operation shall be at or near peak efficiency. Pumps shall be capable of operating at 25 percent beyond design capacity without exceeding breakoff point. Impeller diameter shall not exceed minimum published diameter plus 90 percent of the difference between published maximum and minimum impeller diameters.

D. Casing: of material specified, with ANSI flanges on inlet and outlet, plugged drain and vent connections, and replaceable bronze wearing rings.

E. Impeller: Centrifugal type except as noted, totally enclosed, non-over loading, one-piece impeller of material specified, with entire rotating assembly statically, dynamically and hydraulically balanced.

F. Motor: High efficiency, ODP type conforming to specification section “MOTORS”.

G. Abrasive separator: Except as noted, provide seal finish piping connections with stainless steel abrasive separator.

H. Bearings: except as noted, grease lubricated or oil lubricated with oiled, moisture and dust resistant housing, minimum 20,000 hour B-10 life (100,000 hour average life) under scheduled conditions of service.

I. Pumps shall be tested and designed to withstand 1-1/2 times the specified working pressure.

J. Performance curve derived from certified laboratory tests only.

2.2 MANUFACTURERS

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

2.3 CLOSE-COUPLED, IN-LINE CENTRIFUGAL PUMPS

A. Manufacturers:
   1. Grundfos Pumps Corporation.

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. Rate pump for 175-psig (1204-kPa) minimum working pressure and a continuous water temperature of 225 deg F (107 deg C).

C. Pump Construction:
   1. Casing: Radially split, cast iron, with replaceable bronze wear rings, threaded gage tappings at inlet and outlet, 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. Trim impeller to match specified performance.
   3. Pump Shaft: Steel, with copper-alloy shaft sleeve.
   4. Mechanical Seal: 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. Packing Seal: 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: Single speed, with permanently lubricated ball bearings, unless otherwise indicated; and rigidly mounted to pump casing. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

2.4 SEPARATELY COUPLED, VERTICAL, IN-LINE CENTRIFUGAL PUMPS

A. Manufacturers:
   1. Grundfos Pumps Corporation

B. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, separately 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 vertically. Rate pump 175-psig (1204-kPa) minimum working pressure and a continuous water temperature of 225 deg F (107 deg C).

C. Pump Construction:
   1. Casing: Radially split, cast iron, with replaceable bronze wear rings, threaded gage tappings at inlet and outlet, 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. Trim impeller to match specified performance.
   3. Pump Shaft: Stainless steel.
   4. Mechanical Seal: Carbon rotating ring against a ceramic seat held by a stainless-steel spring, and EPT bellows and gasket. Include water slinger on shaft between motor and seal.
   5. Packing Seal: 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.

D. Shaft Coupling: Axially split spacer coupling.

E. Motor: Single speed, with permanently lubricated ball bearings, unless otherwise indicated; rigidly mounted to pump casing with lifting eye and supporting lugs in motor enclosure. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

2.5 AUTOMATIC CONDENSATE PUMP UNITS

A. Manufacturers:
   1. Aurora Pump; Division of Pentair Pump Group.
   2. Hartell Pumps Div.; Milton Roy Co.
   3. Little Giant Pump Co.; Subsidiary of Tecumseh Products Co.

B. 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- (1800-mm-) minimum, electrical power cord with plug.

2.6 PUMP SPECIALTY FITTINGS

A. Suction Diffuser: Angle pattern, 175-psig (1204-kPa) pressure rating, cast-iron body and end cap, pump-inlet fitting; with bronze startup and bronze or stainless-steel permanent strainers; bronze or stainless-steel straightening vanes; drain plug; and factory-fabricated support.

B. Triple-Duty Valve: Angle or straight pattern, 175-psig (1204-kPa) pressure rating, cast-iron body, pump-discharge fitting; with drain plug and bronze-fitted shutoff, balancing, and check valve features. Brass gage ports with integral check valve, and orifice for flow measurement
   1. Provide system side shut-off valve for isolation

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 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 CONCRETE BASES

A. Install concrete bases of dimensions indicated for pumps and controllers. Refer to Division 23 Section "Common Work Results for HVAC."
   1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around full perimeter of base.
   2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
   3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   4. Install anchor bolts to elevations required for proper attachment to supported equipment.

B. Cast-in-place concrete materials and placement requirements are specified in Division 03.

3.3 PUMP INSTALLATION

A. Install pumps according to manufacturer's written instructions.

B. Install pumps with access for periodic maintenance including removal of motors, impellers, couplings, and accessories.

C. Independently support pumps and piping so weight of piping is not supported by pumps and weight of pumps is not supported by piping.

D. Vibration isolation devices are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment." Fabricate brackets or supports as required. Hanger and support materials are specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."

E. Suspend vertically mounted, in-line centrifugal pumps independent of piping. Install pumps with motor and pump shafts vertical. Use continuous-thread hanger rods and spring hangers of sufficient size to support pump weight. Hanger and support materials are specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."

F. Automatic Condensate Pump Units: Install units for collecting condensate and extend to open drain.

3.4 ALIGNMENT

A. Align pump and motor shafts and piping connections after setting on foundation, grout has been set and foundation bolts have been tightened, and piping connections have been made.
   1. First alignment check
      a. The pump to motor shaft alignment must be checked when the pump and motor are first installed on the concrete inertia base.
         1) This alignment verification will help determine that the base to centerline of pump shaft is higher than the motor shaft base to centerline height. If not the pump is to be shimmed up.
         2) This alignment verification will help determine that the axial alignment of the motor can be performed. If not the motor mounting plate or motor feet will need to be enlarged.
   2. Final alignment
      a. The final pump to motor shaft alignment can be performed after the following items are completed
         1) Pump base grouted and foundation bolts tightened
         2) Piping installed and filled.

B. Comply with pump and coupling manufacturers' written instructions.

C. Adjust pump and motor shafts for angular and offset alignment.

D. Manufacturer shall furnish written confirmation / certification that all pumps are properly aligned and operating.

3.5 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to machine to allow 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 valve and throttling or triple-duty and shutoff valve on discharge side of pumps.

F. Install Y-type strainer, suction diffuser and shutoff valve on suction side of pumps.

G. Install pressure gages on pump suction and discharge, 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. Install electrical connections for power, controls, and devices.

J. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

K. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.6 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.
   1. Complete installation and startup checks according to manufacturer's written instructions.
   2. Check piping connections for tightness.
   3. 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. Disconnect coupling and check motor for proper rotation that matches direction marked on pump casing.
      d. Verify that pump is rotating in the correct direction.

B. Starting procedure for pumps with shutoff power not exceeding safe motor power is as follows:
   1. Prime pumps by opening suction valves and closing drains, and prepare pumps for operation.
   2. Open cooling water-supply valves in cooling water supply to bearings, where applicable.
   3. Open cooling water-supply valves if stuffing boxes are water cooled.
   4. Open sealing liquid-supply valves for pumps that are so fitted.
   5. Open warm-up valves of pumps handling hot liquids if pumps are not normally kept at operating temperature.
   6. Open circulating line valves if pumps should not be operated against dead shutoff.
   7. Start motors.
   8. Open discharge valves slowly.
   9. Observe leakage from stuffing boxes and adjust sealing liquid valve for proper flow to ensure lubrication of packing. Let packing "run in" before reducing leakage through stuffing boxes; then tighten glands.
   10. Check general mechanical operation of pumps and motors.
   11. Close circulating line valves once there is sufficient flow through pumps to prevent overheating.

C. When pumps are to be started against closed check valves with discharge shutoff valves open, steps are the same, except open discharge valves before starting motors.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain hydronic pumps. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION

This page is intentionally left blank.

SECTION 23 22 13

STEAM AND CONDENSATE HEATING PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following for LP and HP steam and condensate piping:
1. Pipe and fittings.
2. Strainers.
3. Safety valves.
4. Pressure-reducing valves.
5. Steam traps.
6. Thermostatic air vents and vacuum breakers.
7. Flash Tanks

1.3 DEFINITIONS

A. HP Systems: High-pressure piping operating at more than 15 psig as required by ASME B31.1.

B. LP Systems: Low-pressure piping operating at 15 psig or less as required by ASME B31.9

1.4 PERFORMANCE REQUIREMENTS

A. Components and installation shall be capable of withstanding the following minimum working pressures and temperatures:
1. HP Steam Piping: 125 psig
2. LP Steam Piping: 15 psig
3. Condensate Piping: 15 psig at 250 deg F
4. Makeup-Water Piping: 80 psigat 150 deg F.
5. Air-Vent and Vacuum-Breaker Piping: Equal to pressure of the piping system to which it is attached.
6. Safety-Valve-Inlet and -Outlet Piping: Equal to pressure of the piping system to which it is attached.

1.5 SUBMITTALS

A. Product Data: For each type of the following:
1. Pressure-reducing and safety valve.
2. Steam trap.

3. Air vent and vacuum breaker.
4. Flash Tanks

B. Shop Drawings: Detail, 3/8inch equals 1 footscale, fabrication of pipe anchors, hangers, pipe, multiple pipes, alignment guides, and expansion joints and loops and their attachment to the building structure. Detail locations of anchors, alignment guides, and expansion joints and loops

C. Prepare general layout drawings as follows:
1. Minimum 3/8 inch scale piping layout with fittings, valves and equipment, use single line for pipe sizes 3 inches and smaller and double line for pipe sizes 4 inches and greater.
2. Minimum 3/8 inch scale double line layout and sections including for coordination drawings.
3. Indicate location of hangers, supports, guides and anchors, expansion joints, loops, drains, vents and sleeves.

D. Steam piping layout:
1. Prepare steam piping shop drawings.

E. Qualification Data: For Installer.

F. Welding certificates.

G. Field quality-control test reports.

H. Operation and Maintenance Data: For valves, safety valves, pressure-reducing valves, steam traps, air vents, vacuum breakers, and meters to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

A. Installer Qualifications:

B. Steel Support Welding: Qualify processes and operators according to AWS D1.1, "Structural Welding Code - Steel."

C. Pipe Welding: Qualify processes and operators according to the following:
1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."
2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

D. ASME Compliance: Comply with ASME B31.1, Power Piping and ASME B31.9, Building Services Piping for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp flash tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1

E. Steel Pipe Welding:
1. Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, “Welding and Brazing Qualifications.”
2. Welders shall be qualified for all required pipe sizes, material, wall thickness, and position in accordance with the American Society of Mechanical Engineering (ASME) Section IX, boiler and pressure Vessel Code

3. Copies of the certified welder qualification reports shall be maintained by the responsible welding agency and the company performing the welding, and shall be submitted to the owner and/or Inspector upon request.
4. All defective welds shall be chipped out and repaired at no cost to the Owner, based on procedure to be specified at the time.
5. The contractor shall bear the cost of reinspection of the repaired welds and the inspection of two (2) additional welds, as selected by the owner, for each failed weld.
6. Field Procedures:
   a. Clean pipe free from rust, scale and oxide.
   b. Bevel pipe on each end per acceptable procedures.
   c. Contractor is responsible for preparation of pipe in accordance with ASME B 31.1, Chapter V and for visual inspection during the welding operation and for all required welding examinations with certified welding inspector(s), in accordance with ANSI/AWS B.1.10-86 or latest issue section 3.1, 3.1.1, 3.1.2, and 3.1.3.

PART 2 - PRODUCTS

2.1 STEEL PIPE AND FITTINGS

A. Steel Pipe: ASTM A 106, black steel, plain ends, Type, Grade, and Schedule as indicated in Part 3 piping applications articles. Pipe material shall not be manufactured in China or Taiwan.

B. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125 and 150 as indicated in Part 3 piping applications articles.

C. Malleable-Iron Threaded Fittings: ASME B16.3; Classes 150 as indicated in Part 3 piping applications articles.

D. Malleable-Iron Unions: ASME B16.39; Classes 150 and 250 as indicated in Part 3 piping applications articles.

E. Cast-Iron Threaded Flanges and Flanged Fittings: ASME B16.1, Classes 125 and 250 as indicated in Part 3 piping applications articles; raised ground face, and bolt holes spot faced.

F. Wrought-Steel Fittings: ASTM A 234/A 234M, wall thickness to match adjoining pipe.

G. Wrought-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
   1. Material Group: 1.1.
   2. End Connections: Butt welding.
   3. Facings: Raised face.

H. Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M, black steel of same Type, Grade, and Schedule as pipe in which installed.

I. Stainless-Steel Bellows, Flexible Connectors:
   1. Body: Stainless-steel bellows with woven, flexible, bronze, wire-reinforced, 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.

2.2 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 thickness or specific material is indicated.
      a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
      b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
      c. For high pressure steam and condensate – Garlock, Style 9800 only
      d. For low pressure steam and condensate - Klinger C4430
      e. For joints of dissimilar metals, provide isolating gaskets, sleeves and washers between flanges, bolts and nuts. Gaskets shall be similar to Dupont Teflon.

B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.

C. Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

D. Welding Materials: Comply with Section II, Part C, of ASME Boiler and Pressure Vessel Code for welding materials appropriate for wall thickness and for chemical analysis of pipe being welded.

2.3 DIELECTRIC FITTINGS

A. Description: Combination fitting of copper alloy and ferrous materials with threaded, solder-joint, plain, or weld-neck end connections that match piping system materials.

B. Insulating Material: Suitable for system fluid, pressure, and temperature.

C. Dielectric Unions:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Capitol Manufacturing Company.
      b. Central Plastics Company.
      c. Hart Industries, International Inc.
      d. Watts Water Technologies, Inc.
      e. Zurn Plumbing Products Group.
   2. Factory-fabricated union assembly, for 250-psig minimum working pressure at 180 deg F.

2.4 STRAINERS

A. Y-Pattern Strainers:

1. Low pressure steam, low pressure condensate and pumped condensate systems of steel construction 15 psig and below:
    a. Working pressure: To 250 psig wsp @ 406°F. Sizes 1/4 inch to 2 inches: ANSI 250 lb Class:
        1) Connections: Threaded.
        2) Body:
            a) Cast iron, ASTM A 126, Class B.
            b) With machined seat for screen retention.
            c) Galvanized as required to match connecting piping.
        3) Cover: Cast iron gasketed.
        4) Screen:
            a) 3/64 inch perforations.
            b) 304 stainless steel, ASTM 240.
            c) Free area not less than 2.5 times inlet area.
        5) Blowoff outlet: With female MPT tapping.
        6) Manufactured by Keckley
    b. Working pressure: For sizes 2-1/2 inches to 12 inches: To 250 psig wsp @ 450°F. For sizes 14 inches to 24 inches: To 200 psig wsp @ 406°F.
        1) Connections: Flanged.
        2) Body:
            a) Cast iron, ASTM A 126, Class B.
            b) With machined seat for screen retention.
            c) Galvanized as required to match connecting piping.
        3) Cover flange:
            a) Cast iron, ASTM A 126, Class B.
            b) With machined seat for screen retention.
            c) With female tapped NPT blowoff connection.
            d) With EPDM o-ring seal.
        4) Screen:
            a) To 8 inches: 3/64 inch perforations.
            b) 10 inches and larger: 1/16 inch perforations.
            c) 304 stainless steel, ASTM 240.
            d) Free area not less than 2.5 times inlet area.
        5) Blowoff outlet: With female NPT tapping.
        6) Manufactured by Keckley
2. High pressure steam and high pressure condensate return systems of steel construction in excess of 15 psig to 100 psig.
    a. Working pressure: To 450 psig @ 650°F.
        1) Sizes 1/4 inch to 2 inches: ANSI Class 300.
        2) Connections: Threaded.
        3) Body:
            a) Ductile iron, ASTM A 536, Grade 65-45-12.
            b) With tapered self-aligning seat.
            c) Galvanized as required to match connecting piping.
        4) Cap: Ductile iron, gasketed.
        5) Screen:
            a) 3/64 inch perforations.
            b) 304 stainless steel, ASTM 240.
            c) Free area not less than 2.5 times inlet area.

6) Blowoff outlet: With female NPT tapping.
7) Manufactured by Keckley

b. Working pressure to 150 psig @ 565°F, ANSI Class 150:
1) Sizes 1/2 inch to 12 inches:
a) Connections: Flanged or butt welded to match piping system.
b) Body: Carbon steel, ASTM A 216, Grade WCB. With machined seat for screen retention cover.
c) Cover: Carbon steel, ASTM A 216, Grade WCB. With machined seat for screen retention. With female tapped NPT blowoff connection. With non-asbestos gasket.
d) Screen: To 4 inches: 1/32 inch perforations. 5 inches and larger: 3/64 inch perforations. 304 stainless steel, ASTM 240. Free area not less than 4 times inlet area.
e) Blowoff outlet: With female NPT tapping.
f) Manufactured by Keckley

3. High pressure steam and high pressure condensate systems of steel construction in excess of 100 psig:
a. Working pressure to 150 psig @ 565°F, ANSI Class 150 and 300 psig @ 838°F, ANSI Class 300:
1) Sizes 1/2 inch to 12 inches:
a) Connections: Flanged to butt welded to match piping system/
b) Body: Carbon steel, ASTM A216, Grade WCB. With machined seat for screen retention.
c) Cover: Carbon steel, ASTM A216, Grade WCB. With machined seat for screen retention. With female tapped NPT blowoff connection. With non-asbestos gasket.
d) Screen: To 4 inches: 1/32 inch perforations. 5 inches and larger: 3/64 inch perforations. 304 stainless steel, ASTM 240. Free area not less than 4 times inlet area.
e) Blowoff outlet: With female NPT tapping.
f) Manufactured by Keckley

2.5 SAFETY VALVES

A. Bronze Safety Valves:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Armstrong International, Inc.
b. Kunkle Valve; a Tyco International Ltd. Company.
c. Spirax Sarco, Inc.
d. Watts Water Technologies, Inc
e. Leslie.
2. Disc Material: Forged copper alloy.
3. End Connections: Threaded inlet and outlet.
4. Spring: Fully enclosed steel spring with adjustable pressure range and positive shutoff, factory set and sealed.
5. Pressure Class: 250.

6. Drip-Pan Elbow: Cast iron and having threaded inlet and outlet with threads complying with ASME B1.20.1.
7. Size and Capacity: As required for equipment according to ASME Boiler and Pressure Vessel Code.

2.6 FLASH TANKS

A. Shop or factory fabricated of welded steel according to ASME Boiler and Pressure Vessel Code, for 150-psig rating; and bearing ASME label. Minimum 3/8 carbon steel plate. Fabricate with tappings for low-pressure steam and condensate outlets, high-pressure condensate inlet, air vent, safety valve, and legs.

B. Features:

1. Vertical tank.
2. Tangential inlet with 3/8 inch wear plate.
3. Protected gauge glass with 3/4 inch angle shutoff valves.
4. Low pressure steam outlet.
5. Condenser outlet.
6. Air vent.
7. Relief valve.
8. Support base

2.7 STEAM PRESSURE-REDUCING STATION

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Spence
2. Spirax- Sarco

B. Provide single stage PRV stations where indicated and as scheduled on drawings. Each station shall consist of steam pressure reducing valves, strainers, relief valves, isolation gate valves, globe style bypass valves, pressure gauges etc. as detailed.

C. Regulators shall be single seated, flanged, ASA 250 lb.; cast iron body, stainless steel diaphragm, stainless steel metal disc, stainless steel stem, and carbon steel main spring. Valves shall be normally closed type and designed for dead end service. Steam velocity through the valve shall be limited to 7,000 fpm. Valve shall have stellited seat ring and plug.

2.8 STEAM TRAPS

A. Thermostatic Traps:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Watson McDaniel
   b. Spirax Sarco
2. Body: Bronze angle-pattern body with integral union tailpiece and screw-in cap.

3. Trap Type: Balanced-pressure.
4. Bellows: Stainless steel or monel.
5. Head and Seat: Replaceable, hardened stainless steel.
6. Maximum allowable Pressure: 125 psig
7. The maximum operating pressure is to be selected for the intended service

B. Thermodynamic Traps:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Watson McDaniel
   b. Spirax Sarco
2. Body: Stainless steel with screw-in cap.
3. End Connections: Threaded.
4. Disc and Seat: Stainless steel.
5. Maximum allowable Pressure: 600 psig.to 800 def F.
6. The maximum operating pressure is to be selected for the intended service.

C. Float and Thermostatic Traps:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Watson McDaniel
   b. Spirax Sarco
2. Body and Bolted Cap: ASTM A 126, cast iron.
3. End Connections: Threaded.
4. Float Mechanism: Replaceable, stainless steel.
5. Head and Seat: Hardened stainless steel.
6. Trap Type: Balanced pressure.
7. Thermostatic Bellows: Stainless steel or monel.
8. Thermostatic air vent capable of withstanding 45 deg F of superheat and resisting water hammer without sustaining damage.
9. Vacuum Breaker: Thermostatic with phosphor bronze bellows, and stainless steel cage, valve, and seat.
10. Maximum allowable Pressure: 125 psig up to 450 deg F.
11. The maximum operating pressure is to be selected for the intended service.

D. Inverted Bucket Traps:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Watson McDaniel
   b. Spirax Sarco
2. Body and Cap: Cast iron.
3. End Connections: Threaded.
4. Head and Seat: Stainless steel.
5. Valve Retainer, Lever, and Guide Pin Assembly: Stainless steel.
6. Bucket: Brass or stainless steel.
7. Strainer: Integral stainless-steel inlet strainer within the trap body.
8. Air Vent: Stainless-steel thermostatic vent.
9. Maximum allowable Pressure: 250 psig.
10. The maximum operating pressure is to be selected for the intended service.

2.9 THERMOSTATIC AIR VENTS AND VACUUM BREAKERS

A. Thermostatic Air Vents:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Watson McDaniel
      b. Spirax Sarco
   2. Body: Cast iron, bronze or stainless steel.
   3. End Connections: Threaded.
   4. Float, Valve, and Seat: Stainless steel.
   5. Thermostatic Element: Phosphor bronze bellows in a stainless-steel cage.
   6. Maximum allowable Pressure: : 125 psig.
   7. The maximum operating pressure is to be selected for the intended service.
   8. Maximum Temperature Rating: 350 deg F.

B. Vacuum Breakers:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Watson McDaniel
      b. Spirax Sarco
   2. Body: Cast iron, bronze, or stainless steel.
   3. End Connections: Threaded.
   4. Sealing Ball, Retainer, Spring, and Screen: Stainless steel.
   5. O-ring Seal: EPR.
   6. Pressure Rating: 125 psig.
   7. Maximum Temperature Rating: 350 deg F

2.10 PIPE FLANGE GASKET MATERIALS

A. Flange gaskets shall be one-piece ring type 1/16 inch thick (minimum) except as noted, suitable for temperature, pressure (operating and test) and service of system.
   1. For high pressure steam and condensate – Garlock, Style 9800 only
   2. For low pressure steam and condensate - Klinger C4430
   3. For joints of dissimilar metals, provide isolating gaskets, sleeves and washers between flanges, bolts and nuts. Gaskets shall be similar to Dupont Teflon.
   4. Full-Face Type: For flat-face, Class 125, cast iron and cast bronze flanges.
   5. Narrow Face Type: For raised face, class 250, cast iron flanges.

2.11 RING SPACERS AND TEST BLANKS:

A. Provide between flanges where shown on drawing or where necessary to isolate equipment from the piping system, in accordance with B 3.1.1, Chapter VI, section 137.2.4. Ring spacers to be replaced by test blanks during hydrostatic testing and/or during chemical cleaning for equipment isolation.

B. Size and rating to match companion flanges.

PART 3 - EXECUTION

3.1 STEAM PIPING APPLICATIONS

A. High pressure steam system, in excess of 100 psig to 225 psig, total temperature below 450 deg F:
   1. Material shall be steel in accordance with ASTM A106 Grade B seamless.
   2. Wall thickness shall be:
      a. To 2 inch: Schedule 40, socket weld ends only.
      b. 2-1/2 inch to 10 inch: Schedule 40, butt weld ends only.
      c. 12 inch to 24 inch: 0.375 inch wall thickness, butt weld ends only.

B. High pressure steam system, in excess of 15 psig to 100 psig total temperature not exceeding 450 deg F:
   1. Material shall be steel in accordance with ASTM A106 Grade B seamless.
   2. Wall thickness shall be:
      a. To 2 inch: Schedule 40, socket weld ends only.
      b. 2-1/2 inch to 10 inch: Schedule 40, butt weld ends only.
      c. 12 inch to 24 inch: 0.375 inch wall thickness, butt weld ends only.

C. Low pressure steam system, 15 psig or below:
   1. Material shall be steel in accordance with ASTM A106 Grade B seamless.
   2. Wall thickness shall be:
      a. To 2 inch: Schedule 80 with threaded ends, or Schedule 40 with socket welds.
      b. 2-1/2 inch to 10 inch: Schedule 40, butt weld ends only.
      c. 12 inch to 24 inch: 0.375 inch wall thickness, butt weld ends only.

D. High pressure condensate return system, above 100 psig:
   1. Material shall be steel in accordance with ASTM A106 Grade B seamless.
   2. Wall thickness shall be:
      a. To 2 inch: Schedule 80, socket weld ends only.
      b. 2-1/2 inch to 10 inch: Schedule 80, butt weld ends only.
      c. 12 inch and larger: Schedule 80, butt weld ends only.

E. High pressure condensate return system, between 15 psig and 100 psig
   1. Material shall be steel in accordance with ASTM A106 Grade B seamless.
   2. Wall thickness shall be:
      a. To 2 inch: Schedule 80, socket weld ends only.
      b. 2-1/2 inch to 10 inch: Schedule 80, butt weld ends only.
      c. 12 inch and larger: 0.375 wall thickness, butt weld ends only.

F. Low pressure condensate return system, below 15 psig:
   1. Material shall be steel in accordance with ASTM A106 Grade B seamless.
   2. Wall thickness shall be:
      a. To 2 inch: Schedule 80 with threaded ends, or Schedule 40 with socket welds.
      b. 2-1/2 inch to 10 inch: Schedule 40, butt weld ends only.
      c. 12 inch and larger: 0.375 wall thickness, butt weld ends only.

G. Pumped condensate return system:
   1. Material shall be steel in accordance with ASTM A106 Grade B seamless.
   2. Wall thickness shall be:

a. To 2 inch: Schedule 80 with threaded ends, or Schedule 80 with socket welds.
b. 2-1/2 inch to 10 inch: Schedule 40, butt weld ends only.
c. 12 inch and larger: 0.375 wall thickness, butt weld ends only.

3.2 ANCILLARY PIPING APPLICATIONS

A. Air-Vent Piping:
1. Inlet: Same as service where installed.
2. Outlet: Type K annealed-temper copper tubing with soldered or flared joints.

B. Vacuum-Breaker Piping: Outlet, same as service where installed.

C. Safety-Valve-Inlet and -Outlet Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed.

3.3 LP STEAM-TRAP APPLICATIONS

A. Thermostatic Traps: Convectors and finned-tube radiation.

B. Float and Thermostatic Traps: Steam main and riser drip legs, laundry equipment, kitchen equipment, heat exchangers, and heating coils.

C. As indicated on the drawings.

3.4 HP STEAM-TRAP APPLICATIONS

A. Thermostatic Traps: Convectors and finned-tube radiation.

B. Inverted Bucket Traps: Steam main and riser drip legs, and laundry equipment.

C. Float and Thermostatic Traps: Kitchen equipment, heat exchangers, and heating coils.

D. Thermodynamic Traps: Steam main and riser drip legs, and heat tracer lines.

E. As indicated on the drawings

3.5 VALVE APPLICATIONS

A. General-Duty Valve Applications: Unless otherwise indicated, use the following valve types:
1. Shutoff Duty: Gate and ball valves.
2. Throttling Duty: Globe and ball valves
3. <u>All steam valves shall have steel bodies.</u>

B. Install shutoff duty valves at branch connections to steam supply mains, at steam supply connections to equipment, and at the outlet of steam traps.

C. Install safety valves on pressure-reducing stations and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install safety-valve discharge piping to safe termination point in accordance with building codes , without valves, as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1, for installation requirements.

3.6 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Use indicated piping locations and arrangements if such 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.

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 free of sags and bends.

G. Install fittings for changes in direction and branch connections.

H. Install piping to allow application of insulation.

I. Select system components with pressure rating equal to or greater than system operating pressure.

J. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

K. Install drains, consisting of a tee fitting, NPS 3/4 full port-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.

L. Install steam supply piping at a minimum uniform grade of 0.2 percent downward in direction of steam flow.

M. Install condensate return piping at a minimum uniform grade of 0.4 percent downward in direction of condensate flow.

N. Reduce pipe sizes using eccentric reducer fitting installed with level side down.

O. Install branch connections to mains using tee fittings in main pipe, with the branch connected to top of main pipe.

P. Install valves according to Division 23 Section "General-Duty Valves for HVAC Piping."

Q. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.

R. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.

S. Install strainers on supply side of control valves, pressure-reducing valves, traps, and elsewhere as indicated. Install NPS 3/4 nipple and full port ball valve in blowdown connection of strainers NPS 2 and larger. Match size of strainer blowoff connection for strainers smaller than NPS 2.

T. Install expansion loops, expansion joints, anchors, and pipe alignment guides as specified in Division 23 Section "Expansion Fittings and Loops for HVAC Piping."
   1. Install piping to permit free expansion and contraction without damaging piping, equipment, or construction.
   2. Provide expansion joints, offsets, expansion loops, anchors, guides and supports to permit expansion, within stress limits of ANSI Code for Pressure Piping for temperature range of 40 deg F to minimum of 20 deg F above maximum system temperature.
      1) Steam piping shall be cold-sprung.
      2) Piping up to 1-1/2 inch: Cold-sprung 100 percent of expansion.
      3) Piping 2 inch and larger: Cold-sprung 50 percent of expansion.
   3. Install anchors and guides on both sides of expansion loops, zees, etc., to provide safe installation and trouble-free operation

U. Identify piping as specified in Division 23 Section "Identification for HVAC Piping and Equipment."

V. Install drip legs at low points and natural drainage points such as ends of mains, bottoms of risers, and ahead of pressure regulators, and control valves.
   1. Drips: Provide as follows:
      a. Steam piping:
         1) Maximum 75 foot intervals.
         2) At bottom of vertical lines.
         3) At rising points in piping.
   2. Provide drain valves where condensate may be pocketed.
   3. Provide drip points with dirt pockets, the same size as piping, with removable caps. Welded piping shall have ends with flange. Screwed piping shall have caps screwed, made up with graphite.
   4. Dirt pockets; Provide full size of riser, 12 inches long at bottom of each riser, end of mains, ends of headers, ahead of pressure regulators, control valves, isolation valves, changes of direction, pipe loops, expansion joints, and as noted
   5. Connect drips to condensate return and refer to drip detail.
   6. Pitch steam, condensate return and drip piping for gravity drainage.

W. Provide three elbow type swing joints on steam and condensate return connections to equipment and piping systems.

X. .Provide riser shutoff valves in runout to each steam and condensate return riser.

Y. Install ring spacers and test blanks as required for hydrostatic testing

3.7 STEAM-TRAP INSTALLATION

A. Install steam traps in accessible locations as close as possible to connected equipment.

B. Install full-port ball valve, strainer, and union upstream from trap; install union, check valve, and full-port ball valve downstream from trap unless otherwise indicated.

3.8 PRESSURE-REDUCING VALVE INSTALLATION

A. Install pressure-reducing valves in accessible location for maintenance and inspection.

B. Install bypass piping around pressure-reducing valves, with globe valve equal in size to area of pressure-reducing valve seat ring, unless otherwise indicated.

C. Install gate valves on both sides of pressure-reducing valves.

D. Install unions or flanges on both sides of pressure-reducing valves having threaded- or flanged-end connections respectively.

E. Install pressure gages on low-pressure side of pressure-reducing valves after the bypass connection according to Division 23 Section "Meters and Gages for HVAC Piping."

F. On two-stage pressure-reducing stations, install drip trap and pressure gage upstream from second stage pressure-reducing valve

G. Install strainers upstream for pressure-reducing valve.

H. Install safety valve downstream from pressure-reducing valve station.

I. Install noise suppressor as per manufacturers requirements

3.9 SAFETY VALVE INSTALLATION

A. Install safety valves according to ASME B31.1, Power Piping and ASME B31.9, Building Services Piping.

B. Pipe safety-valve discharge without valves to atmosphere outside the building.

C. Install drip-pan elbow fitting adjacent to safety valve and pipe drain connection to nearest floor drain.

D. Install exhaust head with drain to waste, on vents equal to or larger than NPS 2-1/2.

3.10 HANGERS AND SUPPORTS

A. Install hangers and supports according to Division 23 Section "Hangers and Supports for HVAC Piping and Equipment." Comply with requirements below for maximum spacing.

B. Seismic restraints are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

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.

D. Install hangers with the following maximum spacing and minimum rod sizes:

1. NPS 3/4: Maximum span, 9 feet; minimum rod size, 1/4 inch.
2. NPS 1: Maximum span, 9 feet; minimum rod size, 1/4 inch.
3. NPS 1-1/2: Maximum span, 12 feet; minimum rod size, 3/8 inch.
4. NPS 2: Maximum span, 13 feet; minimum rod size, 3/8 inch.
5. NPS 2-1/2: Maximum span, 14 feet; minimum rod size, 3/8 inch.
6. NPS 3: Maximum span, 15 feet; minimum rod size, 3/8 inch.
7. NPS 4: Maximum span, 17 feet; minimum rod size, 1/2 inch.
8. NPS 6: Maximum span, 21 feet; minimum rod size, 1/2 inch.
9. NPS 8: Maximum span, 24 feet; minimum rod size, 5/8 inch.
10. NPS 10: Maximum span, 26 feet; minimum rod size, 3/4 inch.
11. NPS 12: Maximum span, 30 feet; minimum rod size, 7/8 inch.

E. Install hangers for drawn-temper copper piping with the following maximum spacing and minimum rod sizes:
1. NPS 1/2: Maximum span, 6 feet; minimum rod size, 1/4 inch.
2. NPS 3/4: Maximum span, 7feet; minimum rod size, 1/4 inch.
3. NPS 1: Maximum span, 8feet; minimum rod size, 1/4 inch.
4. NPS 1-1/2: Maximum span, 10feet; minimum rod size, 3/8 inch.
5. NPS 2: Maximum span, 11feet; minimum rod size, 3/8 inch.
6. NPS 2-1/2: Maximum span, 13feet; minimum rod size, 3/8 inch.
7. NPS 3: Maximum span, 14feet; minimum rod size, 3/8 inch.

F. Support vertical runs at roof, at each floor, and at 10-foot intervals between floors

G. Vertical piping:
1. Base elbow support: Provide bearing plate on structural support, similar to F&S Manufacturing Co. Fig. 720 or 721.
2. Provide guides at every third floor but not exceed:
3. 25 ft for piping to 2 inch.
4. 36 ft for piping 2-1/2 inch to 12 inch.
5. 50 ft for piping 14 inch and larger.
6. Top support: Provide special hanger or saddle in horizontal connection and make provisions for expansion.
7. Intermediate supports: Steel pipe clamp at floor. Bolt and weld to pipe with extension ends bearing on structural steel or bearing plates.
8. For multiple pipes, coordinate guides, bearing plates and accessory steel.

3.11 PIPE JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 23 Sections specifying piping systems.

B. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

C. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

D. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:
1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.

2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

E. Welded Joints: Construct joints according to AWS D10.12, using qualified processes and welding operators according to Part 1 "Quality Assurance" Article.

F. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

3.12 TERMINAL EQUIPMENT CONNECTIONS

A. Size for supply and return piping connections shall be the same as or larger than equipment connections.

B. Install traps and 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 vacuum breakers downstream from control valve, close to coil inlet connection.

E. Install a drip leg at coil outlet.

F. Install ports for pressure and temperature gages at coil inlet connections.

G. Install a drip leg at coil outlet.

H. Equipment piping and connections: Provide steam, condensate return, drip and vent piping connections as noted and as recommended by equipment manufacturer. Verify location, number and size of connections.
   1. Domestic hot water heaters: Install temperature regulators supplied under Plumbing Sections of the specification.
   2. Heating coils: Locate condensate return traps so as not to be subject to freezing.
   3. Boiler plant equipment: Refer to Section "Boilers, Feedwater Equipment and Related Apparatus" and to the drawings for requirements.
   4. Laboratory, kitchen, laundry and medical equipment: Provide steam, condensate return, drip and vent piping for equipment using steam: As noted and in accordance with requirements of equipment manufacturer.
      a. Verify exact location, number and size of equipment connections in accordance with drawings and specifications fro purchased equipment.
      b. Provide globe valve in each steam connection.
      c. In each return connection, provide globe valve at equipment, trap, strainer, upstream of trap and check valve and gate valve on trap discharge.
      d. Exposed, uninsulated steam, return and drip piping, valves, strainers and traps shall be chromium plated.
      e. Pressure reducing valves: Provide single-stage, self-contained PRV in steam connections to equipment as noted. Provide strainer at inlet. Exposed pressure reducing valves and strainers shall be chromium plated.

I. Steam and water mixing unit connections: Provide steam piping connected to unit.
   1. In steam connection, provide the following:
      a. Globe valve.
      b. Single-stage, self-contained pressure reducing valve. Maximum outlet pressure: 5 psig.
      c. Strainer at inlet to pressure reducing valve.
   2. Exposed piping, valves, pressure valves and strainers shall be chromium plated.
   3. Chromium plated valves shall be heat resisting composition cone handle.

J. Condensate cooler:
   1. Connect cooling water to valved outlet provided under Plumbing work. Discharge to floor drain, or as shown on the drawings.

K. Direct radiation: Provide valves at supply end of each radiation element as noted and in accessible locations. Valves shall be readily accessible. Provide thermostatic traps as noted. Pitch down in direction of steam flow. Provide 1/8 inch key operated air vent at top of each element.

L. Unit heaters: Provide control valves and traps as noted.

3.13 FIELD QUALITY CONTROL

A. Prepare steam and condensate piping according to ASME B31.1, "Power Piping" and ASME B31.9, "Building Services Piping," 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 system with clean water. Clean strainers.
   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.

B. Perform the following tests on steam and condensate 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. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the 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.
   3. After hydrostatic test pressure has been applied for at least 4 hours, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks

C. Prepare written report of testing.

END OF SECTION

This page is intentionally left blank.

SECTION 23 22 23

STEAM CONDENSATE PUMPS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes electric-driven steam condensate pumps.

1.3 SUBMITTALS

A. Product Data: Include certified performance curves and rated capacities, operating characteristics, furnished specialties, and accessories for each type of product indicated. Indicate pump's operating point on curves. Include receiver capacity and material.

B. Shop Drawings: Show pump layout and connections. Include setting drawings with templates for installing foundation and anchor bolts and other anchorages.
   1. Wiring Diagrams: Power, signal, and control wiring.

C. Operation and Maintenance Data: For pumps to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Source Limitations: Obtain steam condensate pumps through one source from a single manufacturer.

B. Product Options: Drawings indicate size, profiles, and dimensional requirements of steam condensate pumps and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. ASME Compliance: Fabricate and label steam condensate pumps to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Manufacturer's Preparation for Shipping: Clean flanges and exposed machined metal surfaces and treat with anticorrosion compound after assembly and testing. Protect flanges, pipe openings, and nozzles with wooden flange covers or with screwed-in plugs.

B. Store steam condensate pumps in dry location.

C. Retain protective covers for flanges and protective coatings during storage.

D. Protect bearings and couplings against damage from sand, grit, and other foreign matter.

E. Comply with pump manufacturer's written rigging instructions.

1.6 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

2.2 ELECTRIC-DRIVEN STEAM CONDENSATE PUMPS

A. Description: Factory-fabricated, packaged, electric-driven pumps; with receiver, pump(s), controls, and accessories suitable for operation with steam condensate.

B. Configuration: Duplex floor-mounting pumps with receiver and float switches; rated to pump minimum 210 deg F (99 deg C) steam condensate.
   1. Manufacturers:
      a. Domestic Pump; Div. of ITT Industries.
      b. Spirax Sarco, Inc.
      c. Skidmore
      d. Shipco
   2. Receiver: Floor-mounting close-grained cast iron or welded steel; externally adjustable float switches; with water-level gage, steam condensate thermometer, discharge-pressure gage for each pump, bronze gate valves between receiver and pumps, flanges for pump mounting, and lifting eyebolts.
   3. Inlet Strainer: Cast iron with self-cleaning bronze screen, dirt pocket, and cleanout plug on receiver inlet.
   4. Pumps: Centrifugal, close coupled, vertical design, permanently aligned, and bronze fitted; with replaceable bronze case rings, stainless-steel shafts, and mechanical seals; mounted on receiver flanges; rated to operate with a minimum of 2 feet (6 kPa) of NPSH.
   5. Control Panel: NEMA 250, Type 2 enclosure with hinged door and grounding lug, mounted on pump; factory wired for single external electrical connection; and with the following components within cabinet:
      a. Motor controller for each pump.
      b. Electrical pump alternator to operate pumps in lead-lag sequence and allow both pumps to operate on receiver high level.

c. Manual lead-lag control to override electrical pump alternator to manually select the lead pump.
d. Momentary contact "TEST" push button on cover for each pump.
e. Numbered terminal strip.
f. Disconnect switch.
g. Fused transformer for control circuit.

2.3 MOTORS

A. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

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 work.

B. Examine rough installation of steam condensate piping.

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

3.2 INSTALLATION

A. Install pumps to provide access for periodic maintenance including removing motors, impellers, couplings, and accessories.

B. Support pumps and piping separately so piping is not supported by pumps.

C. Install pumps on concrete bases. Anchor pumps to bases using inserts or anchor bolts.

D. Install thermometers and pressure gages.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to machine to allow service and maintenance.

C. Install check valve, gate valve, and globe valve at pump discharge connections for each electric-driven pump.

D. Pipe drain to nearest floor drain for overflow and drain piping connections.

E. Install full-size vent piping to outdoors, terminating in 180-degree elbow at point above highest steam system connection or as indicated.

F. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

G. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.4 STARTUP SERVICE

A. Verify that steam condensate pumps are installed and connected according to the Contract Documents.

B. Complete installation and startup checks according to manufacturer's written instructions.

C. Clean strainers.

D. Set steam condensate pump controls.

E. Set pump controls for automatic start, stop, and alarm operation.

F. Perform the following preventive maintenance operations and checks before starting:
   1. Set float switches to operate at proper levels.
   2. Set throttling valves on pump discharge for specified flow.
   3. Check motors for proper rotation.
   4. Test pump controls and demonstrate compliance with requirements.
   5. Replace damaged or malfunctioning pump controls and equipment.
   6. Verify that pump controls are correct for required application.

G. Start steam condensate pumps according to manufacturer's written startup instructions.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain steam condensate pumps. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION

SECTION 23 25 00

HVAC WATER TREATMENT

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following HVAC water-treatment systems:
   1. Bypass chemical-feed equipment and controls.
   2. Chemical treatment test equipment.
   3. HVAC water-treatment chemicals.
   4. Glycol feeder makeup package

1.3 DEFINITIONS

A. EEPROM: Electrically erasable, programmable read-only memory.

B. 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.

C. RO: Reverse osmosis.

D. TDS: Total dissolved solids.

E. UV: Ultraviolet.

1.4 GENERAL REQUIREMENTS

A. A single water treatment company shall provide all products and serviced for undivided responsibility throughout the warranty period.

B. The water treatment company shall be a recognized specialist in the field of industrial water treatment for a minimum of ten (10) years.

C. The water treatment company shall have knowledgeable and experienced personnel on staff who are chemical engineers or chemists and have been in the field of industrial water treatment for over ten (10) years.

D. The water treatment company shall have a technical service representative within two (2) hours drive of the job site for the duration of the warranty period.

E. The water treatment company shall have a well-equipped laboratory managed by qualified personnel.

F. All products furnished shall be proven reliable and have good proven performances.

1.5 DESCRIPTION OF WATER TREATMENT SERVICE.

A. Furnish the following as base bid
   1. Retain qualified water treatment firm for the following:
   2. Supervision of installation of chemical feeding and treatment control equipment, and of initial application of water treatment.
      a. Supply release title to chemicals for initial cleaning, chemicals for required water treatment, equipment for feeding water treatment chemicals, equipment for control water treatment written instructions for application and control of initial. Cleaning and have water treatment, material Safety Data Sheets for each cleaning and treatment chemical and test equipment and reagents.
      b. Corrosion test coupons and 4 pass carbon steel apparatus in accordance with ASTM D2688 Method B for all water systems.

1.6 PERFORMANCE REQUIREMENTS

A. Water quality for HVAC systems shall minimize corrosion, scale buildup, and biological growth for optimum efficiency of HVAC equipment without creating a hazard to operating personnel or the environment.

B. Base HVAC water treatment on quality of water available at Project site, HVAC system equipment material characteristics and functional performance characteristics, operating personnel capabilities, and requirements and guidelines of authorities having jurisdiction.

C. Closed hydronic systems, including chilled water and hot-water heating, shall have the following water qualities:
   1. pH: Maintain a value within 8.0 to 10.3.
   2. Soluble Copper: Maintain a maximum value of 0.10 ppm.
   3. TDS: Do not exceed 4,000 mmhs.
   4. Ammonia: Maintain a maximum value of less than 2.0 ppm.
   5. Microbiological Limits:
      a. Total Aerobic Plate Count: Maintain a maximum value of 1000 cells/ml.
      b. Total Anaerobic Plate Count: Maintain a maximum value of 50 cells/ml.
      c. Nitrate Reducers: Maintain a maximum value of 50 cells/ml.
      d. Sulfate Reducers: Maintain a maximum value of 50 cells/ml.
      e. Iron Bacteria: Maintain a maximum value of 50 cells/ml.

1.7 SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for the following products:
   1. Bypass feeders.
   2. Water meters.
   3. Chemical test equipment.
   4. Chemical material safety data sheets.
   5. Glycol feeder make-up package.

B. Shop Drawings: Pretreatment and chemical treatment equipment showing maintenance space required, and piping connections to HVAC systems. Retain subparagraph below if equipment includes wiring.

C. Field quality-control test reports.

D. Other Informational Submittals:
   1. Water-Treatment Program: Written sequence of operation on an annual basis for the application equipment required to achieve water quality defined in the "Performance Requirements" Article above.
   2. Water Analysis: Illustrate water quality available at Project site.

1.8 QUALITY ASSURANCE

A. HVAC Water-Treatment Service Provider Qualifications: An experienced HVAC water-treatment service provider capable of analyzing water qualities, installing water-treatment equipment, and applying water treatment as specified in this Section.

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.

1.9 MAINTENANCE SERVICE

A. Scope of Maintenance Service: Provide chemicals and service program to maintain water conditions required above to inhibit corrosion, scale formation, and biological growth for [heating, hot-water piping] and equipment. Services and chemicals shall be provided for a period of one year from date of Substantial Completion, and shall include the following:
   1. Initial water analysis and HVAC water-treatment recommendations.
   2. Startup assistance for Contractor to flush the systems, clean with detergents, and initially fill systems with required chemical treatment prior to operation.
   3. Periodic field service and consultation.
   4. Customer report charts and log sheets.
   5. Laboratory technical analysis.
   6. Analyses and reports of all chemical items concerning safety and compliance with government regulations.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Barclay Chemical Co.; Water Management, Inc.

2.2 MANUAL CHEMICAL-FEED EQUIPMENT

A. Bypass Feeders: Combination side stream filter, and chemical shot feeder:

   1. Combination side stream filter and shot feeders shall be installed where indicated on plans. Units shall be by Vexo International (X-Pot).
   2. Units shall be fabricated of 304 stainless steel and contain replaceable bag filters. The filter will be held in place by a removable retention system (baffle plate). Located above the baffle plate will be rare earth magnet rods held

within a 316 stainless steel grate with removable caps for cleaning. The magnet grate will allow full flow of system water within the side stream filter.

3. The unit will have a removable lid to access all of the internal filter components for replacement and cleaning.
4. Units shall be complete with an automatic air vent.
5. Units will come complete with a funnel and non return valve for use when operating as a chemical shot feeder.
6. Units shall come with roughing cartridges for initial flushing until the final filtration rate of 5 microns is achieved. Cartridge filter types shall be as recommended by the manufacturer.
7. The unit shall come with a removable insulation jacket.

2.3 GLYCOL FEEDER MAKEUP PACKAGE

A. The contractor shall supply and install, as indicated on the plans and in the specifications, a prefabricated, automatic and autonomous make-up package for each glycol system or one system to serve all system with isolation valuing.

B. The package shall be designed to occupy a minimum amount of floor space to operate on a standard 110V, 60Hz electrical circuit, and to maintain a fill pressure in the glycol system. The pumping assembly shall be mounted in a sturdy steel frame with legs to keep it off the floor. It shall include a pump sized by treatment manufacturer, a motor, a magnetic starter, a pressure tank with a pressure control, a priming valve, a PRV, a shut-off valve and a pressure gauge. It shall be connected to the system with a ½" NPT connection.

C. It shall feature a cut-off and alarm arrangement which will stop the pump in case of excessive pressure, or a low solution level, and active an audible (which can be silenced) and a visual alarm. A 110V shall also be available for a remote alarm. A translucent polyethylene (50) gallon solution container, complete with lid, shall be mounted on the pumping assembly and shall include a strainer and a shut off valve. A glycol solution recovery line shall be piped in from the system relief valve outlet to the solution container, through its lid in such a way that the lid can be removed for filling and mixing.

D. The make-up package shall be Wessels Model GMP with discharge pressure factory preset and fixed adjustable.

PART 3 - EXECUTION

3.1 WATER ANALYSIS

A. Perform an analysis of supply water to determine quality of water available at Project site.

3.2 TREATMENT

A. Provide Treatment for systems as follows:
1. Chilled water and hot water systems, treatment shall be as follows:
   a. For pH range, refer to Treatment Schedule at end of this section.
   b. Mixture of Molybdate, Silicate, Polymeric dispersant and Tolytriazole or equivalent non-ferrous inhibitor, maintaining minimum concentration as noted in Treatment schedule at end of this section. The inhibitor shall

maintain corrosion of steel and copper below 2 mils per year and 0.2 mils per year respectively.

c. Non-oxidizing, non-acidic and non-cationic biocide, glutaraldhyde or approved equal, to control total bacteria count below 1000 colonies per ml.

d. Preliminary work required, but is not limited to:
   1) Refer to the drawing for additional information and clarification
   2) Provide a training manual to include operating and maintenance procedures on equipment, chemical control limits, material safety data sheets, lay-up and start-up procedures.
   3) All steps in the following cleaning and treatment procedures must be accomplished in immediate succession with no delay. Provide overtime manpower to accomplish same.
   4) Leave all valve trains in place and open for cleaning and treatment procedures and hydrostatic testing.
   5) Install drain outlets at deadends, low points and heat exchangers.
   6) Insert temporary wire screens of 140 microns or 9/64 inch perforations at chiller inlets. Use a 50 micron bag in the sidestream bag filter.

e. Preliminary cleaning procedures:
   1) Remove all extraneous loose debris, construction material, trash and dirt from piping, filters and all equipment. Remove as much dry material as possible, for this material prevents protective coating transfer to hard to reach portions of the system.
   2) Flush water fill line separately to drain. If a new water line has been installed, be sure that rust and debris from it is not washed into the system.
   3) Fill the system piping and equipment with water and recirculate for one with the temporary bypasses at open positions.
   4) Turn on direct make-up and begin blowing down deadends, low points and y-strainers until water runs “city-water clean” as fast as make-up will allow.
   5) Remove all screens and strainers, clean and replace. Flush all temporary bypasses.
   6) Add alkaline, non-foaming, non-chlorinated detergent disinfectant plus non-foaming wetting agent to remove cutting oil, excess pipe joint compound, fine solids and other materials at a dosage of 5 lbs per 100 gallons of system water.
   7) Recirculate for 4 to 8 hours.
   8) Turn on direct make-up and begin flushing all drain outlets, y-strainers, deadends and bypasses until water meets the following parameters: Iron levels within 1 ppm, conductivity within 10 mmhs, orthophosphate within 1 ppm and turbidity within 1 FTU.
   9) Isolate tower basins to carry out vacuuming and power spray washing of tower interior. Immediately begin the “pretreatment procedure”.

f. Pretreatment procedure:
   1) Fill the system piping and equipment with water while adding non-foaming, water- based lay-up inhibitors to protect the piping as per chemical manufacturer’s recommended dosage.

2) Recirculate for 2 hours. All heat exchangers and condensers must be off-line and with no heat load.
3) Stop the pumps and secure the system for hydrostatic tests.
4) If the hydrostatic test fails, refill the system and begin pretreatment procedures again from step “g”.
5) After successful completion of the hydrostatic test, disconnect all apparatus and secure the system for the resumption of the pretreatment procedure.
6) Begin flushing systems as fast as make-up will allow. Continue until water is “city water clean”.
7) Remove all screens, strainers and temporary bypasses. Clean and replace screens and strainers immediately and begin the “passivation procedure”.

g. Passivation Procedure
1) Fill the system piping and equipment with water while adding TWICE the regular amount of the maintenance corrosion inhibitor into the water.
2) Recirculate for 24-72 hours.
3) Change the filter bag to a 10 micron high efficiency bag.
4) Keep pressure differential across the bag filter less than 15 psig by washing or replacing the filter bag.

h. Initial chilled water and hot water system treatment:
1) Install corrosion coupons and 5 micron, high-efficiency filter bag in the sidestream filter.
2) Test water for corrosion inhibitor level. Add corrosion inhibitor if necessary to restore the regular control range.
3) Add biocide per water treatment contractor’s recommended dosage.
4) Record make-up water meter reading.

i. Chilled water and hot water maintenance:
1) Dose system with corrosion inhibitor based on test results and water meter readings.
2) Remove corrosion coupons on a quarterly basis.
3) Change the filter bags on pressure differential and flow meter readings.
4) Test water monthly for pH, alkalinity, ammonia, hardness, molybdates, silicates, iron, copper, conductivity, total bacteria, turbidity, iron bacteria and sulfur reducing bacteria.

2. Steam and steam condensate systems.

a. Preliminary work required includes, but is not limited to:
1) All steps in the following treatment procedures must be accomplished in immediate succession with no delay. Provide overtime manpower to accomplish same.
2) Install shut off ball valves at the horizontal headers for a temporary connection with hoses, recirculating pumps and tanks.
3) Install vent and drain outlets at the temporary piping.
4) Clean the piping with aqueous cleaning solutions first, followed with steam blowout.

b. Cleaning procedure:
1) Remove all lose mill scale with circulation of plain city water at 3 ft per second or higher (300 gpm in the riser) for 15 minutes.

2) Add a liquid alkaline inhibited chelate cleaner into the piping to create a 5% cleaning solution to remove old mill scale and rust.
3) Cleaner shall contain erythorbate as a corrosion inhibitor, sodium gluconate and EDTA as chelates, non-foaming wetting agent and low molecular weight polymeric dispersant.
4) Circulate cleaner for 4 to 8 hours. Test for residual chelate and corrosion inhibitor levels during circulation. Add additional cleaner if necessary to maintain he strength of the cleaner AT 5% and 200 ppm of erythorbate.
5) Drain and flush the loop with city water until it meets the following parameters: Iron levels within 1 ppm, conductivity within 10 mmhs, orthophosphate within 1 ppm and turbidity within 1 FTU.

3. Passivation procedure:
   a. Fill the temporary piping with water while adding alkaline silicate based passivator at an amount of half a gallon to 100 gallons.
   b. Recirculate the piping for 24 to 48 hours.
   c. Drain piping and begin cleaning new pipes with steam
4. Humidifiers:
   a. Spray coil and pan types:
      1) See treatment schedule at the end of the section for corrosion/scale inhibitor and organic dispesant.
      2) For pH range, refer to the treatment schedule at the end of this section.
      3) Biocides: if significant slime is detected after operation, provide two different types of treatment for alternating application. Treatment shall be EPA registered for use in air-washers or humidifiers and shall be non-volatile and odorless. Compounds of mercury, copper and arsenic will not be permitted. Treatment should be in accordance with EPA approved label.
      4) For external treatment with demineralized and UV sterilizers: See Equipment.

3.3 INSTALLATION

A. Install water testing equipment on wall near water chemical application equipment.

B. Bypass Feeders: Install in closed hydronic systems, including [hot-water heating], and equipped with the following:
   1. Install bypass feeder in a bypass circuit around circulating pumps, unless otherwise indicated on Drawings.
   2. Install test-coupon assembly in bypass circuit around circulating pumps, unless otherwise indicated on Drawings.
   3. Install a gate or full-port ball isolation valves on inlet, outlet, and drain below feeder inlet.
   4. Install a swing check on inlet after the isolation valve.

C. Install glycol makeup system with all required piping and valving.

3.4 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to equipment to allow service and maintenance.

C. Make piping connections between HVAC water-treatment equipment and dissimilar-metal piping with dielectric fittings. Dielectric fittings are specified in Division 23 Section "Common Work Results for HVAC."

D. Install shutoff valves on HVAC water-treatment equipment inlet and outlet. Metal general-duty valves are specified in Division 23 Section "General-Duty Valves for HVAC Piping."

E. Refer to Division 22 Section "Domestic Water Piping Specialties" for backflow preventers required in makeup water connections to potable-water systems.

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. Report results in writing.

B. Perform tests and inspections and prepare test reports.
   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 field-assembled components and equipment installation, including piping and electrical connections.
   2. Inspect piping and equipment to determine that systems and equipment have been cleaned, flushed, and filled with water, and are fully operational before introducing chemicals for water-treatment system.
   3. Place HVAC water-treatment system into operation and calibrate controls during the preliminary phase of HVAC systems' startup procedures.
   4. Do not enclose, cover, or put piping into operation until it is tested and satisfactory test results are achieved.
   5. Test for leaks and defects. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
   6. Leave uncovered and unconcealed new, altered, extended, and replaced water piping until it has been tested and approved. Expose work that has been covered or concealed before it has been tested and approved.
   7. Cap and subject piping to static water pressure of 50 psig (345 kPa) above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow test pressure to stand for four hours. Leaks and loss in test pressure constitute defects.
   8. Repair leaks and defects with new materials and retest piping until no leaks exist.

D. Remove and replace malfunctioning units and retest as specified above.

E. Comply with ASTM D 3370 and with the following standards:
   1. Silica: ASTM D 859.
   2. Steam System: ASTM D 1066.
   3. Acidity and Alkalinity: ASTM D 1067.
   4. Iron: ASTM D 1068.
   5. Water Hardness: ASTM D 1126.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC water-treatment systems and equipment. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION

This page is intentionally left blank.

SECTION 23 31 13

METAL DUCTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
1. Single-wall rectangular ducts and fittings.
2. Double-wall rectangular ducts and fittings.
3. Single-wall round and flat-oval ducts and fittings.
4. Double-wall round and flat-oval ducts and fittings.
5. Sheet metal materials.
6. Duct liner.
7. Sealants and gaskets.
8. Hangers and supports.
9. Seismic-restraint devices.
10. Backdraft and pressure relief dampers.
11. Barometric relief dampers.
12. Manual volume dampers.
13. Control dampers.
14. Fire dampers.
15. Smoke dampers.
16. Combination fire and smoke dampers.
17. Turning vanes.
18. Remote damper operators.
19. Duct mounted access doors.
20. Flexible connectors.
21. Flexible ductwork.
22. Antimicrobial coatings
23. ~~UL listed zero clearance kitchen hood exhaust.~~
24. Fire resistive ductwork and accessories

B. Related Sections:
1. Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
2. Division 23 Section “Noise Control” for double wall ductwork.

1.3 PERFORMANCE REQUIREMENTS

A. 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, latest edition" and performance requirements and design criteria indicated.

1. DESIGN
STATIC PRESSURE

PRESSURE CLASS	OPERATING PRESSURE
2 IN. W.G	UP TO 2 IN. W.G.
6 IN. W.G.	OVER 2 IN. UP TO 6 IN. W.G.

a. Based on the following:
   1) Single duct system: Static pressure at respective point in ductwork during normal operation.
   2) Variable volume duct systems: Static pressure at beginning of fan discharge duct.

b. Description of ductwork pressure class and equipment:
   1) 6” and greater Duct Class: All supply ductwork from discharge of fans, air handling units, or AC units to inlets of terminal boxes on floor, all outdoor ductwork and all ductwork running through unconditioned spaces. Seal Class “A”, leakage class 4 (rectangular metal) or Class 3 (round)
   2) 6” and greater Duct Class: All return and hood exhaust air ductwork from suction of fans, air handling units or AC units to inlets of terminal boxes on floor. Seal Class “A”, leakage class 4 (rectangular metal) or Class 3 (round)
   3) 3” Duct Class: All suction and discharge of ~~kitchen exhaust and~~
   4) other exhaust ductwork. Seal Class “B”, leakage class 12 *rectangular metal or Class 6 (round)
   5) 2” Duct Class and less: All other low pressure ductowork. Seal Class “C”, leakage Class 24 (rectangular) or Class 12 (round).

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 SEI/ASCE 7.
   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.

1.4 SUBMITTALS

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

B. Shop Drawings (CAD Generated and Drawn to 3/8 scale):
   1. Sheetmetal shop standards shall be compiled directly from the “SMACNA DUCT CONSTRUCTION STANDARDS- Metal and Flexible” manual. Modifications for a specific project, if any, shall be indicated directly on the SMACNA templates. Modified shop standards not taken directly from the SMACNA templates will not be accepted. Any deviations from SMACNA shall be noted.

2. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
3. Factory- and shop-fabricated ducts and fittings.
4. Duct layout (double line) indicating sizes, transitions, configuration, liner material, and static-pressure classes.
5. Elevation of top of ducts.
6. Dimensions of main duct runs from building grid lines.
7. Sheet metal thicknesses
8. Fittings.
9. Reinforcement details and spacing.
10. Seam and joint construction and sealing
11. Materials, fabrication, assembly, and spacing of hangers and supports.
12. Penetrations through fire-rated and other partitions.
13. Equipment installation based on equipment being used on Project.
14. Access clearance for all equipment and accessories
15. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
16. Hangers and supports, including methods for duct and building attachment, seismic restraints, and vibration isolation.
17. 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.

C. 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.

D. Welding certificates.

E. Field quality-control reports.

1.5 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 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 D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.

C. NFPA Compliance:
1. NFPA 90A, " Installation of Air conditioning and Ventilating Systems."
2. NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."
3. NFPA 96, "Ventilation Control and Fire Protection of Commercial Cooking Operations."

D. Indicate compliance with USGBC LEED rating criteria for Indoor environmental quality (IEQ.

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", latest edition, based on indicated static-pressure class unless otherwisedicated.

B. The following fitting connections and duct construction gauges are NOT acceptable
1. Drive slip T-1, T-2 fitting connections
2. 26 gauge ductwork.

C. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible,"Transverse (Girth) 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." Fittings and/or joints of two different gauges, connected joint rating shall meet more stringent conditions
1. Use the following SMACNA Transverse (Girth) Joints
   a. Duct construction as follows for 2" w.g. class:
      1) Up to 12" wide use T-6 or T-7
      2) 13" to 28" wide use T-11 or T12
      3) 29" wide and up use TDC or TDF
   b. Duct construction as follows for 3" w.g. class:
      1) Up to 20" wide use T-6 or T-7
      2) 21" to 24" wide use T-11 or T12
      3) 25" wide and up use TDC or TDF
   c. Duct construction as follows for 6" w.g. class:
      1) Up to 12" wide use T-6 or T-7
      2) 13" to 18" wide use T-11 or T12
      3) 19" wide and up use TDC or TDF

D. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible "Longitudinal Seams - Rectangular Ducts," 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."

E. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible,"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 DOUBLE-WALL RECTANGULAR DUCTS AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. McGill AirFlow LLC.
   2. Sheet Metal Connectors, Inc.

B. Rectangular Ducts: Fabricate ducts with indicated dimensions for the inner duct.

C. The following fitting connections and duct construction gauges are NOT acceptable
   1. Drive slip T-1, T-2 fitting connections
   2. 26 gauge ductwork

D. Outer Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.

E. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," "Transverse (Girth) 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. Use the following SMACNA Transverse (Girth) Joints
      a. Duct construction as follows for 2” w.g. class:
         1) Up to 12” wide use T-6 or T-7
         2) 13” to 28” wide use T-11 or T12
         3) 29” wide and up use TDC or TDF
      b. Duct construction as follows for 3” w.g. class:
         1) Up to 20” wide use T-6 or T-7
         2) 21” to 24” wide use T-11 or T12
         3) 25” wide and up use TDC or TDF
      c. Duct construction as follows for 6” w.g. class:
         1) Up to 12” wide use T-6 or T-7
         2) 13” to 18” wide use T-11 or T12
         3) 19” wide and up use TDC or TDF

F. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible,"Longitudinal Seams - Rectangular Ducts," 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."

G. Interstitial Insulation: Fibrous-glass liner complying with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."
   1. Maximum Thermal Conductivity: 0.25 Btu x in./h x sq. ft. x deg F (0.034 W/m x K) at 75 deg F (24 deg C) mean temperature.

2. Install spacers that position the inner duct at uniform distance from outer duct without compressing insulation.
3. Coat insulation with antimicrobial coating.
4. Cover insulation with polyester film complying with UL 181, Class 1.

H. Inner Duct: Minimum 0.028-inch (0.7-mm) perforated galvanized sheet steel having 3/32-inch- (2.4-mm-) diameter perforations, with overall open area of 23 percent.

I. Formed-on Transverse Joints (Flanges): Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible,"Traverse (Girth) 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. Use the following SMACNA Transverse (Girth) Joints
Duct construction as follows for 2” w.g. class:
1) Up to 12” wide use T-6 or T-7
2) 13” to 28” wide use T-11 or T12
3) 29” wide and up use TDC or TDF
b. Duct construction as follows for 3” w.g. class:
1) Up to 20” wide use T-6 or T-7
2) 21” to 24” wide use T-11 or T12
3) 25” wide and up use TDC or TDF
c. Duct construction as follows for 6” w.g. class:
1) Up to 12” wide use T-6 or T-7
2) 13” to 18” wide use T-11 or T12
3) 19” wide and up use TDC or TDF

J. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible,"Longitudinal Seams - Rectangular Ducts," 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 SINGLE-WALL ROUND DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
a. Lindab Inc.
b. McGill AirFlow LLC.
c. SEMCO Incorporated.
d. Sheet Metal Connectors, Inc.
e. Spiral Manufacturing Co., Inc.

B. Provide spiral seams for all ducts and fittings.

C. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible,"Transverse Joints - Round Duct," 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 (1524 mm) in Diameter: Flanged.

D. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, 1995 edition, Figure 3-2, 2005 edition, "Seams - Round Duct and Fittings," 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 (2286 mm) in diameter with butt-welded longitudinal seams.
2. Fabricate flat-oval ducts larger than 72 inches (1830 mm) in width (major dimension) with butt-welded longitudinal seams.

E. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," 90 Degree Tees and Laterals," and "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."

2.4 DOUBLE-WALL ROUND DUCTS AND FITTINGS

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

1. Lindab Inc.
2. McGill AirFlow LLC.
3. SEMCO Incorporated.
4. Sheet Metal Connectors, Inc.

B. Provide spiral seams for all ducts and fittings

C. Outer Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on static-pressure class unless otherwise indicated.

1. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible,"Transverse Joints - Round Duct," 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."
   a. Transverse Joints in Ducts Larger Than 60 Inches (1524 mm) in Diameter: Flanged.
2. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Seams - Round Duct and Fittings," 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."
   a. Fabricate round ducts larger than 90 inches (2286 mm) in diameter with butt-welded longitudinal seams.
   b. Fabricate flat-oval ducts larger than 72 inches (1830 mm) in width (major dimension) with butt-welded longitudinal seams.

3. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible,90 Degree Tees and Laterals," and "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."

D. Inner Duct: Minimum 0.028-inch (0.7-mm) perforated galvanized sheet steel having 3/32-inch- (2.4-mm-) diameter perforations, with overall open area of 23 percent.

E. Interstitial Insulation: Fibrous-glass liner complying with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."
1. Maximum Thermal Conductivity: 0.25 Btu x in./h x sq. ft. x deg F (0.034 W/m x K) at 75 deg F (24 deg C) mean temperature.
2. Install spacers that position the inner duct at uniform distance from outer duct without compressing insulation.
3. Coat insulation with antimicrobial coating.
4. Cover insulation with polyester film complying with UL 181, Class 1.

2.5 SHEET METAL MATERIALS

A. General Material Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible", latest edition 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. Exposed Ductwork
1. Where ductwork is indicated to be exposed to view in occupied spaces, provide materials which are free from visual imperfections, including pittings, seam marks, stains, discolorations, and other imperfections. Provide finishes which will allow painting. Provide flat type seams and joints for all exposed duct construction

C. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.
1. Galvanized Coating Designation: G60 (Z180).
2. Finishes for Surfaces Exposed to View: Mill phosphatized.

D. Carbon-Steel Sheets: Comply with ASTM A 1008/A 1008M, with oiled, matte finish for exposed ducts.

E. 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.

F. Aluminum Sheets: Comply with ASTM B 209 (ASTM B 209M) Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.

G. 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.

H. Tie Rods: Galvanized steel, 1/4-inch (6-mm) minimum diameter for lengths 36 inches (900 mm) or less; 3/8-inch (10-mm) minimum diameter for lengths longer than 36 inches (900 mm).

I. Watertight construction where noted with edges bent 1/2 inch for watertight seal. Longitudinal seam sealant shall be similar to 3M Brand No. 800; Alcoa, aluminastic Type C, or solder. Stiffeners shall be plug or spot welded. Transverse joints shall be bolted companion angles with 1/4 inch cadmium plated bolts with 6 inch minimum on centers and gasket.

J. Air tight construction where noted with longitudinal seams soldered. Stiffeners shall be plug or spot welded. Transverse joints shall be bolted companion angle with 1/4 inch cadmium plated bolts with 6 inch minimum on centers and gasket. Exposed, uninsulated ductwork shall be flush flat seam. Provide airtight concrete, masonry and other construction materials for plenums and shafts only where noted

K. Flush flat seam ductwork: Provide for all exposed uninsulated ducts and transverse joint detail shall be as indicated. Provide sheet metal 2 gauge numbers heavier than required for pressure classification with normal (standing) seam construction. Provide all joints and seams, smooth and aligned with no projections. For internal reinforcing, at transverse joints and on 2 ft centers, provide on ducts 31 inch to 60 inch wide, single vertical stay at duct midpoint, on ducts 61 inch to 90 inch wide provide 2 vertical stays on duct third (1/3) points and for ducts over 90 inch wide provide 3 vertical stays at ducts quarter (1/4) points. For vertical stays: provide 10 USSG galvanized steel, free of burrs and rough edges with both ends bent and fastened to top and bottom of duct.

2.6 DUCT LINER

A. Comply with requirements specified in Division 23 Section “NOISE CONTROL” .

B. Shop Application of Duct Liner: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible,"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. .
   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 (12.7 m/s).
   7. Secure liner with mechanical fasteners 4 inches (100 mm) from corners and at intervals not exceeding 12 inches (300 mm) transversely; at 3 inches (75 mm) from transverse joints and at intervals not exceeding 18 inches (450 mm) 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 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 (2.4-mm) 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.

2.7 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. Indicate compliance with USGBC LEED rating criteria for Indoor environmental quality (IEQ)

C. 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: 3 inches (76 mm).
   3. Sealant: Modified styrene acrylic.
   4. Water resistant.
   5. Mold and mildew resistant.
   6. Maximum Static-Pressure Class: 10-inch wg (2500 Pa), positive and negative.
   7. Service: Indoor and outdoor.
   8. Service Temperature: Minus 40 to plus 200 deg F (Minus 40 to plus 93 deg C).
   9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.

D. 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 (2500 Pa), 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.

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.

F. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

G. Round Duct Joint O-Ring Seals:

1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg (0.14 L/s per sq. m at 250 Pa) and shall be rated for 10-inch wg (2500-Pa) 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.

2.8 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,"Rectangular Duct Hangers Minimum Size," and "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.

2.9 SEISMIC-RESTRAINT DEVICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Cooper B-Line, Inc.; a division of Cooper Industries.
2. Ductmate Industries, Inc.
3. Hilti Corp.
4. Kinetics Noise Control.

5. Loos & Co.; Cableware Division.
6. Mason Industries.
7. TOLCO; a brand of NIBCO INC.
8. Unistrut Corporation; Tyco International, Ltd.

B. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by an evaluation service member of the ICC Evaluation Service.
   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.

C. 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.

D. Restraint Cables: ASTM A 603, galvanized-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.

E. Hanger Rod Stiffener: Steel tube or steel slotted-support-system sleeve with internally bolted connections to hanger rod.

F. 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.

2.10 BACKDRAFT AND PRESSURE RELIEF DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Greenheck Fan Corporation.
   2. Pottorff; a division of PCI Industries, Inc.
   3. Ruskin Company.

B. Description: Gravity balanced.

C. Maximum Air Velocity: 2000 fpm (10 m/s).

D. Maximum System Pressure: 2-inch wg (0.5 kPa).

E. Frame: 0.052-inch- (1.3-mm-) thick, galvanized sheet steel, with welded corners and mounting flange.

F. Blades: Multiple single-piece blades, center-pivoted, maximum 6-inch (150-mm) width, 0.050-inch- (1.2-mm-) thick aluminum sheet with sealed edges.

G. Blade Action: Parallel.

H. Blade Seals: Extruded vinyl, mechanically locked.

I. Blade Axles:
   1. Material: Non-metallic.
   2. Diameter: 0.20 inch (5 mm).

J. Tie Bars and Brackets: Aluminum.

K. Return Spring: Adjustable tension.

L. Bearings: Synthetic pivot bushings.

M. Accessories:
   1. Counterweights and spring-assist kits for vertical airflow installations.

N. Sleeve: Minimum 16-gage thickness.

2.11 MANUAL VOLUME DAMPERS

A. Dampers to be the same as duct construction.

B. Standard, Steel, Manual Volume Dampers:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Pottorff; a division of PCI Industries, Inc.
      b. Ruskin Company.
   2. Standard leakage rating, with linkage outside airstream.
   3. Suitable for horizontal or vertical applications.
   4. Frames:
      a. Hat-shaped, galvanized -steel channels, 0.064-inch (1.62-mm) minimum thickness.
      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. Provide single blade dampers up to 6 inch width and opposed multtiblade dampers above 6 inches in width.
      c. Parallel- or opposed-blade design.
      d. Stiffen damper blades for stability.
      e. Galvanized-steel, 0.064 inch (1.62 mm) thick (16 ga.).
   6. Blade Axles: Galvanized steel.
   7. Bearings:
      a. Molded synthetic.
      b. Dampers in ducts with pressure classes of 3-inch wg (750 Pa) 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.

C. Standard, Aluminum, Manual Volume Dampers:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Pottorff; a division of PCI Industries, Inc.
      b. Ruskin Company.
   2. Standard leakage rating, with linkage outside airstream.
   3. Suitable for horizontal or vertical applications.
   4. Frames: Hat-shaped, 0.10-inch- (2.5-mm-) 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- (2.5-mm-) thick aluminum sheet.
e. Extruded-Aluminum Blades: 0.050-inch- (1.2-mm-) thick extruded aluminum.

6. Blade Axles: Nonferrous metal.
7. Bearings:
   a. Molded synthetic.
   b. Dampers in ducts with pressure classes of 3-inch wg (750 Pa) or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
8. Tie Bars and Brackets: Aluminum.

D. Low-Leakage, Steel, Manual Volume Dampers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Pottorff; a division of PCI Industries, Inc.
   b. Ruskin Company.
2. Low-leakage rating, with linkage outside airstream, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.
3. Suitable for horizontal or vertical applications.
4. Frames:
   a. Hat shaped.
   b. Galvanized-steel channels, 0.064 inch (1.62 mm) thick.
   c. Mitered and welded corners.
   d. 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, roll-formed steel, 0.064 inch (1.62 mm) thick. (16 ga.).
6. Blade Axles: Galvanized steel.
7. Bearings:
   a. Molded synthetic.
   b. Dampers in ducts with pressure classes of 3-inch wg (750 Pa) or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
8. Blade Seals: Neoprene.
9. Jamb Seals: Cambered aluminum.
10. Tie Bars and Brackets: Galvanized steel.
11. Accessories:
    a. Include locking device to hold single-blade dampers in a fixed position without vibration.

E. Low-Leakage, Aluminum, Manual Volume Dampers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Ruskin Company.
   b. Trox USA Inc.

2. Low-leakage rating, with linkage outside airstream, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.
3. Suitable for horizontal or vertical applications.
4. Frames: Hat-shaped, 0.10-inch- (2.5-mm-) 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. Roll-Formed Aluminum Blades: 0.10-inch- (2.5-mm-) thick aluminum sheet.
   d. Extruded-Aluminum Blades: 0.050-inch- (1.2-mm-) thick extruded aluminum.
6. Blade Axles: Stainless steel.
7. Bearings:
   a. Molded synthetic.
   b. Dampers in ducts with pressure classes of 3-inch wg (750 Pa) or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
8. Blade Seals: Neoprene.
9. Jamb Seals: Cambered aluminum.
10. Tie Bars and Brackets: Aluminum.
11. Accessories:
    a. Include locking device to hold single-blade dampers in a fixed position without vibration.

F. Jackshaft:
1. Size: 1-inch (25-mm) 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.

G. Damper Hardware:
1. Zinc-plated, die-cast core with dial and handle made of 3/32-inch- (2.4-mm-) thick zinc-plated steel, and a 3/4-inch (19-mm) hexagon locking nut.
2. Include center hole to suit damper operating-rod size.
3. Include elevated platform for insulated duct mounting.

2.11 CONTROL DAMPERS

H. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Greenheck Fan Corporation.
2. Ruskin Company.

I. Low-leakage rating, with linkage outside airstream, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage. All dampers serving outside air connections/service shall be internal insulated type.

J. Dampers to be the same as duct construction.

K. For internally lined ductwork: Provide 2 internal saddles to protect lining.

L. Frames:
   1. Hat shaped.
   2. Galvanized-steel channels, 0.064 inch (1.62 mm) thick.
   3. Mitered and welded corners.

M. Blades:
   1. Provide airfoil blades.
   2. Multiple blade with maximum blade width of 8 inches (200 mm).
   3. Provide dampers with parallel blades for 2 position control and opposed blades for modulating control.
   4. Parallel- and opposed-blade design.
   5. Galvanized steel.
   6. 0.064 inch (1.62 mm) thick.
   7. Blade Edging: Closed-cell neoprene edging.
   8. Blade Edging: Inflatable seal blade edging, or replaceable rubber seals.

N. Blade Axles: 1/2-inch- (13-mm-) diameter; nonferrous metal; 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 (minus 40 to plus 93 deg C).

O. Bearings:
   1. Molded synthetic.
   2. Dampers in ducts with pressure classes of 3-inch wg (750 Pa) 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.

2.12 FIRE DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Pottorff; a division of PCI Industries, Inc.
   2. Ruskin Company.

B. Type: Dynamic; rated and labeled according to UL 555 by an NRTL.

C. Closing rating in ducts up to 4-inch wg (1-kPa) static pressure class and minimum 4000-fpm (20-m/s) velocity.

D. Fire Rating: 1-1/2 and 3 hours.

E. Frame: Curtain type with blades outside airstream ("Type B"); fabricated with roll-formed, 0.034-inch- (0.85-mm-) thick galvanized steel; with mitered and interlocking corners.

F. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.
   1. Minimum Thickness: 0.052 or 0.138 inch (1.3 or 3.5 mm) 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, 0.034-inch- (0.85-mm-) thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch- (0.85-mm-) thick, galvanized-steel blade connectors.

I. Horizontal Dampers: Include blade lock and stainless-steel closure spring.

J. Heat-Responsive Device: Replaceable, 165 deg F (74 deg C) rated, fusible links.

K. Provide fire dampers as noted on the plans and in ducts and openings in the following:
   1. Floors.
   2. Fire walls.
   3. Fire-resistance partitions.
   4. Fire rated ceilings.
   5. Exit corridor walls.

L. Provide access door in duct adjacent to each fire damper.

2.13 SMOKE DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Ruskin Company.
   2. Pottorff; a division of PCI Industries, Inc.

B. General Requirements: Label according to UL 555S by an NRTL.

C. Frame: Multiple blade type; fabricated with roll-formed, 0.034-inch- (0.85-mm-) thick galvanized steel; with mitered and interlocking corners.

D. Blades: Airfoil type Roll-formed, horizontal, interlocking, 0.034-inch- (0.85-mm-) thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch- (0.85-mm-) thick, galvanized-steel blade connectors.

E. Leakage: Class I.

F. Rated pressure and velocity to exceed design airflow conditions.

G. Mounting Sleeve: Factory-installed, 0.052-inch- (1.3-mm-) thick, galvanized sheet steel; length to suit wall or floor application with factory-furnished silicone calking.

H. Provide motor mount bracket strengthener for dampers over 10" in height.

I. Provide a 10 gauge welded vertical stiffener at each corner to prevent damper misalignment.

J. Damper Motors: Two-position action, unless control sequence requires modulating. Coordinate with ATC contractor.

K. Actuators mounted out of the air stream, with automatic reset.

L. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "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 Division 23 Section "Instrumentation and Control for HVAC."
3. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
4. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf (17 N x m) and breakaway torque rating of 150 in. x lbf (17 N x m).
5. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F (minus 40 deg C).
6. Electrical Connection: 115 V, single phase, 60 Hz.

M. Accessories:
1. Auxiliary switches for position indication.
2. Test and reset switches, remotemounted.

N. The HVAC contractor shall provide all devices, relays, end switches, e/p switches, control components, air piping, power wiring, control wiring and interlock wiring as required to accomplish the sequence of operation for these dampers.

O. Provide access door in duct adjacent to each combination fire / smoke damper.

2.14 COMBINATION FIRE AND SMOKE DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Pottorff; a division of PCI Industries, Inc., model FSD-151, FSD-341, 1-1/2 or 3 hours rated as applicable
2. Ruskin Company.model FSD-60, 1-1/2 or 3 hour rated as applicable

B. Type: Dynamic; rated and labeled according to UL 555 and UL 555S by an NRTL.

C. Closing rating in ducts up to 4-inch wg static pressure class and minimum 4000-fpm (20-m/s) velocity.

D. Fire Rating: 1-1/2 and 3 hours.

E. Frame: multiblade type fabricated with roll-formed, 0.034-inch- (0.85-mm-) thick galvanized steel; with mitered and interlocking corners.

F. Heat-Responsive Device: Replaceable, 165 deg F (74 deg C) rated, fusible links.

G. Blades: 14 gauge galvanized airfoil shaped double skin, single piece construction, maximum 6 inches wide..

H. Leakage: Class I.

I. Rated pressure and velocity to exceed design airflow conditions.

J. Mounting Sleeve: Factory-installed, 0.052-inch- (1.3-mm-) thick, galvanized sheet steel; length to suit wall or floor application with factory-furnished silicone calking.

K. Provide motor mount bracket strengthener for dampers over 10" in height.

L. Provide a 10 gauge welded vertical stiffener at each corner to prevent damper misalignment

M. Master control panel for use in dynamic smoke-management systems.

N. Damper Motors: Two-position action unless control sequence requires modulating. Coordinate with ATC contractor.

O. Actuators mounted out of the air stream,

P. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "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 Division 23 Section "Instrumentation and Control for HVAC."
   3. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
   4. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf (17 N x m) and breakaway torque rating of 150 in. x lbf (17 N x m).
   5. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F (minus 40 deg C).
   6. Electrical Connection: 115 V, single phase, 60 Hz.

Q. Accessories:
   1. Auxiliary switches for position indication.
   2. Test and reset switches, remote mounted.

R. The HVAC contractor shall provide all devices, relays, end switches, e/p switches, control components, air piping, power wiring, control wiring and interlock wiring as required to accomplish the sequence of operation for these dampers.

S. Provide combination fire / smoke dampers as noted on the plans.

T. Provide access door in duct adjacent to each combination fire / smoke damper.

2.15 TURNING VANES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Ductmate Industries, Inc.
   2. Duro Dyne Inc.
   3. METALAIRE, Inc.
   4. SEMCO Incorporated.

B. 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. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; "Vanes and Vane Runners," and "Vane Support in Elbows."

D. Vane Construction: Double wall.

E. The maximum unsupported vane length shall not exceed 48 inches.

F. Single vane and short radius vanes are not acceptable.

2.16 REMOTE DAMPER OPERATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Pottorff; a division of PCI Industries, Inc.
   2. Ventfabrics, Inc.
   3. Young Regulator Company.

B. Description: Cable system designed for remote manual damper adjustment.

C. Tubing: Brass.

D. Cable: Stainless steel.

E. Wall-Box Mounting: Recessed, 3/4 inches (19 mm) deep Surface.

F. Wall-Box Cover-Plate Material: Steel.

2.17 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. Pottorff; a division of PCI Industries, Inc.
   5. Ventfabrics, Inc.

B. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 2-10, "Duct Access Doors and Panels," and 2-11, "Access Panels - 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-inch (25-by-25-mm) butt 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 (300 mm) Square: ~~No hinges and two sash locks.~~**Piano hinge and one sash lock**
      b. Access Doors up to 18 Inches (460 mm) Square: ~~Two hinges and~~ **Piano hinge and** two sash locks.

c. Access Doors up to 24 by 48 Inches (600 by 1200 mm): ~~Three hinges~~ **Piano hinge** and two compression latches with outside and inside handles.

d. Access Doors Larger Than 24 by 48 Inches (600 by 1200 mm): ~~Four hinges~~ **Piano hinge** and two compression latches with outside and inside handles.

C. Furnish and install gasketed grease tight access doors on the grease hood exhaust duct as required under NFPA 96.

2.18 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 3-1/2 inches (89 mm) wide attached to 2 strips of 2-3/4-inch- (70-mm-) wide, 0.028-inch- (0.7-mm-) thick, galvanized sheet steel or 0.032-inch- (0.8-mm-) 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. (880 g/sq. m).
2. Tensile Strength: 480 lbf/inch (84 N/mm) in the warp and 360 lbf/inch (63 N/mm) in the filling.
3. Service Temperature: Minus 40 to plus 200 deg F (Minus 40 to plus 93 deg C).

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. (810 g/sq. m).
2. Tensile Strength: 530 lbf/inch (93 N/mm) in the warp and 440 lbf/inch (77 N/mm) in the filling.
3. Service Temperature: Minus 50 to plus 250 deg F (Minus 45 to plus 121 deg C).

G. High-Temperature System, Flexible Connectors: Glass fabric coated with silicone rubber.
1. Minimum Weight: 16 oz./sq. yd. (542 g/sq. m).
2. Tensile Strength: 285 lbf/inch (50 N/mm) in the warp and 185 lbf/inch (32 N/mm) in the filling.
3. Service Temperature: Minus 67 to plus 500 deg F (Minus 55 to plus 260 deg C).

H. High-Corrosive-Environment System, Flexible Connectors: Glass fabric with chemical-resistant coating.
1. Minimum Weight: 14 oz./sq. yd. (474 g/sq. m).

2. Tensile Strength: 450 lbf/inch (79 N/mm) in the warp and 340 lbf/inch (60 N/mm) in the filling.
3. Service Temperature: Minus 67 to plus 500 deg F (Minus 55 to plus 260 deg C).

I. Thrust Limits: Combination coil spring and elastomeric insert with spring and insert in compression, and with a load stop. Include rod and angle-iron brackets for attaching to fan discharge and duct.
1. Frame: Steel, fabricated for connection to threaded rods and to allow for a maximum of 30 degrees of angular rod misalignment without binding or reducing isolation efficiency.
2. Outdoor Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the 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. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
7. Coil Spring: Factory set and field adjustable for a maximum of 1/4-inch (6-mm) movement at start and stop.

2.19 FLEXIBLE DUCTWORK

A. Manfacturers: Subject to compliance with requirements, provide products by one of the following:
1. Buckley Associates
2. Novaflex

B. Construction
1. Flex duct shall comply with UL 181, Class 1.
2. Flex duct shall be Type 4, with a heavy coated fiberglass cloth fabric liner, mechanically locked without adhesives. Helix shall be corrosive resistant galvanized steel formed and mechanically locked to fabric.
3. For duct systems requiring insulation, the flex duct shall have 1 inch thick fiberglass insulation blanket encapsulated in a fire retardant polyethylene outer jacket with a flame spread less than 25 and smoke developed rating less than 50

~~2.20 FIRE RESISTIVE DUCT AND FAN ENCLOSURES~~

~~A. Approved manufacturers:~~
~~1. Flamebar as supplied by Conquest Firespray LLC. Warren, Michigan or Miramar, Florida~~
~~2. Approved Equal~~

~~B. GENERAL~~

~~1. Ductwork shall be fabricated in accordance to the relevant Fire Resistive Duct manufacturer's construction standards. All details shall be furnished to the contractor for absolute clarity and single source responsibility with the manufacturer of this system. All Fire Resistive Duct shall be Duct B tested to~~

~~fire inside and fire outside in accordance with ISO 6944. ASTM E2816 equivalent shall be Condition C or Condition D (Condition A or Condition B is not acceptable).~~

~~a. All Fire Resistive Ductwork shall be scheduled on the plans for scope:~~

~~1) Smoke Control Pressurization and Exhaust Duct shall be 2-Hour Duct Duct B Fire Rated Duct.~~

~~2. Fan enclosures shall be fire resistive panelized construction providing full access for service and maintenance. Fan replacement shall be feasible without the necessity of destructive disassembly of the fire rated enclosure. Fan enclosures shall provide adequate space and clearance for mounting of required accessories including Variable Frequency Drives, Smoke Control Automation Interfaces and Fire Alarm Interfaces. Fan enclosures shall make provision for fire resistive rated through penetration of all control and power cabling. Fan enclosure shall be ventilated in accordance with fan manufacturer's listing limitations.~~

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 and flat-oval 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 (25 mm), 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 (38 mm).

K. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Division 23 Section "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 "Duct Cleanliness for New Construction Guidelines."

M. Flexible duct runouts to diffusers/registers/grilles shall not exceed six feet in length, fully extended.

N. 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.

O. Install backdraft dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.

P. 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. Provide manual balancing volume dampers as required properly balance the air distribution system. If the location of balancing dampers are not defined on the drawings, the following minimum standards shall govern:
      a. Low Pressure: All supply main air branches from trunk, each split, and all sub branches from main shall be provided with balancing dampers.
      b. Low Pressure: All exhaust main air branches from trunk, each split, and all sub branches from main shall be provided with balancing dampers.
      c. Medium Pressure: All branches and takeoffs downstream of terminal boxes (CV, VAV and FPB) shall be provided with low leakage balancing dampers.
      d. Ducts connecting to common plenums.
      e. Ducts serving single outlet.
      f. At open return duct in hung ceiling.
      g. As noted on plans.
   2. For internally lined ductwork: Provide 2 internal saddles to protect lining.
   3. Install levers to be accessible through the insulation

Q. Set dampers to fully open position before testing, adjusting, and balancing.

R. Install test holes at fan inlets and outlets and elsewhere as indicated.

S. Install, combination fire & smoke fire and smoke dampers according to UL listing.

T. Connect ducts to duct silencers rigidly.

U. 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. Downstream from manual volume dampers, control dampers, turning vanes, and equipment.
   3. 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.
4. At each change in direction and at maximum 50-foot (15-m) spacing.
5. Upstream of turning vanes.
6. Elsewhere as indicated.

V. Install access doors with swing against duct static pressure.

W. 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.

X. Label access doors according to Division 23 Section "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.

Y. Install flexible connectors to connect ducts to equipment.

Z. For fans developing static pressures of 5-inch wg and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.

AA. Connect terminal units to supply ducts directly. Do not use flexible ducts provide flexible connections for all fan powered terminal boxes.

BB. Connect diffusers to flexible ducts with draw bands.

CC. Install duct test holes where required for testing and balancing purposes.

DD. 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 (6-mm) movement during start and stop of fans.

3.2 SEAM AND JOINT SEALING

A. Seal duct seams and joints for duct static-pressure and leakage classes specified in "Performance Requirements" Article, according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Standard Duct Sealing Requirements," unless otherwise indicated..

3.3 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," "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 (100 mm) thick.

4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches (100 mm) thick.
5. Do not use powder-actuated concrete fasteners for seismic restraints.

C. Hanger Spacing: Comply with the requirements of this section, the BUILDING CODE and SMACNA's "HVAC Duct Construction Standards - Metal and Flexible,"Rectangular Duct Hangers Minimum Size," and "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing whichever is more stringent. Install hangers and supports within 24 inches (610 mm) of each elbow and within 48 inches (1200 mm) 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.

G. Hangers, horizontal ducts:
1. To 2 sq ft in area: Provide galvanized steel strap hangers, minimum 1 inch x 1/8 inch, maximum 8 ft - 0 inch spacing.
2. 2 to 4 sq ft in area: Galvanized steel strap hangers, minimum 1 inch x 1/8 inch, maximum 8 ft 0 inch spacing.
3. Strap hangers shall be bent 2 inch under the bottom corner of rectangular ducts. One screw shall secure 2 inch portion of hanger to bottom of duct. Straps shall be secured to side of duct with a minimum of two screws and more, as necessary, to provide a maximum screw spacing of 12 inch. Side-of-duct screws shall be located not more than 2 inch from top and bottom of duct.
4. 4 to 10 sq ft in area: Provide galvanized steel trapeze angles from steel threaded rods with a maximum 6 ft - 0 inch spacing.
5. Over 10 sq ft in area: Provide galvanized steel trapeze angles from steel threaded rods with a maximum 4 ft - 0 inch spacing.
6. Provide stronger support to match larger and heavier ducts; provide cross-bracing, angle iron hangers, as required for rigid and adequate supports.
7. In mechanical rooms: Provide black steel painted or galvanized, vertical angles or rods and horizontal angles across ductwork.
~~8. Kitchen exhaust in accordance with NFPA 96.~~

H. Hangers Vertical ducts: At each floor, provide minimum 2 supports per duct fastened to duct and spanning shaft opening. Fasten supports to floor or structural construction. Maximum screw spacing shall be 12 inch on center and maximum shall be four screw per riser.
1. Angles and channels: Provide painted black steel or galvanized. Where angles are specified, channels of equivalent strength, material and protective coating will be permitted. Where more than one duct is supported by a common set of angles, support size shall be determined by sum of width dimensions.
2. Supports: Provide as follows, except increase supports as required for load and span where span of angles exceed 6 ft or floor-to-floor height exceeds 14 ft.

a. Duct width to 30 inch: Provide angle size: 1-1/4 inch x 1-1/4 inch x 1/8 inch.
b. Duct width, 31 inch to 54 inch: Angle size shall be 2 inch x 2 inch x 3/16 inch.
c. Duct width, 55 inch to 90 inch: Angle size shall be 2 inch x 2 inch x 1/4 inch.

~~3. Vertical kitchen exhaust, fireproofed and plastered ducts: Provide minimum 3 inch, 4.1 lb/ft, steel channels fastened to slab, welded to building structural steel or as acceptable. Supports shall be bolted or welded to ducts and in accordance with NFPA 96.~~

~~3.4 FIRE RESISTIVE DUCTWORK INSTALLATION~~

~~A. Examine areas and conditions under which ductwork is to be installed. Do not proceed with the work until unsatisfactory conditions have been corrected in a manner acceptable to the manufacturer.~~

~~B. The drawings are intended to indicate the sizes of ductwork and if certain sizes are omitted or unclear, obtain additional information before proceeding.~~

~~C. Locate and size all openings for ductwork in the building construction.~~

~~3.5 FIRE RESISTIVE RATED Duct Hangers and Supports~~

~~A. Provide a complete hourly rated fire resistive hanger and support system as per mfr's requirements. This work shall be performed as required by job conditions and as instructed by the Fire Resistive Duct manufacturer's field agent in the field to support all air distribution ductwork and devices in both horizontal and vertical planes. Install in accordance with the relevant manufacturers construction standards and any applicable local codes.~~

~~B. Provide suitable angle iron threaded rods, unistrut and supports inside the mechanical shafts, mechanical rooms and in ceilings of the buildings, and on the roof. This work shall be performed as required by job conditions and exactly per the manufacturer's requirements, the tested assembly requirements, or 48" on center, whichever is more stringent.~~

~~C. When supporting the ductwork, the following shall be complied with:~~
~~1. Ductwork shall be supported in accordance with the manufacturer's requirements and associated fire test data~~
~~2. Ductwork shall be securely attached to the building construction per the manufacturer's requirements.~~
~~3. The maximum hanger spacing shall be 48" on centers, and additionally on each side of an elbow or change-in-direction fitting.~~
~~4. The use of straps or cable type hangers shall not be allowed unless tested, listed and approved for use in supporting a Fire Resistive Duct system.~~

3.6 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." SEI/ASCE 7.

1. Space lateral supports a maximum of 40 feet (12 m) o.c., and longitudinal supports a maximum of 80 feet (24 m) o.c.
2. Brace a change of direction longer than 12 feet (3.7 m).

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 evaluation service member of the ICC Evaluation Service.

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.

3.7 CONNECTIONS

A. Make connections to equipment with flexible connectors.

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.8 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 Division 09 painting Sections.

3.9 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Leakage Tests:
1. Comply with SMACNA's "HVAC Air Duct Leakage Test Manual."

2. All testing shall be done in the presence of the engineer or owner's representative. The contractor is responsible for providing all collars, caps, electric power, etc. necessary to perform the tests. The contractor is also responsible for scheduling the test no less than three (3) business days prior to its intended occurrence. Low pressure ductwork (2" class) shall be tested on an as needed basis at the engineer's direction. Leakage test procedure shall follow the outlines and classifications in the SMACNA HVAC duct leakage test manual. If specimen fails to meet allotted leakage level, the contractor shall modify to bring it into compliance and shall retest it until acceptable leakage is demonstrated. Tests and necessary repair shall be completed prior to concealment of ducts.
3. Test the following systems:
   a. All ductwork greater than 2" class as defined within is to be tested. .
4. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.
5. Test for leaks before insulation application.
6. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test entire system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure. 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.

3.10 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.
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, condensate drain pans, humidifiers, 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.

3.11 DUCT SCHEDULE

A. Fabricate ducts with galvanized sheet steel except as follows:

B. Exposed ductwork:
   1. Where ductwork is indicated to be exposed to view in occupied spaces, provide materials which are free from visual imperfections, including pittings, seam marks, stains, discolorations, and other imperfections. Provide finishes which will allow painting. Provide flat type seams and joints for all exposed duct construction
   2. Watertight Ductwork exposed to weather, except as noted shall be as follows:
      a. Aluminum.
      b. Watertight.
   3. Outside air, exhaust and relief duct shall be as follows:
      a. Aluminum.
      b. Watertight.
      c. Extent:

1) Within 10 ft. of louvers.

4. Ductwork at duct humidifiers shall be as follows:
   a. Aluminum.
   b. Watertight.
   c. Minimum 2 ft. upstream.
   d. Minimum 10 ft downstream.
5. Sub Sterile Exhaust Ductwork, provide as follows:
   a. 316 Stainless Steel.
   b. Welded.
   c. Construction shall be in accordance with SMACNA rectangular industrial duct construction standards.
6. Canopy fume hoods shall be as follows:
   a. ACGIH Industrial Ventilation Manual, unless noted otherwise.
   b. Stainless steel No. 16 USSG.
   c. Internal angles and seams.
   d. Bolts shall be countersunk.
   e. Size, configuration and support shall be as indicated.

C. Liner:
   1. Comply with requirements specified in Division 23 Section 'NOISE CONTROL' .

D. Double-Wall Duct Interstitial Insulation / acoustic lining:
   1. Supply- and Return-Air Ducts, 1 inch thick.

E. Elbow Configuration:
   1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Rectangular Elbows."
      1) Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
      2) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Vanes and Vane Runners," and "Vane Support in Elbows."
      3) Provide splitter vanes on all short radius elbows.
      4) Provide double thickness turning vanes on all square elbows.
   2. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," "Round Duct Elbows."
      a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments, conform to SMACNA.
         1) Velocity 1000 fpm or Lower: 0.6 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.
      b. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.
      c. Round Elbows, 14 Inches and Larger in Diameter: Welded.

F. Branch Configuration:
   1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," "Branch Connections."

a. Rectangular Main to Rectangular Branch: 45-degree entry.
b. Rectangular Main to Round Branch: flanged spin in, conical.
c. Do not use "butt flange" straight taps.
d. Divided flow branches
1) Provide long radius takeoff or square elbow as per SMACNA.

2. Round and Flat Oval: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible,"90 Degree Tees and Laterals," and "Conical Tees."
a. Velocity 1000 fpm or Lower: 90-degree tee fitting.
b. Velocity 1000 to 1500 fpm: Conical fitting.
c. Velocity 1500 fpm or Higher: 45-degree lateral fitting.
d. Saddle taps are NOT permitted.
e. No bull head tees
f. Divided flow branches, conical tees, y- branch or reducing Y-branch or Tee's

G. Obstructions
1. Conform to SMACNA

H. Offsets and transitions
1. Conform to SMACNA

END OF SECTION

SECTION 23 33 00

AIR DUCT ACCESSORIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
1. Backdraft and pressure relief dampers.
2. Barometric relief dampers.
3. Manual volume dampers.
4. Control dampers.
5. Fire dampers.
6. Ceiling dampers.
7. Smoke dampers.
8. Combination fire and smoke dampers.
9. Corridor dampers.
10. Flange connectors.
11. Turning vanes.
12. Remote damper operators.
13. Duct-mounted access doors.
14. Flexible connectors.
15. Duct security bars.
16. Duct accessory hardware.

B. Related Sections:
1. Division 23 Section "HVAC Gravity Ventilators" for roof-mounted ventilator caps.
2. Division 28 Section "Fire Detection and Alarm" for duct-mounted fire and smoke detectors.

1.3 SUBMITTALS

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

C. 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.

D. Source quality-control reports.

E. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

1.4 QUALITY ASSURANCE

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 AMCA 500-D testing for damper rating.

1.5 EXTRA MATERIALS

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

PART 2 - PRODUCTS

2.1 MATERIALS

A. 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: G60.
2. Exposed-Surface Finish: Mill phosphatized.

C. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304, and having a No. 2D finish for concealed ducts and No 4 finish for exposed ducts.

D. 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.

E. Extruded Aluminum: Comply with ASTM B 221, Alloy 6063, Temper T6.

F. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

G. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.2 BACKDRAFT AND PRESSURE RELIEF DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Greenheck Fan Corporation.
   2. Pottorff; a division of PCI Industries, Inc.
   3. Ruskin Company.

B. Description: Gravity balanced.

C. Maximum Air Velocity: 2000 fpm

D. Maximum System Pressure: 2-inch wg

E. Frame: 0.052-inch-thick, galvanized sheet steel with welded corners and mounting flange.

F. Blades: Multiple single-piece blades, center-pivoted, maximum 6-inch width, 0.050-inch-thick aluminum sheet noncombustible, tear-resistant, neoprene-coated fiberglass with sealed edges.

G. Blade Action: Parallel.

H. Blade Seals: Neoprene, mechanically locked.

I. Blade Axles:
   1. Material: Stainless steel
   2. Diameter: 0.20 inch

J. Tie Bars and Brackets: Aluminum

K. Return Spring: Adjustable tension.

L. Bearings: Synthetic pivot bushings.

M. Accessories:
   1. Adjustment device to permit setting for varying differential static pressure.
   2. Counterweights and spring-assist kits for vertical airflow installations.
   3. Electric actuators.
   4. Chain pulls.
   5. Front of rear screens.
   6. 90-degree stops.

N. Sleeve: Minimum 16-gage thickness.

2.3 BAROMETRIC RELIEF DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Greenheck Fan Corporation.
   2. Pottorff; a division of PCI Industries, Inc.

3. Ruskin Company.

B. Suitable for horizontal or vertical mounting.

C. Maximum Air Velocity: 2000 fpm

D. Maximum System Pressure: 2-inch wg

E. Frame: 0.064-inch-thick, galvanized sheet steel with welded corners and mounting flange.

F. Blades:
1. Multiple, 0.050-inch-thick aluminum sheet.
2. Maximum Width: 6 inches.
3. Action: Parallel.
4. Balance: Gravity.
5. Eccentrically pivoted.

G. Blade Seals: Neoprene.

H. Blade Axles: Nonferrous metal.

I. Tie Bars and Brackets:
1. Material: Aluminum
2. Rattle free with 90-degree stop.

J. Return Spring: Adjustable tension.

K. Bearings: Synthetic

L. Accessories:
1. Flange on intake.
2. Adjustment device to permit setting for varying differential static pressures.

2.4 MANUAL VOLUME DAMPERS

A. Dampers to be the same as duct construction.

B. Standard, Steel, Manual Volume Dampers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Pottorff; a division of PCI Industries, Inc.
   b. Ruskin Company.
2. Standard leakage rating, with linkage outside airstream.
3. Suitable for horizontal or vertical applications.
4. Frames:
   a. Hat-shaped, galvanized -steel channels, 0.064-inch minimum thickness.
   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. Provide single blade dampers up to 6 inch width and opposed multtiblade dampers above 6 inches in width.
   c. Parallel- or opposed-blade design.
   d. Stiffen damper blades for stability.
   e. Galvanized -steel, 0.064 inch thick (16 ga.).

6. Blade Axles: Galvanized steel.
7. Bearings:
   a. Molded synthetic.
   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.

C. Standard, Aluminum, Manual Volume Dampers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Pottorff; a division of PCI Industries, Inc.
   b. Ruskin Company.
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. Extruded-Aluminum Blades: 0.050-inch-thick extruded aluminum.
6. Blade Axles: Nonferrous metal.
7. Bearings:
   a. Molded synthetic.
   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.

D. Low-Leakage, Steel, Manual Volume Dampers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Pottorff; a division of PCI Industries, Inc.
   b. Ruskin Company.
2. Low-leakage rating, with linkage outside airstream, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.
3. Suitable for horizontal or vertical applications.
4. Frames:
   a. Hat shaped.
   b. Galvanized -steel channels, 0.064 inch thick.
   c. Mitered and welded corners.
   d. 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, roll-formed steel, 0.064 inch thick. (16 ga.).
6. Blade Axles: Nonferrous metal.
7. Bearings:
   a. Molded synthetic.

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. Blade Seals: Neoprene.
9. Jamb Seals: Cambered aluminum.
10. Tie Bars and Brackets: Galvanized steel.
11. Accessories:
    a. Include locking device to hold single-blade dampers in a fixed position without vibration.

E. Low-Leakage, Aluminum, Manual Volume Dampers:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Ruskin Company.
    b. Trox USA Inc.
2. Low-leakage rating, with linkage outside airstream, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.
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. Extruded-Aluminum Blades: 0.050-inch-thick extruded aluminum.
6. Blade Axles: Stainless steel.
7. Bearings:
    Molded synthetic.
    a. 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. Blade Seals: Neoprene.
9. Jamb Seals: Cambered aluminum.
10. Tie Bars and Brackets: Aluminum.
11. Accessories:
    a. Include locking device to hold single-blade dampers in a fixed position without vibration.

F. Jackshaft:
1. Size: 1-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.

G. 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.

2.5 CONTROL DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Greenheck Fan Corporation.
   2. 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. Dampers to be the same as duct construction.

D. For internally lined ductwork: Provide 2 internal saddles to protect lining.

E. Frames:
   1. Hat shaped.
   2. Galvanized -steel channels, 0.064 inch thick.
   3. Mitered and welded corners.

F. Blades:
   1. Provide airfoil blades.
   2. Multiple blade with maximum blade width of 8 inches.
   3. Provide dampers with parallel blades for 2 position control and opposed blades for modulating control.
   4. Parallel- and opposed blade design.
   5. Galvanized steel.
   6. 0.064 inch thick.
   7. Blade Edging: Closed-cell neoprene edging.

G. Blade Axles: 1/2-inch-diameter; nonferrous metal; 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.

H. Bearings:
   1. Molded synthetic.
   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.

2.6 FIRE DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Pottorff; a division of PCI Industries, Inc.
   2. Ruskin Company.

B. Type: Dynamic; 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 4000-fpm velocity.

D. Dampers shall contain a NYC MEA# and be approved for use in NYC.

E. Fire Rating: 1-1/2 hours.

F. Frame: Curtain type with blades outside airstream (“Type B”); fabricated with roll-formed, 0.034-inch-thick galvanized steel; with mitered and interlocking corners.

G. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.
   1. Minimum Thickness: 0.052 or 0.138 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.

H. Mounting Orientation: Vertical or horizontal as indicated.

I. Blades: Roll-formed, interlocking, 0.034-inch-thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch-thick, galvanized-steel blade connectors.

J. Horizontal Dampers: Include blade lock and stainless-steel closure spring.

K. Heat-Responsive Device: Replaceable, 165 deg F rated, fusible links.

L. Heat-Responsive Device: Electric resettable link and switch package, factory installed, 165 deg F rated.

M. The HVAC contractor shall provide all devices, relays, end switches, e/p switches, control components, air piping, power wiring, control wiring and interlock wiring as required to accomplish the sequence of operation for these dampers.

N. Provide fire dampers as noted on the plans and in ducts and openings in the following:
   1. Shafts.
   2. Floors.
   3. Fire walls.
   4. Fire-resistance partitions.
   5. Fire rated ceilings.
   6. Exit corridor walls.

O. Provide access door in duct adjacent to each fire damper.

2.7 CEILING DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Ruskin Company.
   2. Pottorff; a division of PCI Industries, Inc.

B. General Requirements:
   1. Labeled according to UL 555C by an NRTL.
   2. Comply with construction details for tested floor- and roof-ceiling assemblies as indicated in UL's "Fire Resistance Directory."

C. Frame: Galvanized sheet steel, round or rectangular, style to suit ceiling construction.

D. Blades: Galvanized sheet steel with refractory insulation.

E. Heat-Responsive Device: Replaceable, 165 deg F rated, fusible links.

F. Fire Rating: 2 hours.

2.8 SMOKE DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Ruskin Company.
   2. Pottorff; a division of PCI Industries, Inc.

B. General Requirements: Label according to UL 555S by an NRTL.

C. Frame: Multiple blade type; fabricated with roll-formed, 0.034-inch-thick galvanized steel; with mitered and interlocking corners.

D. Blades: Airfoil type Roll-formed, horizontal, interlocking, 0.034-inch-thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch-thick, galvanized-steel blade connectors.

E. Leakage: Class I .

F. Rated pressure and velocity to exceed design airflow conditions.

G. Mounting Sleeve: Factory-installed, 0.052-inch-thick, galvanized sheet steel; length to suit wall or floor application with factory-furnished silicone calking.

H. Provide motor mount bracket strengthener for dampers over 10" in height.

I. Provide a 10 gauge welded vertical stiffener at each corner to prevent damper misalignment.

J. Damper Motors: Modulating or two-position action.

K. Actuators mounted out of the air stream, 120 volt by Belimo

L. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "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 Division 23 Section "Instrumentation and Control for HVAC."
   3. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
   4. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf and breakaway torque rating of 150 in. x lbf.
   5. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F.
   6. Electrical Connection: 115 V, single phase, 60 Hz.

M. Accessories:
   1. (2) Auxiliary switches for position indication, one for HVAC and one for Fire alarm.
   2. Test and reset switches, remote mounted.

N. The HVAC contractor shall provide all devices, relays, end switches, e/p switches, control components, air piping, power wiring, control wiring and interlock wiring as required to accomplish the sequence of operation for these dampers.

O. Provide access door in duct adjacent to each combination fire / smoke damper.

2.9 COMBINATION FIRE AND SMOKE DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Pottorff; a division of PCI Industries, Inc., model FSD-151, FSD-341, 1-1/2 or 3 hours rated as applicable
   2. Ruskin Company.model FSD-60, 1-1/2 or 3 hour rated as applicable

B. Type: Dynamic; rated and labeled according to UL 555 and UL 555S by an NRTL.

C. Closing rating in ducts up to [4-inch wg static pressure class and minimum 4000-fpm velocity.

D. Fire Rating: 1-1/2 hours.

E. Frame: multiblade type fabricated with roll-formed, 0.034-inch-thick galvanized steel; with mitered and interlocking corners.

F. Heat-Responsive Device: Replaceable, 165 deg F rated, fusible links.

G. Heat-Responsive Device: Electric resettable link and switch package, factory installed, rated. Provide dual temperature heat responsive device.

H. Blades: 14 gauge galvanized airfoil shaped double skin, single piece construction, maximum 6 inches wide..

I. Leakage: Class I .

J. Rated pressure and velocity to exceed design airflow conditions.

K. Mounting Sleeve: Factory-installed, 0.052-inch-thick, galvanized sheet steel; length to suit wall or floor application with factory-furnished silicone calking.

L. Provide motor mount bracket strengthener for dampers over 10" in height.

M. Provide a 10 gauge welded vertical stiffener at each corner to prevent damper misalignment

N. Master control panel for use in dynamic smoke-management systems.

O. Damper Motors: Modulating or two-position action, 120 volt by Belimo

P. Actuators mounted out of the air stream,

Q. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "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 Division 23 Section "Instrumentation and Control for HVAC."

3. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.
4. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf and breakaway torque rating of 150 in. x lbf.
5. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F.
6. Electrical Connection: 115 V, single phase, 60 Hz.

R. Accessories:
1. (2) Auxiliary switches for position indication, one for HVAC and one for Fire alarm. Multiple damper sections that are part of the same damper can be wired in series as one large damper indictor.
2. Test and reset switches, remote mounted.

S. The HVAC contractor shall provide all devices, relays, end switches, e/p switches, control components, air piping, power wiring, control wiring and interlock wiring as required to accomplish the sequence of operation for these dampers.

T. Provide combination fire / smoke dampers as noted on the plans and in ducts and openings in the following:
1. Shafts.
2. Floors.
3. Fire walls.
4. Fire-resistance partitions.
5. Fire rated ceilings.
6. Exit corridor walls.

U. Provide access door in duct adjacent to each combination fire / smoke damper.

2.10 TURNING VANES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Ductmate Industries, Inc.
2. Duro Dyne Inc.
3. METALAIRE, Inc.
4. SEMCO Incorporated.

B. 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. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; "Vanes and Vane Runners," and "Vane Support in Elbows."

D. Vane Construction: Double wall.

E. The maximum unsupported vane length shall not exceed 48 inches.

F. Single vane and short radius vanes are not acceptable.

2.11 REMOTE DAMPER OPERATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Pottorff; a division of PCI Industries, Inc.
   2. Ventfabrics, Inc.
   3. Young Regulator Company.

B. Description: Cable system designed for remote manual damper adjustment.

C. Tubing: Brass.

D. Cable: Stainless steel.

E. Wall-Box Mounting: Recessed, 3/4 inches deep

F. Wall-Box Cover-Plate Material: Stainless steel.

2.12 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. Pottorff; a division of PCI Industries, Inc.
   5. Ventfabrics, Inc.

B. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 2-10, "Duct Access Doors and Panels," and 2-11, "Access Panels - 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-inch butt 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: Two hinges and two sash locks.
      c. Access Doors up to 24 by 48 Inches: Three hinges and two compression latches with outside handles
      d. Access Doors Larger Than 24 by 48 Inches: Four hinges and two compression latches with outside and inside handles.

C. Pressure Relief Access Door:
   1. Door and Frame Material: Galvanized sheet steel.
   2. Door: Double wall with insulation fill with metal thickness applicable for duct pressure class.

3. Operation: Open outward for positive-pressure ducts and inward for negative-pressure ducts.
4. Factory set at 10-inch wg
5. Doors close when pressures are within set-point range.
6. Hinge: Continuous piano.
7. Latches: Cam.
8. Seal: Neoprene or foam rubber.
9. Insulation Fill: 1-inch-thick, fibrous-glass or polystyrene-foam board.

2.13 DUCT ACCESS PANEL ASSEMBLIES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following
   1. Ductmate Industries, Inc.
   2. Flame Gard, Inc.
   3. 3M.

B. Labeled according to UL 1978 by an NRTL.

C. Panel and Frame: Minimum thickness 0.0428-inch stainless steel.

D. Fasteners: Stainless steel. Panel fasteners shall not penetrate duct wall.

E. Gasket: Comply with NFPA 96; grease-tight, high-temperature ceramic fiber, rated for minimum 2000 deg F.

F. Minimum Pressure Rating: 10-inch wg, positive or negative.

2.14 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 3-1/2 incheswide attached to 2 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.

G. High-Temperature System, Flexible Connectors: Glass fabric coated with silicone rubber.
   1. Minimum Weight: 16 oz./sq. yd..
   2. Tensile Strength: 285 lbf/inch in the warp and 185 lbf/inch in the filling.
   3. Service Temperature: Minus 67 to plus 500 deg F.

H. High-Corrosive-Environment System, Flexible Connectors: Glass fabric with chemical-resistant coating.
   1. Minimum Weight: 14 oz./sq. yd..
   2. Tensile Strength: 450 lbf/inch in the warp and 340 lbf/inch in the filling.
   3. Service Temperature: Minus 67 to plus 500 deg F.

I. Thrust Limits: Combination coil spring and elastomeric insert with spring and insert in compression, and with a load stop. Include rod and angle-iron brackets for attaching to fan discharge and duct.
   1. Frame: Steel, fabricated for connection to threaded rods and to allow for a maximum of 30 degrees of angular rod misalignment without binding or reducing isolation efficiency.
   2. Outdoor Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
   3. Minimum Additional Travel: 50 percent of the 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. Elastomeric Element: Molded, oil-resistant rubber or neoprene.
   7. Coil Spring: Factory set and field adjustable for a maximum of 1/4-inch movement at start and stop.

2.15 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

3.1 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 backdraft 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. Coordinate subparagraphs below with Division 23 Section "Metal Ducts."Install steel volume dampers in steel ducts.
   2. Install aluminum volume dampers in aluminum ducts.
   3. Provide manual balancing volume dampers as required properly balance the air distribution system. If the location of balancing dampers are not defined on the drawings, the following minimum standards shall govern:
      a. Low Pressure: All supply main air branches from trunk, each split, and all sub branches from main shall be provided with balancing dampers.
      b. Low Pressure: All exhaust main air branches from trunk, each split, and all sub branches from main shall be provided with balancing dampers.
      c. Medium Pressure: All branches and takeoffs downstream of terminal boxes (CV, VAV and FPB) shall be provided with balancing dampers.
      d. Ducts connecting to common plenums.
      e. Ducts serving single outlet.
      f. At open return duct in hung ceiling.
      g. As noted on plans.
   4. For internally lined ductwork: Provide 2 internal saddles to protect lining.
   5. Install levers to be accessible through the insulation and mark with a 12 inch orange ribbon.

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, combination fire & smoke fire and smoke dampers according to UL listing.

H. Install duct security bars. Construct duct security bars from 0.164-inch steel sleeve, continuously welded at all joints and 1/2-inch-diameter steel bars, 6 inches o.c. in each direction in center of sleeve. Weld each bar to steel sleeve and each crossing bar. Weld 2-1/2-by-2-1/2-by-1/4-inch steel angle to 4 sides and both ends of sleeve. Connect duct security bars to ducts with flexible connections. Provide 12-by-12-inch hinged access panel with cam lock in duct in each side of sleeve.

I. Connect ducts to duct silencers rigidly.

J. 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. Downstream from manual volume dampers, control dampers, turning vanes, and equipment.
   3. 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.
   4. At each change in direction and at maximum 50-foot spacing.
   5. Upstream of turning vanes.
   6. Elsewhere as indicated.

K. Install access doors with swing against duct static pressure.

L. 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.

M. Label access doors according to Division 23 Section "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.

N. Install flexible connectors to connect ducts to equipment.

O. For fans developing static pressures of 5-inch wgand more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.

P. Connect terminal units to supply ducts directly. Do not use flexible ducts.rovide flexible connections for all fan powered terminal boxes.

Q. Connect diffusers to low-pressure ducts directly.

R. Install duct test holes where required for testing and balancing purposes.

S. 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.

3.2 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

SECTION 23 34 16

CENTRIFUGAL HVAC FANS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Section 01 81 13 “Sustainable Design Requirements – LEED v4 for Building Design & Construction – New Construction” for sustainable design requirements and detailed sustainable design submittal requirements.

C. Section 01 74 19 “Construction and Demolition Waste Management and Disposal” for disposal of construction, demolition and packaging waste disposal requirements.

1.2 SUMMARY

A. This Section includes the following:
1. Airfoil centrifugal fans.
2. Backward-inclined centrifugal fans.
3. Laboratory exhaust fans

B. Sustainable Building Requirements:
1. The Owner requires the Contractor to implement practices and procedures to meet the project’s environmental performance goals, which include achieving LEED version 4 Certified level Certification. Specific project goals that may impact this area of work include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; construction waste recycling; and the implementation of a construction indoor air quality management plan. The Contractor shall ensure that the requirements related to these goals, as defined in the Articles below, are implemented to the fullest extent. Substitutions, or other changes to the work proposed by the Contractor or their Subcontractors, shall not be allowed if such changes compromise the aforementioned environmental goals and LEED certification.

1.3 PERFORMANCE REQUIREMENTS

A. Project Altitude: Base fan performance ratings on sea level.

B. Operating Limits: Classify according to AMCA 99.

1.4 SUBMITTALS

A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated and include the following:
1. Certified fan performance curves with system operating conditions indicated.

2. Submit the family of rpm curves indicating operating point relative to fan class.
3. Drive construction and rating.
4. Catalog cuts and dimension drawings.
5. Submit all selected sheave (fan and motor) calculations.
6. Correction chart for fans equipped with variable inlet vanes indicating performance at various percentage of opening.
7. VFD application: Submit fan selection with system curve indication, operating point, family of all rpm curves in fan class and the "DO NOT SELECT TO THE LEFT OF THIS CURVE". The minimum rpm shall be indicated.
8. Certified fan sound-power ratings.
9. Motor ratings and electrical characteristics, plus motor and electrical accessories.
10. Material thickness and finishes, including color charts.
11. Dampers, including housings, linkages, and operators.
12. Roof curbs

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
1. Wiring Diagrams: Power, signal, and control wiring.
2. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
3. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, and base weights.

C. Coordination Drawings: Show fan room layout and relationships between components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate and certify field measurements.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For centrifugal fans to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. AMCA Compliance: Products shall comply with performance requirements and shall be licensed to use the AMCA-Certified Ratings Seal.
1. Test and rate all fans in accordance with the standards of AMCA. All fans shall bear the AMCA rating and seal.

C. NEMA Compliance: Motors and electrical accessories shall comply with NEMA 1.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver fans as factory-assembled units, to the extent allowable by shipping limitations, with protective crating and covering.

B. Disassemble and reassemble units, as required for moving to the final location, according to manufacturer's written instructions.

C. Lift and support units with manufacturer's designated lifting or supporting points.

1.7 COORDINATION

A. Coordinate size and location of structural-steel support members.

B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

C. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

PART 2 - PRODUCTS

2.1 GENERAL

A. Make appropriate allowances for the effects on fan performance of all installation conditions including plenum enclosures and inlet and discharge arrangements so that actual installed fan performance equals that specified.

B. Fans shall be non-overloading and operate stably without surging at design conditions.

C. Fan characteristic curves provided by manufacturer must be such that that the fan operating point:
   1. Is to the right of peak efficiency.
   2. Is on the steep part of the fan curve such that an increase in static pressure over the specified duty results in not more than the same percent decrease in volume (CFM) and does not affect the stability of fan operation.
   3. Is no greater than 60 to 70 percent of the peak static pressure.
   4. Has the ability to provide an allowable increase in fan speed of 15 percent above the design point without surging or increasing the class of fan.

D. Provide non-overloading design, except as noted with minimum capacities as noted and with certified ratings by AMCA.

E. Wheel shall be factory balanced statically and dynamically. Brake horsepower ratings shall be 5 percent maximum above those noted and published for a minimum of two (2) years.

F. Fans shall be direct drive with motors provided with sealed bearings.

G. Provide removable flanged screens at inlets or outlets where no connecting ductwork is indicated, including inlets to fans in field erected casings.

H. Split construction: Provide split construction for fans too large for available doorways or passageways. Split in half along center of shaft with angles, etc., to allow removal of section without disturbing inlet and discharge connection; arranged for bolting. Provide bolts with lockwashers and nuts. Construction shall be inspected by manufacturer after field assembly and certified that they have been properly assembled and ready for proper operation.

I. The drive end of the fan shaft shall be countersunk for tachometer readings.

J. For all fans located outdoors, except roof ventilators exposed to the weather, provide custom fitted weather guards completely enclosing the fan motor, drive and bearings. Provide weatherproof louvers in the enclosure to permit circulation of air but to exclude rain and snow. Arrange one side of the enclosure to be completely removable for access to motors, drives, bearings and other equipment located within requiring maintenance. Construct the enclosure of 16 gauge aluminum, braced with aluminum angles. Paint the fan exterior with two coats of weatherproof aluminum paint.

2.2 AIRFOIL CENTRIFUGAL FANS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Greenheck
   2. Loren Cook Company.

B. Description: Factory-fabricated, -assembled, -tested, and -finished, belt-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, and support structure.
   1. The fan shall be of welded construction utilizing corrosion resistant fasteners. The scroll wrapper and scroll side panels shall be minimum 12 gauge steel (minimum 8 gauge steel for Class III).

C. Housings: Formed panels to make curved-scroll housings with shaped cutoff, with doors or panels to allow access to internal parts and components.
   1. The entire fan housing shall have continuously welded seams for leak proof operation and shall have a minimum 1-1/2 inch outlet discharge flange. A performance cut-off shall be furnished to prevent the recirculation of air in the fan housing. Bearing support shall be minimum 1/4 inch steel. Lifting lugs shall be provided for ease of installation. Unit shall bear an engraved aluminum nameplate and shall be shipped in ISTA certified transit tested packaging.
   2. Panel Bracing: Steel angle- or channel-iron member supports for mounting and supporting fan scroll, wheel, motor, and accessories.
   3. Spun inlet cone with flange.
   4. Outlet flange.

D. Airfoil Wheels: Single-width-single-inlet and double-width-double-inlet construction with curved inlet flange; heavy backplate; hollow die-formed, airfoil-shaped blades continuously welded at tip flange and backplate; and cast-iron or cast-steel hub riveted to backplate and fastened to shaft with set screws.

E. Shafts: Statically and dynamically balanced and selected for continuous operation at maximum rated fan speed and motor horsepower, with final alignment made after installation.
   1. Turned, ground, and polished hot-rolled steel with keyway. Ship with protective coating of lubricating oil.
   2. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.

F. Accessories:
   1. Scroll Access Doors: Shaped to conform to scroll, with quick-opening latches and gaskets.
   2. Cleanout Door: Quick-opening, latch-type gasketed door allowing access to fan scroll, of same material as housing.

3. Scroll Drain Connection: NPS 1 (DN 25) steel pipe coupling welded to low point of fan scroll.
4. Companion Flanges: Rolled flanges for duct connections of same material as housing.
5. Discharge Dampers: Assembly with opposed blades constructed of two plates formed around and to shaft, channel frame, and sealed ball bearings; with blades linked outside of airstream to single control lever of same material as housing.
6. Inlet Screens: Grid screen of same material as housing.
7. Shaft Seals: Airtight seals installed around shaft on drive side of single-width fans.
8. Weather Cover: Enameled-steel sheet with ventilation slots, bolted to housing.

G. Motors: Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
1. Enclosure Type: Totally enclosed, fan cooled.

2.3 BACKWARD-INCLINED CENTRIFUGAL FANS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Loren Cook Company.
2. Greenheck

B. Description: Factory-fabricated, -assembled, -tested, and -finished, direct-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, and support structure.

C. Housings: Formed panels to make curved-scroll housings with shaped cutoff; with doors or panels to allow access to internal parts and components.
1. Panel Bracing: Steel angle- or channel-iron member supports for mounting and supporting fan scroll, wheel, motor, and accessories.
2. Spun inlet cone with flange.
3. Outlet flange.

D. Backward-Inclined Wheels: Single-width-single-inlet and double-width-double-inlet construction with curved inlet flange, backplate, backward-inclined blades welded or riveted to flange and backplate; cast-iron or cast-steel hub riveted to backplate and fastened to shaft with set screws.

E. Shafts: Statically and dynamically balanced and selected for continuous operation at maximum rated fan speed and motor horsepower, with final alignment made after installation.
1. Turned, ground, and polished hot-rolled steel with keyway. Ship with a protective coating of lubricating oil.
2. Designed to operate at no more than 70 percent of first critical speed at top of fan's speed range.

F. Accessories:
1. Scroll Access Doors: Shaped to conform to scroll, with quick-opening latches and gaskets.
2. Cleanout Door: Quick-opening, latch-type gasketed door allowing access to fan scroll, of same material as housing.

3. Scroll Drain Connection: NPS 1 (DN 25) steel pipe coupling welded to low point of fan scroll.
4. Companion Flanges: Rolled flanges for duct connections of same material as housing.
5. Discharge Dampers: Assembly with opposed blades constructed of two plates formed around and to shaft, channel frame, and sealed ball bearings; with blades linked outside of airstream to single control lever of same material as housing.
6. Inlet Screens: Grid screen of same material as housing.
7. Shaft Seals: Airtight seals installed around shaft on drive side of single-width fans.
8. Weather Cover: Enameled-steel sheet with ventilation slots, bolted to housing

G. Motors: Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
1. Enclosure Type: Totally enclosed, fan cooled.

2.4 SOURCE QUALITY CONTROL

A. Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.

B. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210, "Laboratory Methods of Testing Fans for Rating."

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install centrifugal fans level and plumb.

B. Support floor-mounting units using spring isolators having a static deflection of 1 inch (25 mm). Vibration- and seismic-control devices are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."
1. Secure vibration and seismic controls to concrete bases using anchor bolts cast in concrete base.

C. Install floor-mounting units on concrete bases. Concrete, reinforcement, and formwork requirements are specified in Division 03 Section "Cast-in-Place Concrete."

D. Install floor-mounting units on concrete bases designed to withstand, without damage to equipment, the seismic force required by authorities having jurisdiction. Concrete, reinforcement, and formwork requirements are specified in Division 03 Section "Cast-in-Place Concrete."

E. Support suspended units from structure using threaded steel rods and spring hangers having a static deflection of 1 inch (25 mm). Vibration-control devices are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

F. Install units with clearances for service and maintenance.

G. Label fans according to requirements specified in Division 23 Section "Identification for HVAC Piping and Equipment."

3.2 CONNECTIONS

A. Duct installation and connection requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Division 23 Section "Air Duct Accessories."

B. Install ducts adjacent to fans to allow service and maintenance.

C. Install line-sized piping from scroll drain connection, with trap with seal equal to 1.5 times specified static pressure, to nearest floor drain.

D. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

E. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.3 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:
   1. Verify that shipping, blocking, and bracing are removed.
   2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
   3. Verify that cleaning and adjusting are complete.
   4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system and align
   5. Adjust damper linkages for proper damper operation.
   6. Verify lubrication for bearings and other moving parts.
   7. Balance all fan wheels and all other moving components statically and dynamically. Where a coating is specified and it affects the balance of the fan wheel, perform the balancing after the coating has been applied.
   8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
   9. Refer to Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing procedures.
   10. Disable automatic temperature-control operators, energize motor and confirm proper motor rotation and unit operation, adjust fan to indicated rpm, and measure and record motor voltage and amperage.
   11. For units with variable frequency drives lock out critical frequencies before initial start.
   12. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   13. Replace fan and motor pulleys as required to achieve design airflow.
   14. Shut unit down and reconnect automatic temperature-control operators.
   15. Remove and replace malfunctioning units and retest as specified above.

B. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.4 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Lubricate bearings

C. Refer to Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing procedures.

D. Replace fan and motor pulleys as required to achieve design airflow.

3.5 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain centrifugal fans. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION

SECTION 23 34 23

HVAC POWER VENTILATORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Section 01 81 13 "Sustainable Design Requirements – LEED v4 for Building Design & Construction – New Construction" for sustainable design requirements and detailed sustainable design submittal requirements.

C. Section 01 74 19 "Construction and Demolition Waste Management and Disposal" for disposal of construction, demolition and packaging waste disposal requirements

1.2 SUMMARY

A. This Section includes the following:
1. Utility set fans.
2. Centrifugal roof ventilators.
3. Ceiling-mounting ventilators.
4. In-line centrifugal fans.
5. Propeller fans.

B. Sustainable Building Requirements:
1. The Owner requires the Contractor to implement practices and procedures to meet the project's environmental performance goals, which include achieving LEED version 4 Certified level Certification. Specific project goals that may impact this area of work include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; construction waste recycling; and the implementation of a construction indoor air quality management plan. The Contractor shall ensure that the requirements related to these goals, as defined in the Articles below, are implemented to the fullest extent. Substitutions, or other changes to the work proposed by the Contractor or their Subcontractors, shall not be allowed if such changes compromise the aforementioned environmental goals and LEED certification.

1.3 PERFORMANCE REQUIREMENTS

A. Project Altitude: Base fan-performance ratings on sea level.

B. Operating Limits: Classify according to AMCA 99.

1.4 SUBMITTALS

A. Product Data: Include rated capacities, furnished specialties, and accessories for each type of product indicated and include the following:
   1. Certified fan performance curves with system operating conditions indicated.
   2. Submit the family of rpm curves indicating operating point relative to fan class.
   3. Drive construction and rating.
   4. Catalog cuts and dimension drawings.
   5. Submit all selected sheave (fan and motor) calculations.
   6. Correction chart for fans equipped with variable inlet vanes indicating performance at various percentage of opening.
   7. VFD application: Submit fan selection with system curve indication, operating point, family of all rpm curves in fan class and the "DO NOT SELECT TO THE LEFT OF THIS CURVE". The minimum rpm shall be indicated.
   8. Certified fan sound-power ratings.
   9. Motor ratings and electrical characteristics, plus motor and electrical accessories.
   10. Material thickness and finishes, including color charts.
   11. Dampers, including housings, linkages, and operators.
   12. Roof curbs.
   13. Fan speed controllers.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   1. Wiring Diagrams: Power, signal, and control wiring.
   2. Design Calculations: Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
   3. Vibration Isolation Base Details: Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, and base weights.

C. Coordination Drawings: Reflected ceiling plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
   1. Roof framing and support members relative to duct penetrations.
   2. Ceiling suspension assembly members.
   3. Size and location of initial access modules for acoustical tile.
   4. Ceiling-mounted items including light fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For power ventilators to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. AMCA Compliance: Products shall comply with performance requirements and shall be licensed to use the AMCA-Certified Ratings Seal.
   1. Test and rate all fans in accordance with the standards of AMCA. All fans shall bear the AMCA rating and seal.

C. NEMA Compliance: Motors and electrical accessories shall comply with NEMA standards.

D. UL Standard: Power ventilators shall comply with UL 705.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver fans as factory-assembled unit, to the extent allowable by shipping limitations, with protective crating and covering.

B. Disassemble and reassemble units, as required for moving to final location, according to manufacturer's written instructions.

C. Lift and support units with manufacturer's designated lifting or supporting points.

1.7 COORDINATION

A. Coordinate size and location of structural-steel support members.

B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

C. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

PART 2 - PRODUCTS

2.1 GENERAL

A. Make appropriate allowances for the effects on fan performance of all installation conditions including plenum enclosures and inlet and discharge arrangements so that actual installed fan performance equals that specified.

B. Fans shall be non-overloading and operate stably without surging at design conditions.

C. Fan characteristic curves provided by manufacturer must be such that that the fan operating point:
   1. Is to the right of peak efficiency.
   2. Is on the steep part of the fan curve such that an increase in static pressure over the specified duty results in not more than the same percent decrease in volume (CFM) and does not affect the stability of fan operation.
   3. Is no greater than 60 to 70 percent of the peak static pressure.
   4. Has the ability to provide an allowable increase in fan speed of 15 percent above the design point without surging or increasing the class of fan.

D. Provide non-overloading design, except as noted with minimum capacities as noted and with certified ratings by AMCA. Where variable inlet vanes are used, complete assembly shall be factory installed by the fan manufacturer. The fan horsepower

performance characteristics shall be within 5 percent of published catalog rating data of the standard fan.

E. Wheel shall be factory balanced statically and dynamically. Brake horsepower ratings shall be 5 percent maximum above those noted and published for a minimum of two (2) years.

F. Fans shall be direct drive with motors provided with sealed bearings.

G. Provide removable flanged screens at inlets or outlets where no connecting ductwork is indicated, including inlets to fans in field erected casings.

H. The drive end of the fan shaft shall be countersunk for tachometer readings.

I. For all fans located outdoors, except roof ventilators exposed to the weather, provide custom fitted weather guards completely enclosing the fan motor, drive and bearings. Provide weatherproof louvers in the enclosure to permit circulation of air but to exclude rain and snow. Arrange one side of the enclosure to be completely removable for access to motors, drives, bearings and other equipment located within requiring maintenance. Construct the enclosure of 16 gauge aluminum, braced with aluminum angles. Paint the fan exterior with two coats of weatherproof aluminum paint.

2.2 UTILITY SET FANS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Loren Cook Company.
   2. Greenheck

B. Description: Direct-driven centrifugal fans consisting of housing, wheel, fan shaft, , motor and disconnect switch, drive assembly, and accessories.
   1. The fan shall be of welded construction utilizing corrosion resistant fasteners. The scroll wrapper and scroll side panels shall be minimum 12 gauge steel (minimum 8 gauge steel for Class III).

C. Housing: Fabricated of galvanized steel with side sheets fastened with a deep lock seam or welded to scroll sheets.
   1. The entire fan housing shall have continuously welded seams for leak proof operation and shall have a minimum 1-1/2 inch outlet discharge flange. A performance cut-off shall be furnished to prevent the recirculation of air in the fan housing. Bearing support shall be minimum 1/4 inch steel. Lifting lugs shall be provided for ease of installation. Unit shall bear an engraved aluminum nameplate and shall be shipped in ISTA certified transit tested packaging.
   2. Housing Discharge Arrangement: Adjustable to eight standard positions.

D. Fan Wheels: Single-width, single inlet; welded to cast-iron or cast-steel hub and spun-steel inlet cone, with hub keyed to shaft.
   1. Blade Materials: Steel.
   2. Blade Type: Backward inclined or Airfoil per the schedule.

E. Fan Shaft: Turned, ground, and polished steel; keyed to wheel hub.

F. Direct Drive with motor provided with sealed bearings.

G. Accessories:

1. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted inside fan housing, factory wired through an internal aluminum conduit. Provide NEMA 3R enclosure on all units mounted outside of fan enclosure.
2. Inlet and Outlet: Flanged.
3. Companion Flanges: Rolled flanges for duct connections of same material as housing.
4. Backdraft Dampers: Gravity actuated with counterweight and interlocking aluminum blades with felt edges in steel frame installed on fan discharge.
5. Access Door: Gasketed door in scroll with latch-type handles.
6. Scroll Dampers: Single-blade damper installed at fan scroll top with adjustable linkage.
7. Inlet Screens: Removable wire mesh.
8. Drain Connections: NPS 3/4 (DN 20) threaded coupling drain connection installed at lowest point of housing.
9. Weather Hoods: Weather resistant with stamped vents over motor and drive compartment.
10. Discharge Dampers: Assembly with opposed blades constructed of two plates formed around and to shaft, channel frame, sealed ball bearings, with blades linked outside of airstream to single control lever of same material as housing.

H. Coatings: Powder-baked enamel.

2.3 CENTRIFUGAL ROOF VENTILATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Greenheck.
2. Loren Cook Company.

B. Description: Direct-driven centrifugal fans consisting of housing, wheel, fan shaft, bearings, motor and disconnect switch, drive assembly, curb base, and accessories.

C. Housing: Removable, spun-aluminum, dome top and outlet baffle; square, one-piece, aluminum base with venturi inlet cone.
1. Upblast Units: Provide spun-aluminum discharge baffle to direct discharge air upward, with rain and snow drains.
2. Hinged Subbase: Galvanized-steel hinged arrangement permitting service and maintenance.

D. Fan Wheels: Aluminum hub and wheel with backward-inclined blades.

E. Direct-Driven Drive Assembly with motors provided with sealed bearings.

F. Accessories:
1. Disconnect Switch: Nonfusible type, with thermal-overload protection mounted outside fan housing, factory wired through an internal aluminum conduit.
2. Bird Screens: Removable, 1/2-inch (13-mm) mesh, aluminum or brass wire.
3. Motorized Dampers: Parallel-blade dampers mounted in curb base with electric actuator; wired to close when fan stops.

G. Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2-inch- (40-mm-) thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch (40-mm) wood nailer. Size as required to suit roof opening and fan base.
   1. Configuration: Self-flashing without a cant strip, with mounting flange.
   2. Overall Height: 12 inches (300 mm).
   3. Pitch Mounting: Manufacture curb for roof slope.
   4. Metal Liner: Galvanized steel.
   5. Mounting Pedestal: Galvanized steel with removable access panel.

2.4 CEILING-MOUNTING VENTILATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Greenheck.
   2. Loren Cook Company.

B. Description: Centrifugal fans designed for installing in ceiling or wall or for concealed in-line applications.

C. Housing: Steel, lined with acoustical insulation.

D. Fan Wheel: Centrifugal wheels directly mounted on motor shaft. Fan shrouds, motor, and fan wheel shall be removable for service.

E. Grille: Painted aluminum, louvered grille with flange on intake and thumbscrew attachment to fan housing.

F. Electrical Requirements: Junction box for electrical connection on housing and receptacle for motor plug-in.

G. Accessories:
   1. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.
   2. Manual Starter Switch: Single-pole rocker switch assembly with cover and pilot light.
   3. Time-Delay Switch: Assembly with single-pole rocker switch, timer, and cover plate.
   4. Motion Sensor: Motion detector with adjustable shutoff timer.
   5. Filter: Washable aluminum to fit between fan and grille.
   6. Isolation: Rubber-in-shear vibration isolators.
   7. Manufacturer's standard roof jack or wall cap, and transition fittings.

2.5 IN-LINE CENTRIFUGAL FANS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Greenheck.
   2. Loren Cook Company.

B. Description: In-line, direct-driven centrifugal fans consisting of housing, wheel , fan shaft, bearings, motor and disconnect switch, drive assembly, mounting brackets, and accessories.

C. Housing: Split, spun aluminum with aluminum straightening vanes, inlet and outlet flanges, and support bracket adaptable to floor, side wall, or ceiling mounting.

D. Direct-Driven Units: Provide motor with sealed bearings.

E. Fan Wheels: Aluminum, airfoil blades welded to aluminum hub.

F. Accessories:
   1. Volume-Control Damper: Manually operated with quadrant lock, located in fan outlet.
   2. Companion Flanges: For inlet and outlet duct connections.

2.6 MOTORS

A. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

B. Enclosure Type: Totally enclosed, fan cooled.

2.7 SOURCE QUALITY CONTROL

A. Sound-Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Factory test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Label fans with the AMCA-Certified Ratings Seal.

B. Fan Performance Ratings: Establish flow rate, pressure, power, air density, speed of rotation, and efficiency by factory tests and ratings according to AMCA 210, "Laboratory Methods of Testing Fans for Rating."

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install power ventilators level and plumb.

B. Support units using spring isolators having a static deflection of 1 inch (25 mm). Vibration- and seismic-control devices are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."
   1. Secure vibration and seismic controls to concrete bases using anchor bolts cast in concrete base.

C. Install floor-mounting units on concrete bases. Concrete, reinforcement, and formwork requirements are specified in Division 03 Section "Cast-in-Place Concrete."

D. Install floor-mounting units on concrete bases designed to withstand, without damage to equipment, the seismic force required by code. Concrete, reinforcement, and formwork requirements are specified in Division 03 Section "Cast-in-Place Concrete."

E. Secure roof-mounting fans to roof curbs with cadmium-plated hardware. Refer to Division 07 Section "Roof Accessories" for installation of roof curbs.

F. Ceiling Units: Suspend units from structure; use steel wire or metal straps.

G. Support suspended units from structure using threaded steel rods and spring hangers having a static deflection of 1 inch (25 mm). Vibration-control devices are

specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

H. Install units with clearances for service and maintenance.

I. Label units according to requirements specified in Division 23 Section "Identification for HVAC Piping and Equipment."

3.2 CONNECTIONS

A. Duct installation and connection requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Division 23 Section "Air Duct Accessories."

B. Install ducts adjacent to power ventilators to allow service and maintenance.

C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

D. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.3 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:
   1. Verify that shipping, blocking, and bracing are removed.
   2. Verify that unit is secure on mountings and supporting devices and that connections to ducts and electrical components are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
   3. Verify that cleaning and adjusting are complete.
   4. Disconnect fan drive from motor, verify proper motor rotation direction, and verify fan wheel free rotation and smooth bearing operation. Reconnect fan drive system and align.
   5. Adjust damper linkages for proper damper operation.
   6. Verify lubrication for bearings and other moving parts.
   7. Balance all fan wheels and all other moving components statically and dynamically. Where a coating is specified and it affects the balance of the fan wheel, perform the balancing after the coating has been applied.
   8. Verify that manual and automatic volume control and fire and smoke dampers in connected ductwork systems are in fully open position.
   9. Refer to Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing procedures.
   10. Disable automatic temperature-control operators, energize motor and confirm proper motor rotation and unit operation, adjust fan to indicated rpm, and measure and record motor voltage and amperage.
   11. For units with variable frequency drives lock out critical frequencies before initial start.
   12. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   13. Shut unit down and reconnect automatic temperature-control operators.
   14. Remove and replace malfunctioning units and retest as specified above.

B. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.4 ADJUSTING

A. Adjust damper linkages for proper damper operation.

B. Refer to Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing procedures.

3.5 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain centrifugal fans. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION

This page is intentionally left blank.

SECTION 23 36 00

AIR TERMINAL UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:
   1. Single-duct, pressure independent air terminal units.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated, include rated capacities, furnished specialties, sound-power ratings, and accessories.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, required clearances, method of field assembly, components, and location and size of each field connection.
   1. Include a schedule showing unique model designation, room location, model number, size, and accessories furnished.
   2. Wiring Diagrams: Power, signal, and control wiring.

C. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, based on 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.

D. Operation and Maintenance Data: For air terminal units to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data" include the following:
   1. Instructions for resetting minimum and maximum air volumes.
   2. Instructions for adjusting software set points.

1.4 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of air terminal units and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. NFPA Compliance: Install air terminal units according to NFPA 90A, "Standard for the Installation of Air Conditioning and Ventilating Systems."

1.5 COORDINATION

A. Coordinate layout and installation of air terminal units 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.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. In articles that follow where manufacturers are listed, the following requirements apply to product selection:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 SINGLE-DUCT PRESSURE INDEPENDENT AIR TERMINAL UNITS

A. Manufacturers:
   1. Price
   2. Titus.
   3. Trane.
   4. Volutrol.

B. Configuration: Volume-damper assembly inside unit casing with control components located inside a protective metal shroud.

C. Casing: Solid double wall metal liner
   1. Casing Lining: 1-inch- thick fiberglass insulation with an R-value of 4.1.
   2. Air Inlet: Round stub connection or S-slip and drive connections for duct attachment.
   3. Air Outlet: S-slip and drive connections.
   4. Access: Removable panels for access to dampers and other parts requiring service, adjustment, or maintenance; with airtight gasket. Provide access panel upstream of heating coil for cleaning. Gasketed access panel shall have cam latches for access.

D. Regulator Assembly: Extruded-aluminum or galvanized-steel components; key damper blades onto shaft with nylon-fitted pivot points located inside unit casing.
   1. Automatic Flow-Control Assembly: Combined spring rates shall be matched for each volume-regulator size with machined dashpot for stable operation.
   2. Factory-calibrated and field-adjustable assembly with shaft extension for connection to externally mounted control actuator.

E. Volume Damper: Galvanized steel with peripheral gasket and self-lubricating bearings.
   1. Maximum Damper Leakage: ARI 880 rated, 2 percent of nominal airflow at 3-inch wg inlet static pressure.

F. Attenuator Section: 0.034-inch steel sheet metal.

1. Lining: 1-inch- (25-mm-) thick, non-porous, sealed liner which complies with UL 181 and NFPA 90A. Insulation shall be 4 pound density secured with adhesive. Liner shall be equal to Titus Steri-Loc.
2. All sound attenuators serving boxes that are part of the operating room systems shall be special packless type and shall be as specified under Section 230549 including special cleaning and protection.
3. ~~Refer to drawings for where sound attenuators are required after reheat coils.~~

G. Hot-Water Heating Coil: Copper tube, mechanically expanded into aluminum-plate fins; leak tested underwater to 200 psig (1380 kPa); and factory installed. Coil tube shall be thicker than standard coils and shall be .020 inch thick copper. ~~Refer to drawings for where sound attenuators are required after heating hot water coils.~~

H. DDC Controls: Single-package unitary controller and actuator specified in Division 23 Section "Instrumentation and Control for HVAC." Controller and actuator to be shipped by DDC contractor for factory installation.

2.3 SOURCE QUALITY CONTROL

A. Identification: Label each air terminal unit with plan number, nominal airflow, maximum and minimum factory-set airflows, coil type, and ARI certification seal.

B. Verification of Performance: Rate air terminal units according to ARI 880.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install air terminal units level and plumb. Maintain sufficient clearance for normal service and maintenance.

3.2 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to air terminal units to allow service and maintenance.

C. Hot-Water Piping: In addition to requirements in Division 23 Section "Hydronic Piping," connect heating coils to supply with shutoff valve, strainer, control valve, and union or flange; and to return with balancing valve and union or flange.

D. Connect ducts to air terminal units according to Division 23 Section "Sheet Metal Work".

E. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

F. 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 and UL 486B.

3.3 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

1. After installing air terminal units and after electrical circuitry has been energized, test for compliance with requirements.
2. Leak Test: After installation, fill water coils and test for leaks. Repair leaks and retest until no leaks exist.
3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION

SECTION 23 37 13

DIFFUSERS, REGISTERS, AND GRILLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
1. Rectangular and square ceiling diffusers.
2. Linear bar diffusers.
3. Adjustable bar registers and grilles.
4. Fixed face registers and grilles.
5. Linear bar grilles.
6. Operating Room Diffusors
7. Operating Room Ceiling Grid

B. Related Sections:
1. Division 08 Section "Louvers and Vents" for fixed ~~and adjustable~~ louvers and wall vents, whether or not they are connected to ducts.
2. Division 23 Section "Air Duct Accessories" for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles.

1.3 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.

D. 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.

E. 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. Tuttle & Bailey-Agitair Type RC.
   b. Titus Type TDX.
   c. Anemostat Type D.
   d. Price SMX.
2. Devices shall be specifically designed for variable-air-volume flows with internal directional induction vanes.
3. Material: Steel.
4. Finish: Baked enamel, white.
5. Face Size: 24 by 24 inches.
6. Mounting: T-bar and plaster.
7. Pattern: Refer to drawings.
8. Accessories:
   a. Minimum 3”high plenum (not including duct collar) square to round adapter installed at the factory. Adapter to fit on inside of diffuser neck to minimize leakage.

2.2 LINEAR SLOT OUTLETS

A. Linear Diffuser:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Tuttle & Bailey
   b. Anemostat Products; a Mestek company.
   c. Titus.
   d. Price.
2. Devices shall be specifically designed for variable-air-volume flows.
3. Material: Extruded aluminum.
4. Finish: Baked enamel, white.
5. The diffuser shall be designed so that the air will be discharged at a uniform velocity across the entire length of the unit. The air streams shall be discharged at counter angles parallel to the diffuser mounting surface by extruded aluminum fixed louvers providing one or two way discharge patterns to create induction of room air within the primary air stream to achieve rapid mixing of primary and room air. The diffuser efficiency must be such that the initial temperature differential shall be reduced by 50% at a distance one foot from the point of discharge. Slotted outlets of the grille type lacking diffusion vanes and mixing characteristics shall not be accepted.

6. Diffusers shall be equipped with matching extruded aluminum plaster frames or to match ceiling types. Frames shall be equipped with slots to accept the coil mounting springs mounted on the diffuser for positive mounting within the frame. Visible fasteners shall not be accepted.
7. Mounting: Concealed, Spring clip.
8. Accessories: Plaster frame, Directional vanes, Alignment pins, Core clips and Blank-off strips where indicated.
9. Diffusers in curved walls shall be constructed of lengths that respect the curved surface (maximum 3′-0″) so the diffuser does not need to be curved. Refer to drawings.

B. Ceiling-Integral Continuous Diffuser:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Anemostat Products; a Mestek company.
   b. Titus.
   c. Price.
   d. Tuttle and Bailey
2. Slot Width: shall be as schedule.
3. Section Length: shall be as indicted on the drawing.
4. Straight and curved sections as required to accommodate layout.
5. Mitered tees and corners.
6. Pattern Controllers: 24 inches o.c.
7. Material: Aluminum, extruded, heavy wall.
8. Finishes:
   a. Exterior: Standard white baked enamel.
   b. Interior: Standard black.
9. Mounting: Ceiling and Sidewall.
10. Plenum: all Insulated and vapor proof.
11. Other Features:
   a. Painted interior.
   b. Blank-offs.

2.3 REGISTERS AND GRILLES

A. Adjustable Bar Register:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Anemostat Products; a Mestek company.
   b. Titus.
   c. Tuttle & Bailey
   d. Price.
   e. Krueger.
2. Material: Steel.
3. Finish: Baked enamel, white.
4. Face Blade Arrangement: Horizontal.
5. Core Construction: Integral.
6. Rear-Blade Arrangement: Vertical.
7. Frame: 1 inch wide.
8. Mounting: Concealed.

B. Adjustable Bar Grille:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Anemostat Products; a Mestek company.
   b. Titus.
   c. Tuttle & Bailey.
   d. Price.
   e. Krueger.
2. Material: Steel.
3. Finish: Baked enamel, white.
4. Face Blade Arrangement: Horizontal.
5. Core Construction: Integral.
6. Rear-Blade Arrangement: Vertical.
7. Frame: 1 inch (25 mm) wide.
8. Mounting: Concealed.

2.4 OPERATING ROOM DIFFUSER:

A. Operating Room Diffuser:
   1. Supply and install air systems in each operating room of the sizes and capacities as indicated on the drawings or diffuser schedule. Equivalent manufactures shall include:
      a. Huntair
      b. Price
   2. Where shown on the plans, operating room air system shall consist of modular slot diffusers which shall provide a protective air curtain around the operating area and integrated plenum with laminar flow diffusers with integrated LED lighting which shall provide a supply of sterile air over the operating table area. Where no air curtain is shown, the integrated plenum with laminar flow diffuser with integrated LED lighting shall be the only source of supply air in the room, over the operating table area.
   3. The slot diffuser and laminar flow diffuser shall be of aluminum construction
   4. The slot diffusers shall consist of a .064” (2) aluminum plenum with continuous welded joints and radiused corners to facilitate cleaning, extruded aluminum frames, formed aluminum diffuser face with two slots and fixed pattern deflectors. Plenums shall have formed aluminum inlet collars complete with dampers, removable from plenum face. The removable dampers shall be opposed blade type of stainless steel construction. Damper shall be adjusted without removing face of HORD. The diffuser face shall be attached by 90° quick-release fasteners and safety cable for easy removal and replacement. Entire plenum and diffusers shall have a B11 Sterile White - Thermal Setting finish which meets special requirements for hospital use and will be subjected to regular cleaning with high concentration cleaning solutions and agents for sterilization purposes
   5. The integrated plenum shall incorporate laminar flow diffusers, providing non-aspirating, unidirectional airflow above the sterile zone, complete with room side adjustable aperture plate dampers with locking mechanism. System shall include integrated LED lighting and certified to meet ul1598/csa 22.2 no. 250.0 standard for air-handling luminaire.

a. Laminar diffuser face frame shall be 1/8” thick aluminum extrusion with welded miter corners and secured with four (4) stainless steel counter-sunk bolts and stainless steel retaining cables.

b. Laminar diffuser face shall be composed of 1/8” thick fire-resistant engineered polymer with 13% free area. Perforated face area shall be at least 82% of nominal square footage for each diffuser.

c. The integrated plenum shall be provided with 14 gauge aluminum construction and fully welded vertical seams.

d. Laminar modules will come without hepa filters, providing non-aspirating, unidirectional airflow above the sterile zone.

e. Each integrated plenum diffuser module shall include four (4) eye bolts for hanger wire support.the integrated plenum inlet collars shall be sized based on airflow requirements for the intended space.

f. Modules shall be factory assembled up to 48 inches x 120 inches for attachment to additional modules in the field by others.

6. Integrated lighting:

a. Each laminar diffuser module shall include integrated LED lighting, mounted so as to not interfere with the airflow of the system. LED strip lights and fluorescent tubes directly in the airflow path are not acceptable.

b. The entire perforated face of the laminar diffuser shall be fully equalized with light. Separate LED channels separating laminar diffusers or embedded into the diffuser frames are not acceptable.

c. LED lighting shall have an efficiency greater than 100 lumens per watt, and lighting power shall be equivalent to 25 watts per meter for individual LED strip lighting.

d. LED lighting shall be ip67 rated and not susceptible to dust and liquid cleaning agents.

e. LED lighting shall achieve color rendering index (cri) of 85 or higher.

f. LED lighting shall be rated for l80 > 60,000 hours based on lm-80 testing.

g. LED lighting shall be certified to meet ul2108 and meet fire/smoke ratings of ul2043.

h. Photometric ies files, achieved with a type-c goniometer, shall be available to validate lighting performance.

i. LED lighting shall be paired with drivers supplied from the integrated laminar flow diffuser assembly manufacturer. Driver shall be capable of 0.1% dimming, and pwm dimming shall meet ieee1789.

j. LED driver shall comply with ul8750/csa 22.2 no. 223-m91.

k. LED driver shall achieve total harmonic distortion (thd) < 20% at maximum power.

B. Return Grille

1. The hospital operating room return grilles shall be of stainless steel construction. The core of the return grille will consist of 45° louvres, 0.75" (19) on centre. The grille border shall have a #4 finish. The grille shall use 90° quick-release fasteners to mount to a separate stainless steel wall mounting frame, provided with the unit, thereby allowing easy removal for cleaning.

2.5 OPERATING ROOM CEILINGS

A. The operating room air diffuser manufacturer shall furnish extruded aluminum tee and angle frame ceiling suspension system to support air diffusers, fill-in panels and light fixtures. Tees should have a 1.5" face width and 1.563" overall height. Minimum wall thickness of tees shall be 0.125" with a minimum weight of 0.45 lbs. per linear ft (full tee). All tee and angle frame extrusions should include channels along the top of the stack to support hold-down clips for fill-in panels. Extrusions shall be fabricated using 100% pre-consumer recycled aluminum material. The manufacturer shall coordinate with the medical equipment supplier and other trades to insure fit and finish. The manufacturer shall provide detailed CAD drawings for approval prior to fabrication.

B. The ceiling suspension system shall be factory heliarc welded in sub-assemblies not larger than 5' x 10', where framing sub-assemblies butt together for field assembly. The butting angles shall be half tees mechanically-fastened together with heavy duty bolts.

C. All tees and angles shall be pre-punched on 4.85" centers for attachment to minimum 12 gauge pre-stressed suspending hanger wires on minimum 48" centers. Systems shall be designed to support 15 lbs/sq.ft when installed as per ASTM C636. Hangers are by others.

D. Manufacturer shall furnish 0.125" thick closed-cell polyethylene gasket tape to be (factory) installed on the frame assembly to provide an airtight seal between the tees and diffusers, fill-in panels and/or light fixtures. Gasket shall also be field applied between framing sub-assemblies prior to field assembly. Infill panels shall be (Equal to Price SC Series lay-in type, 0.040" unperforated aluminum, or equal to Price SPB Series perforated panel with border consisting of 0.040" perforated aluminum faceplate with 0.040" solid aluminum backing with B11 finish

1. Fill-in panels should be held down using factory supplied spring clips on all sides of the panel to seal against the closed-cell gasket. Manufacturer shall provide filler panels and access as required (provide a minimum of four access panels at corners of grid). Manufacturer shall coordinate tee and panel layout with medical equipment manufacturer

E. The ceiling suspension system shall have a baked-on powder coat finish to match the laminar flow diffusers and fill-in panels. Paint finish must demonstrate no deterioration when tested in accordance with ASTM D1308 (covered spot & immersion) and ASTM D4752 (MEK double rub) paint durability tests.

2.6 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.

D. Noise level at noted capacities shall not exceed criteria specified in Section NOISE CONTROL. Diffusers shall be suitable for operation at 5 percent excess and 25 percent less then noted capacity. Provide blanking for proper coverage and blow without producing objectionable noise or air motion at occupied level. Finish shall match color sample as approved:

E. Linear diffusers: Frame types shall mate with ceilings. Provide means to neatly butt and align units to give continuous appearance without butting flanges. No screw holes or welded corners visible on diffusers or frames will be permitted. Air volume shall be adjustable through air supply face without requiring removal of face panel. Provide blanked sections for inactive lengths. Provide plaster frames and opposed blade volume dampers with remote cable operators where noted. Refer to Architectural Drawings for mounting details and overall lengths. Finish shall match color sample as approved:

F. Install all fire rated diffusers in compliance with NFPA and UL listed installation instructions.

3.3 ADJUSTING

A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

3.4 OPERATING ROOM CEILING INSTALLATION

A. Install all components in accordance with the manufactures' instructions in accordance to ASTM C 636.

B. Main grid members are to be suspsended on pre-stressed hanger wire at 4' (1200 mm) centers. Minimum gauge for the hanger wire shall be 12 gauge.

C. Maximum allowable deflection shall not exceed L/360.

D. Install ceilings to heights indicated on the plans and specifications to a tolerance of 1/8" in 12'-0" (3.2mm in 3660 mm).

END OF SECTION

SECTION 23 57 00

HEAT EXCHANGERS FOR HVAC

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes
   1. Shell-and-tube heat exchangers.
   2. Unfired steam Generators

1.3 SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings: Signed and sealed by a qualified professional engineer. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   1. Design Calculations: Calculate requirements for selecting seismic restraints and for designing bases.
   2. Base Details: Detail fabrication including anchorages and attachments to structure and to supported equipment.

C. Coordination Drawings: Equipment room, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
   1. Tube-removal space.
   2. Structural members to which heat exchangers will be attached.

D. Manufacturer Seismic Qualification Certification: Submit certification that heat exchanger, accessories, and components will withstand seismic forces defined in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment." Include the following:
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
      a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
      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 Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

E. Operation and Maintenance Data: For heat exchangers to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, performance, and dimensional requirements of heat exchangers and are based on the specific equipment indicated. Refer to Division 01 Section "Product Requirements."

B. ASME Compliance: Fabricate and label heat exchangers to comply with ASME Boiler and Pressure Vessel Code: Section VIII, "Pressure Vessels," Division 1.

C. Registration: Fabricate and label shell-and-tube heat exchangers to comply with the Tubular Exchanger Manufacturers Association's standards.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

2.2 SHELL-AND-TUBE HEAT EXCHANGERS

A. Manufacturers:
1. ITT Industries; Bell & Gossett.
2. Taco, Inc.
3. Patterson Kelley

B. Configuration: U-tube with removable bundle.

C. Shell Materials: Steel Head:
1. Materials: Cast iron
2. Flanged and bolted to shell.

D. Tube:
1. Seamless copper tubes.
2. Tube diameter is determined by manufacturer based on service.

E. Tubesheet Materials: Steel tubesheets.

F. Baffles: Steel.

G. Piping Connections:
1. Shell: Flanged inlet and threaded outlet fluid connections, threaded drain, and vent connections.
2. Head: Flanged inlet and outlet fluid connections.

H. Support Saddles:
1. Fabricated of material similar to shell.

2. Foot mount with provision for anchoring to support.
3. Fabricate attachment of saddle supports to pressure vessel with reinforcement strong enough to resist heat-exchanger movement during a seismic event when heat-exchanger saddles are anchored to building structure.

2.3 UNFIRED STEAM GENERATORS-STEAM TO STEAM

A. Manufacturers:
1. Cemline Corporation

B. Unfired steam generators shall be furnished as a complete package ready for installation including all necessary components for operation. The unfired steam generator, steam to steam type, shall be of the sizes and capacities noted on the Drawings. The generator shall consist of specified materials and components and shall be specifically designed for working pressure scheduled. The unfired steam generator selection shall be provided with the scheduled minimum heat transfer surface area required to meet the scheduled capacity and pressure drops. The unfired steam generator shall be factory mounted, wired, piped, and tested.

C. Unfired steam generators shall be ASME Code constructed and stamped in accordance with Section VIII, Division I, for Unfired Steam Generators and shall be U.L. listed. Generators shall be registered with the National Board of Boiler and Pressure Vessel Inspectors, and a signed copy of the shop inspection report shall be furnished to the Owner. When generating steam above 50 psi, generator welds shall be 100 percent x-rayed in accordance with Section VIII "Unfired Steam Generators" and shall bear the "UB" stamp.

D. Mount on a suitable I-Beam support skid, which shall be permanently welded to the shell.

E. Insulation shall be a minimum of 3 inches of fiberglass insulation, protected by not less than a 20 gage thick enamel painted steel jacket.

F. Furnish with materials for the generated steam fluids as noted below:
1. Construct of Type 316L stainless steel shell with NPT or flanged supply connection.
2. Furnish with submerged u-tube type heat exchanger coil of 18 gage Type 316L stainless steel tubes expanded into a stainless steel tube sheet with ca shall be provided on the coil. Where the source steam pressure is less than 80 psig, 20 gage stainless steel shall be provided on the coil. Tubes shall be expanded into a Type 316L stainless steel tube sheet with cast iron heads.
3. Components subject to the generated steam side shall be Type 316L stainless steel construction. Component piping on generated steam side shall be carbon steel.
4. Furnish with a vessel steam gauge and pressure transmitter to monitor the generated steam. Gauge shall be of stainless steel construction with a stainless steel case and shall be of the appropriate range for the generated steam pressure.
5. Furnish with a stainless steel float type level controller with Type 316L stainless steel water column.
6. Furnish with an ASME Code Section I stainless steel pressure relief valve with a capacity to relief the total BTU output of the generator.

7. Furnish with a vacuum breaker.
8. Blowdown components shall be of stainless steel construction. Blowdown piping on generated steam side shall be stainless steel up to the condensate cooler.
9. Unfired steam generators operating at 15 psi or below shall be furnished with a stainless steel feed water solenoid valve (factory wired to level control), stainless steel check valve, and high limit solenoid valve. Unfired steam generators operating above 15 psi shall be additionally furnished with a multistage feed water pump (with stainless steel wetted components) sized to generate adequate feedwater pressure for the scheduled generated steam pressure and capacity. Pump shall be factory supplied with a starter wired to the level control. The pump shall discharge into a stainless steel ball valve, stainless steel feed water solenoid valve (factory wired to level control), stainless steel check valve, and high limit solenoid valve.

G. Furnish with a source steam gauge to monitor the source steam pressure. Gauge shall be of copper or brass construction with a steel case and shall be of the appropriate range for the source steam pressure.

H. Furnish with a pilot actuated control valve to modulate incoming steam to maintain desired output of steam pressure +/- 2 psi. Control valve shall be suitable for 150 psi at 300 degrees F. Control valve pilot pressure transmitter shall monitor output steam pressure and modulate the boiler steam to maintain constant output pressure.

I. Factory supply with dual float and thermostatic traps, one for the coil and one for the drip before the control valve. Provide an incoming steam strainer.

J. Furnished with an internal steam separator.

K. Factory furnish with a high water shut-off. High water shut-off shall include an electronic probe mounted in the top of the unit connected to an electric operated power to open spring to close ball valve for boiler operating at or below 15 psi. For boilers operating above 15 psi steam, high water shut-off shall open the feed water pump circuit. In the event of high water, the ball valve will close.

L. Provide with dry contacts to alert the building automation system (BAS) of either a high pressure, low water, or high water condition occurs. Additionally, the unit shall be provided with a 120-volt alarm bell that is factory wired to sound at any of these conditions. Furnish with an alarm-silencing relay with red alarm light and manual push button.

M. Furnish with a relay for remote on-off control from the BAS system.

N. Furnish with a TDS Blow Down system. A factory installed time sample feed water blow down system consisting of a control, which measures the total dissolved solids in the generator. The blow down operates on a timed basis and if the total dissolved solids exceed the set point, the valve shall blow down the boiler until fresh water brings the total dissolved solids level to the desired setting. Automatic blow off system shall be furnished with a NEMA I control system and be factory wired to a single point 120 volt connection. Field piping of cold water to the unit's mixing valve and venting from the unit shall be the responsibility of the Contractor.

O. Factory furnish with a factory-mounted blow down \ condensate cooler, ASME code constructed, and stamped for 150 psi working pressure.

P. Minimum steel thickness is 3/16 inches. The blow down enters the tangential inlet where it meets a 90 degree stainless steel wear plate. The wear plate will prevent erosion of the sidewall of the vessel. The tangential blow down entry causes the blow down to swirl around the circumference of the vessel where part of the liquid will flash to steam and the balance will settle to the bottom. The internal flash will go through the vent to atmosphere and the hot condensate and sludge will fall to the bottom of the vessel where it will flow by gravity to the drain leg. The temperature of the condensate will activate the thermal control valve, which will feed cold water into the drain leg where the cold water and hot condensate will mix. This results in drained liquid temperature less than 140 degrees F which is acceptable for municipal sewage. A thermometer is furnished in the drain leg and a check valve is furnished on the coldwater inlet. Tank shall be mounted and piped as part of the Unfired Steam Generator package.

Q. Furnish as factory packages with all wiring to single terminal strip and factory pipe for field connections to city water, source steam, source steam condensate, clean steam outlet, drain, and relief valve outlets.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas for compliance with requirements for installation tolerances and for structural rigidity, strength, anchors, and other conditions affecting performance of heat exchangers.
   1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 HEAT-EXCHANGER INSTALLATION

A. Install shell-and-tube heat exchangers on saddle supports.

B. Install shell-and-tube heat exchangers on concrete base. Concrete base is specified in Division 23 Section "Common Work Results for HVAC," and concrete materials and installation requirements are specified in Division 03.

C. Concrete Bases: Anchor heat exchanger to concrete base.
   1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around full perimeter of base.
   2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
   3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
   4. Install anchor bolts to elevations required for proper attachment to supported equipment.
   5. Cast-in-place concrete materials and placement requirements are specified in Division 03.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Maintain manufacturer's recommended clearances for service and maintenance. Install piping connections to allow service and maintenance of heat exchangers.

C. Install shutoff valves at heat-exchanger inlet and outlet connections.

D. Install relief valves on heat-exchanger heated-fluid connection and install pipe relief valves, full size of valve connection, to floor drain.

E. Install vacuum breaker at heat-exchanger steam inlet connection.

F. Install hose end valve to drain shell.

3.4 FIELD QUALITY CONTROL

A. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.5 CLEANING

A. After completing system installation, including outlet fitting and devices, inspect exposed finish. Remove burrs, dirt, and construction debris and repair damaged finishes.

3.6 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain heat exchangers. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION

SECTION 23 64 23

SCROLL WATER CHILLERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
   1. Packaged, air-cooled, electric-motor-driven, scroll water chillers.

1.3 DEFINITIONS

A. COP: Coefficient of performance. The ratio of the rate of heat removal to the rate of energy input using consistent units for any given set of rating conditions.

B. EER: Energy-efficiency ratio. The ratio of the cooling capacity given in terms of Btu/h to the total power input given in terms of watts at any given set of rating conditions.

C. IPLV: Integrated part-load value. A single number part-load efficiency figure of merit calculated per the method defined by AHRI 550/590 and referenced to AHRI standard rating conditions.

D. kW/Ton: The ratio of total power input of the chiller in kilowatts to the net refrigerating capacity in tons at any given set of rating conditions.

E. NPLV: Nonstandard part-load value. A single number part-load efficiency figure of merit calculated per the method defined by AHRI 550/590 and intended for operating conditions other than the AHRI standard rating conditions.

1.4 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Scroll water chillers 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 and the unit will be fully operational after the seismic event."

1.5 SUBMITTALS

A. Product Data: Include refrigerant, rated capacities, operating characteristics, furnished specialties, and accessories.
   1. Performance at AHRI standard conditions and at conditions indicated.
   2. Performance at AHRI standard unloading conditions.
   3. Minimum evaporator flow rate.

4. Refrigerant capacity of water chiller.
5. Oil capacity of water chiller.
6. Fluid capacity of evaporator.
7. Characteristics of safety relief valves.
8. Minimum entering condenser-air temperature
9. Performance at varying capacity with constant design entering condenser-air temperature. Repeat performance at varying capacity for different entering condenser-air temperatures from design to minimum in 10 deg F increments.

B. LEED Submittals:
1. Product Data for Credit EA 4: For refrigerants, indicating printed statement that refrigerants are free of HCFCs.

C. Shop Drawings: Complete set of manufacturer's prints of water chiller assemblies, control panels, sections and elevations, and unit isolation. Include the following:
1. Assembled unit dimensions.
2. Weight and load distribution.
3. Required clearances for maintenance and operation.
4. Size and location of piping and wiring connections.
5. Wiring Diagrams: For power, signal, and control wiring.

D. Coordination Drawings: Floor 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. Structural supports.
2. Piping roughing-in requirements.
3. Wiring roughing-in requirements, including spaces reserved for electrical equipment.
4. Access requirements, including working clearances for mechanical controls and electrical equipment, and tube pull and service clearances.

E. Certificates: For certification required in "Quality Assurance" Article.

F. Seismic Qualification Certificates: For water chillers, accessories, and components from manufacturers.
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.

G. Source quality-control test reports.

H. Startup service reports.

I. Operation and Maintenance Data: For each water chiller to include in emergency, operation, and maintenance manuals.

J. Warranty: Sample of special warranty.

1.6 QUALITY ASSURANCE

A. AHRI Certification: Certify chiller according to AHRI 590 certification program.

B. AHRI Rating: Rate water chiller performance according to requirements in AHRI 550/590, "Water Chilling Packages Using the Vapor Compression Cycle."

C. ASHRAE Compliance:
   1. ASHRAE 15 for safety code for mechanical refrigeration.
   2. ASHRAE Guideline 3 for refrigerant leaks, recovery, and handling and storage requirements.
   3. ASHRAE/IESNA 90.1 for energy efficiency.

D. ASME Compliance: Fabricate and stamp water chiller heat exchangers to comply with ASME Boiler and Pressure Vessel Code.

E. Comply with NFPA 70.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Ship water chillers from the factory fully charged with refrigerant and filled with oil.

B. Deliver chillers with protective crating and covering.

C. Store chillers to prevent damage and protect from weather, dirt, fumes, water, and construction debris in clean dry space.

D. Protect units from physical damage. Leave factory shipping covers in place until installation.

E. Handle chillers according to manufacturer's written rigging and installation instructions for unloading, transporting, and setting in final location.

1.8 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

B. Coordinate sizes, locations, and anchoring attachments of structural-steel support structures.

C. 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 water chillers that fail in materials or workmanship within specified period.
   1. Compressor Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PACKAGED MODULAR AIR-COOLED WATER CHILLERS

A. Provide outdoor packaged air-cooled liquid chiller with the capacity as scheduled on drawings.

B. Chiller shall be designed to operate using R-410A Refrigerant.

C. Chiller shall be designed for parallel evaporator water flow.

D. The liquid to be chilled will be water containing corrosion inhibitors and 35% propylene glycol antifreeze solution.

E. Approved manufacturer is Airstack or Arctic Chill.

F. System Description:
   1. Chiller shall incorporate Scroll type compressors and can consist of multiple 30 – ton modules. Each refrigerant circuit shall consist of an individual compressor set, common single circuit evaporator, single circuited condenser, electronic expansion valve (thermal expansion valve not acceptable), liquid line solenoid valve, filter drier, fin and tube condenser, and control system. Each circuit shall be constructed to be independent of other circuits from a refrigeration and electrical stand-point. The multi-circuit chiller (requires multiple modules) must be able to produce chilled water even in the event of a failure of one or more refrigerant circuits. Circuits shall contain R-410a refrigerant. Provide with a 308 gallon stainless steel buffer tank module

G. General
   1. Chiller Modules shall be ETL listed in accordance with UL Standard 1995, CSA certified per Standard C22.2#236.
   2. Chiller modules shall be AHRI certified.
   3. Modules shall ship wired and charged with refrigerant. All modules shall be factory run tested prior to shipment on an AHRI certified or 3rd party verified test stand.
   4. Compressors, heat exchangers, condenser fans, piping and controls shall be mounted on a heavy gauge, powder coated steel frame. Electrical controls, contactors, and relays for each module shall be mounted within that module. Module shall be provided within a steel enclosure suitable for outdoor use. Exposed steel surfaces shall be provided with a powder coat paint finish.

H. Chilled Water Mains:
   1. Each module shall include supply and return mains for chilled water. Cut grooved end connections are provided for interconnection to six inch standard (6.625” outside diameter) piping with grooved type couplings. Rolled grooved shall be unacceptable.

I. Evaporators:
   1. Each evaporator shall be a brazed plate heat exchanger constructed of 316 stainless steel; designed, tested, and stamped in accordance with UL 1995 code for 650 psig working pressure. The evaporator heat exchanger shall not be mounted above the compressor, to eliminate the effect of migration of refrigerant to the cold evaporator with consequent liquid slugging on start-up.

J. Compressor:
   1. Each module shall contain two hermetic scroll compressors in a tandem piping arrangement mounted to the module with rubber-in-shear isolators. Each system also includes high discharge pressure and low suction pressure safety cut-outs.

K. Condenser Fans:
   1. Each module shall contain dual condenser fans for each refrigerant circuit. These fans shall be multi-blade vane-axial type made of plastic composite material for quiet operation. Fans shall be direct drive at a maximum RPM of 1,150. Fan motors shall all be pressure controlled and suitable for outdoor use. Condenser fans shall have variable frequency drives.

L. Central Control System.
   1. Scheduling of the various compressors shall be performed by a microprocessor based control system (Master Controller). Manufacturer to

provide a fully redundant spare Master Controller that is preprogramed to replace the initial Master Controller, should there be a failure. A new lead compressor is selected every 24 hours to assure even distribution of compressor run time.

2. The Master Controller shall monitor and report the following on each refrigeration system:
   a. Discharge Pressure Fault
   b. Suction Pressure Fault
   c. Compressor Winding Temperature
   d. Suction Temperature
   e. Evaporator Leaving Chilled Water Temp.
3. The Master Controller shall be powered by the chillers single point power connection and shall monitor and report the following system parameters:
   a. Chilled Water Entering and Leaving Temperature
   b. Discharge Refrigerant Temperature
   c. Chilled Water Flow
4. An out of tolerance indication from these controls or sensors shall cause a "fault" indication at the Master Controller and shutdown of that compressor with the transfer of load requirements to the next available compressor. In the case of a System Fault the entire chiller will be shut down. When a fault occurs, the Master Controller shall record conditions at the time of the fault and store the data for recall. This information shall be capable of being recalled through the keypad of the Master Controller and displayed on the Master Controller's 2 line by 40 character back-lit LCD. A history of faults shall be maintained including date and time of day of each fault (up to the last 20 occurrences).
5. Individual monitoring of leaving chilled water temperatures from each refrigeration system shall be programmed to protect against freeze-up.
6. The control system shall monitor entering and leaving chilled water temperatures to determine system load and select the number of compressor circuits required to operate. Response times and set points shall be adjustable. The system shall provide for variable time between compressor sequencing and temperature sensing, so as to optimize the chiller performance to different existing building loads.
7. Interoperability web portal
   a. The Chiller shall be capable of interfacing to a building automation system. Interface shall be accomplished using an Interoperability Web Portal and shall be capable of communication over BACnet, Modbus or LON.
   b. Fail to run mode (FRM)
      (1) Chiller shall be capable of operation in the event that the Master Controller has lost communication. FRM provides the ability to switch the chiller into manual mode automatically keeping the chiller online until a replacement Master Controller can be provided. Included is a power phase monitor and IFM flow switch per module.
8. Chiller shall have external inputs and outputs to be compatible with the building management system to include Remote Start/Stop capability and Cooling Alarm output.
9. The unit control system shall provide automatic changeover between Mechanical Cooling, Pre-Cooling and Free-Cooling modes with the following field adjustable set points:

a. Changeover Set point (Ambient Air Temperature): Below this set point chiller will be in free cooling mode. If adequate cooling cannot be accomplished through free cooling coils, mechanical cooling will be staged up to meet building load requirements.
b. Leaving Glycol Temperature Set point: This setting will provide two-stage thermostatic control of the unit fans to meet indicated setting for chiller leaving glycol temperature.
c. Leaving Glycol Low Temperature Lock-out: At any time if the leaving glycol drops below this field adjustable setting, free cooling will be suspended and system glycol will be diverted around the glycol cooling coils. This will prevent over cooling of the chilled water system due to ambient wind blowing through the glycol coils under cold winter conditions.

M. Low Ambient to -20°F
1. Chiller shall incorporate appropriate refrigerant specialties including a properly sized refrigerant receiver and flooded head pressure control valves for operation to -20°F. This option includes VFD driven condenser fan motors.

N. Single Point Power Connection
1. Chiller shall be provided with a single point power connection at a 5,000 amp SCCR. This will include pre-engineered wiring for field installation and connection to a factory mounted chiller junction box. Junction box shall include branch circuit protection for each module and provide a single point of connection to building power.

O. Free Cooling Module
1. Provide Free Cooling modules in quantity and capacity as indicated on drawings and schedules. Free Cooling Modules shall interconnect through the common chiller header system and require no additional water connections. Free Cooling Modules shall include glycol cooling coils, temperature controlled fans and an automatic 3-way bypass valve to eliminate the need for mechanical cooling under low ambient conditions. Module shall be completely factory assembled and tested before shipment.

P. Isolation Valves
1. Chilled Water Manual isolation valves shall be installed between the heat exchanger and water supply mains for heat exchanger isolation.

Q. Variable Flow Operation
1. Chilled Water Butterfly type isolation valves shall incorporate appropriate accessories and controls to allow the chiller to operate efficiently in a variable primary flow system. Motorized valve per module shall operate for variable flow.

R. Pump Module
1. Provide a Pump Module of size and capacity indicated on the drawings and schedules. The Pump Module shall be interconnected though the common chiller header system and require no additional water connections. Pump Module will become an integral part of the chiller system. Pump Module shall incorporate in-line centrifugal pumps in a Primary/Standby pumping arrangement. Pump starters and controls shall be provided to enable manual selection of lead pump. In addition, in the event of a loss-of-flow failure of the chilled water system, the Pump Module controls shall disable the lead

pump and automatically start the standby pump. Module shall be completely factory assembled and tested prior to shipment. Pump shall be by Grundfos.

S. Lifting Frame
   1. Optional six (W6X15) inch I-beam painted steel frame will be provided with all modules mounted upon it. Typically, all water and wiring connections will be made between the modules at the factory. Depending on chiller length or customer requests, larger I-beams can be furnished.

T. IFM flow switch per module.
   1. Integral to each module and powered by the module for individual module proof of flow and flow safety. Modules without independent IFM switches per module are not acceptable alternates.

U. Safeties, controls and Operation
   1. The chiller safety controls shall be provided (minimum) as follows:
      a. Low evaporator refrigerant pressure
      b. Loss of water flow through the evaporator
      c. High condenser refrigerant pressure
      d. High compressor motor temperature
      e. Low suction gas temperature
      f. Low leaving evaporator water temperature
   2. Failure of chiller to start or chiller shutdown due to any of the above safety cutouts shall be annunciated by display of the appropriate diagnostic description at the unit control panel. This annunciation will be in plain English. Alphanumeric codes shall be unacceptable.
   3. The chiller shall be furnished with a Master Controller as an integral portion of the chiller control circuitry to provide the following functions:
      a. Provide automatic chiller shutdown during periods when the load level decreases below the normal operating requirements of the chiller. Upon an increase in load, the chiller shall automatically restart.
      b. Provisions for connection to automatically enable the chiller from a remote energy management system.
      c. The control panel shall provide alphanumeric display showing all system parameters in the English language with numeric data in English units.

V. Normal Chiller Operation
   1. When chiller is enabled, the factory supplied Master Controller modulates the chiller capacity from minimum to maximum as required by building load.
   2. The Chiller control system shall respond to Entering Water Temperature and will have an integral reset based on entering water temperature to provide for efficient operation at part-load conditions.

2.2 SOURCE QUALITY CONTROL

A. Perform functional test of water chillers before shipping.

B. Factory performance test water chillers, before shipping, according to AHRI 550/590, "Water Chilling Packages Using the Vapor Compression Cycle."

C. Factory test and inspect evaporator according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1. Stamp with ASME label.

D. For water chillers located outdoors, rate sound power level according to AHRI 370 procedure.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Before water chiller installation, examine roughing-in for equipment support, anchor-bolt sizes and locations, piping, and electrical connections to verify actual locations, sizes, and other conditions affecting water chiller performance, maintenance, and operations.
   1. Water chiller locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping and electrical connections.

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

3.2 WATER CHILLER INSTALLATION

A. Install water chillers on support structure indicated.

B. Equipment Mounting: Install water chiller on concrete bases using restrained spring isolators. Comply with requirements for vibration isolation devices specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

C. Maintain manufacturer's recommended clearances for service and maintenance.

D. Charge water chiller with refrigerant if not factory charged and fill with oil if not factory installed.

E. Install separate devices furnished by manufacturer and not factory installed.

3.3 CONNECTIONS

A. Comply with requirements in Division 23 Section "Hydronic Piping" Drawings indicate general arrangement of piping, fittings, and specialties.

B. Comply with requirements in Division 23 Section "Refrigerant Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

C. Install piping adjacent to chiller to allow service and maintenance.

D. Evaporator Fluid Connections: Connect to evaporator inlet with shutoff valve, strainer, thermometer, and plugged tee with pressure gage. Connect to evaporator outlet with shutoff valve, balancing valve, flow switch, thermometer, plugged tee with pressure gage, and drain connection with valve. Make connections to water chiller with a flange .

E. Refrigerant Pressure Relief Valve Connections: For water chillers installed indoors, extend vent piping to the outside without valves or restrictions. Comply with ASHRAE 15.

F. Connect each drain connection with a union and drain pipe and extend pipe, full size of connection, to floor drain. Provide a shutoff valve at each connection if required.

3.4 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

B. Inspect field-assembled components, equipment installation, and piping and electrical connections for proper assemblies, installations, and connections.

C. Complete installation and startup checks according to manufacturer's written instructions and perform the following:
   1. Verify that refrigerant charge is sufficient and water chiller has been leak tested.
   2. Verify that pumps are installed and functional.
   3. Verify that thermometers and gages are installed.
   4. Operate water chiller for run-in period.
   5. Check bearing lubrication and oil levels.
   6. Verify proper motor rotation.
   7. Verify static deflection of vibration isolators, including deflection during water chiller startup and shutdown.
   8. Verify and record performance of chilled water flow and low-temperature interlocks.
   9. Verify and record performance of water chiller protection devices.
   10. Test and adjust controls and safeties. Replace damaged or malfunctioning controls and equipment.

D. Prepare a written startup report that records results of tests and inspections.

3.5 SPARE PARTS

A. Provide one spare master control board for future maintenance and service.

3.6 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain water chillers.

END OF SECTION

This page is intentionally left blank.

SECTION 23 73 14

CUSTOM PACKAGED CENTRAL STATION AIR HANDLING UNITS

PART 1 - GENERAL

1.1 DESCRIPTION:

A. This section of the work includes the design, fabrication, testing, cleaning and packaging, shipment and final assembly of custom built-up air handling units by the unit manufacturer in complete accordance with the following specification.

B. The details outlined and component manufacturers named in this specification may not be deviated from in the air handling unit manufacturer's preparation of the bid, even where techniques are required which are not considered standard by the manufacturer. The construction as described in this specification is considered essential, and any deviation from this specification must be specifically identified and bid as a Voluntary Alternate (add or deduct), but only after complying with the specification defined as the Base Bid.

1.2 SUBMITTALS:

A. WITH THE QUOTATION: Provide the following detailed information on the equipment proposed Unit manufacturer shall itemize all deviations from the specified requirements. If not so indicated, unit manufacturer will be required to furnish at no cost to the owner:
   1. Information requested in the RFQ, including equipment data sheets, schedules and sketches.
   2. Equipment drawings showing dimensions, weights (shipping & operating), configuration, major component locations, access door locations, duct connection sizes and locations, and shipping split locations.
   3. Fan manufacturer and performance curves with the operating points clearly indicated. Motor sizes and types.
   4. Coil selections with sizes, rows, fin spacing, face velocities, temperatures, flow rates, pressure drops, & connection sizes.
   5. Proposed filters indicating size, efficiency, and pressure drop.
   6. Materials of construction for housing and major components.
   7. Airborne and transmitted sound power levels by octave band.

B. AFTER PURCHASE: Make submittals in accordance with requirements of conditions of purchase. Submittals shall show Buyer’s purchase order number, equipment number and project number. Information shall include, as applicable, but not be limited to the following:
   1. Information submitted with quotation, revised and expanded as required.
   2. If applicable) Electrical data, wiring diagrams, and accessory panel layouts. Clearly differentiate between portions of wiring that are factory-installed and portions to be field-installed.
   3. If applicable) Factory testing procedures for review and acceptance.

C. AFTER RECEIPT OF APPROVED DRAWINGS: Submit manuals with detailed description of installation, operation, and maintenance, including the following:
   1. All approved “Certified for Construction” drawings.

2. Written recommendations for field storage, both indoors and outdoors.
3. Installation requirements including assembly instructions, lifting requirements and adjustments.
4. Manufacturer's literature describing each piece of equipment furnished including operation instructions including step by step preparation of starting, shutdown, and draining and maintenance instructions including lubrication.

1.3 OPERATION AND MAINTENANCE DATA

A. Submit operation and maintenance data

B. Include instructions for lubrication, filter replacement, motor and drive replacement, spare parts lists, and wiring diagrams.

1.4 QUALIFICATIONS

A. Manufacturer: Company specializing in manufacturing the Products specified in this section with minimum five years documented experience, who issues complete catalog data on total product.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver, store, protect and handle products to site under provisions of Division 01 and Section 230000.

B. Accept products on site in factory-fabricated protective containers, with factory-installed shipping skids. Inspect for damage.

C. Store in clean dry place and protect from weather and construction traffic. Handle carefully to avoid damage to components, enclosures, and finish.

D. The entire unit shall be sealed with wrap and have water absorption desiccant packs in each section to eliminate moisture during shipping.

1.6 ENVIRONMENTAL REQUIREMENTS

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

1.7 EXTRA STOCK

A. Provide one complete set of extra disposable filters per air handling unit.

PART 2 - PRODUCTS

2.1 CUSTOM AIR HANDLING UNITS MANUFACTURERS

A. Manufacturers: Units shall be as manufactured by Trane Custom, Buffalo, York, Haakon and Ventrol.

2.2 CUSTOM AIR HANDLING UNIT

A. Custom built-up units shall be of the configuration, capacity and style as indicated on the drawings and Equipment Schedule and as specified herein. Through properly designed access; ease of maintenance, removability of components, and unit serviceability shall be assured.

B. General:
   1. The unit manufacturer shall be responsible for provisions of fans, dampers and all other unit and plenum components as specified in this section or other sections of this division and performance characteristics as shown in schedules or on drawings. The unit manufacturer shall provide all field labor for assembly of enclosure and components.
   2. Unit shall be factory-fabricated for shipping and field assembly by experienced manufacturer of large custom air handling units that maintains engineering and production staff.
      a. Provide proof of credentials of manufacturer's staff as required by Owner and Architect.
   3. Shop drawings shall be subject to approval of the Owner and Architect.
   4. Certify conformance with performance requirements specified and shown on Drawings.
   5. Provide necessary appurtenances to perform as specified, whether or not expressly required by Contract Documents mentioned herein in conformance with good trade practice, as determined by Architect.
   6. Seal any casing penetrations made in field for piping, conduit, tubing and equipment installed under other sections. Manufacturer shall supply contractor with details for sealing casing. Manufacturer’s field service representative shall inspect and approve all casing penetrations

C. Testing:
   1. Test to ensure structural integrity, design suitability under simulated operating conditions, systems operation and minimum vibration levels as specified. Certify that unit complies with design intent and Contract Documents.
   2. Manufacturer shall be responsible for correcting any operating deficiencies found during the unit startup after installation.
   3. Prior to shipping the following tests shall be performed:
      a. Pressure test water coils if coil manufacturer has not already performed pressure test, and piping.
      b. Energize electrical devices to ensure operational integrity prior to shipment. Replace non-functioning items.
      c. Submit housing panel acoustical, structural and physical properties performance test data before shipment from independently certified test laboratory.
      ~~d. Performance Test:~~
         ~~1) Perform a unit performance test in the factory. The performance test shall be done to determine unit flow rate, total static pressure across the fan, external static pressure available to overcome system losses, fan speed and input power to the fans. Filter losses shall be simulated to provide average filter loss [1/2(clean & dirty)]. Test results shall confirm the unit is able to produce the required CFM at the listed external static pressure drop on the~~

~~drawing schedules. Fan brake horsepower shall not be greater than design power by more than 5 percent~~

~~2) Unit Air Leakage Rate: Perform unit leak pressure test to meet air leakage rates not to exceed the following values at 1½ times the design static pressure (not to exceed 8 in. w.g.) Manufacturer shall be responsible for any corrections required to meet test criteria. Leak test shall be performed before any ductwork is connected. Factory to provide blank off of openings~~

~~a) ½ of 1% of the Design Airflow~~

4. Provide the following field tests after unit assembly:
   a. Unit operation and vibration analysis. Operate fans at design RPM, set fan drive and conduct complete vibration spectrum as specified. Fan, motor, drive and base assembly, vibration shall be brought to within specified levels. Check motor and drive vibration with fan as a completed assembly. Vibration levels shall be measured in velocity (in/sec peak) in the horizontal, axial and vertical direction on the housing of both fan bearings while tuned to the fan running speed. A second reading based on the overall shall be made as a check on other possible vibration sources other than balance. The following is the acceptance criteria in velocity (in/sec peak):

ISOLATOR SUPPORTS

Direction	Radial	Axial
Filtered	0.16	0.32
Overall	0.40	0.40

D. Unit shall comprise of, but not limited to, sections shown on drawings and the following list:
   1. Double wall aluminum outer cabinet. Construction shall employ 'no through metal' design.
   2. Outside air intake section with minimum and economizer outside air dampers and return air damper.
   3. Pre-Filter (MERV 8)
   4. Blank filter frame section for future charcoal filters.
   5. Discharge HEPA Filters (OR units) ,Discharge MERV 14 for PACU and bed floor units.
   6. Air Blender
   7. Steam preheat coil
   8. Chilled water cooling coil
   9. Humidifier
   10. Supply air fan array section.
   11. UV Lights at Cooling Coil
   12. Discharge Air Plenum
   13. Outdoor air and supply air flow stations (All units). Outdoor air flow station transducer shall be by unit manufacturer. ATC shall provide supply fan transducers.
   14. Smoke Isolation Supply Control dampers
   15. Return air Control dampers

E. Provide safing between internal components and unit casing to prevent air bypass. Safing material shall match unit interior. All seams or voids between safing, components and unit casing shall be caulked and sealed airtight.

F. Unit shall employ aluminum material wherever possible (panels, bases, supports, safing, etc).

2.3 AIR HANDLING UNIT BASE:

A. The unit shall be constructed on 8 inch deep aluminum structural member. Roll formed materials are not acceptable. The base shall be designed to distribute loads properly to a suitable mounting surface and be braced to support internal components without sagging, pulsating or oil canning. The base sections for the field fabricated units shall be provided as complete prefabricated sections for field joining.

B. The entire unit base shall be fully welded and guaranteed waterproof; cooling coil condensate shall have a minimum 3″ deep sump between structural members to serve as a drain pan to prevent building water damage from the unit. Sump to be 14 GA. stainless steel double-sloped towards units drains to positively remove condensate from the unit.

C. The base floor shall be minimum 3/16″ thick aluminum tread plate bonded to the base floor so that there is no thru metal. All seams on floor plates shall be continuously welded. The base floor shall be designed for a minimum live load of 100 pounds per square foot throughout the unit. The base floor is to be supported with adequate stiffening members to prevent oil canning. Unit base shall be provided with aluminum longitudinal base channels that provide adequate support to limit floor deflection to 1/200th of the span. The floor surface shall not be the source of strength for component and service personnel weight. Floors shall have a 2″ turned up lip to form a waterproof surface.

D. The perimeter support members shall be a minimum of 8″ welded structural member properly sized to support all major components and the housing during rigging, handling and operation of the unit.

E. The underneath side of the base pan and base perimeter shall be insulated with minimum 3″ thick 1.5-pcf high density polyisocyanurate injectable foam insulation covered with a plastic sheet to form a vapor barrier. Vapor barrier material is to be continuous with no seams.

F. Each section of the unit base shall contain a minimum 1″ NPT drain to facilitate system washdown, maintenance and condensate removal. Areas in the base where potential standing water cannot be removed through drains or weep holes are not acceptable. Clean out drains shall be provided with removable caps of non-corrosive material.

G. All equipment within air handling unit shall be provided with a minimum 2" high base to raise equipment off unit floor for housekeeping. Equipment mounted directly on unit floor is unacceptable.

H. All unit base service openings shall be framed with a minimum 2″ high water dam continuously welded to the floor.

I. Fastening to floor plate or joining of unit sections to be accomplished by bolting through gasketed joints above the floor line. Fasteners which penetrate base floor plate are not acceptable.

2.4 AIR HANDLING UNIT CASING:

A. Air handling unit casing shall be built up from the unit base with panels. The unit manufacturer shall be the manufacturer of the panel system. Panels shall be load bearing and capable of forming the enclosure without additional structural members. Panels shall be joined together with independent joining member and fastened with stainless steel fasteners.

B. All panels shall be double wall all aluminum construction with minimum .050" aluminum exterior and .050" solid aluminum interior skin. Interior finish to be smooth mill finish, exterior to be a low reflective textured mill finished. Fan sections shall have acoustical absorptive panels. Acoustical absorptive panels shall not be used within 24" downstream of cooling coil. Each panel shall contain an integral frame or be properly supported by a structural framing system. Panel shall have continuous tight seal at the interior and exterior skins completely encapsulating the insulation.

1. The minimum panel thickness shall be 3" thick with 3-pcf high density polyisocyanurate injectable foam insulation. Core material shall comply with NFPA 90A requirements. Housing insulation shall have a "U" valve greater than 0.07 BTU/Hr/Sq. Ft./ Deg. F.

C. Thickness of the panel skin, core density, rib structural frame spacing shall be regulated to eliminate panel pulsation and restrict the maximum deflection to L/250 of any span at 12 inches TSP positive or negative plus snow and wind loading. Casings shall be built to exceed AMCA Class "C" requirements.

D. Casing system shall be guaranteed to assure the owner that system capacity, performance, and cleanliness standards specified are not compromised. All panel joints shall be sealed with gasket insulation. The gasketing shall be sealed to provide a full thermal and air leak free connection.

E. All casing walls shall be of panel construction, including the fan discharge walls and mixing section walls

F. Panel system shall incorporate an integral thermal break system throughout the unit such that there is no through metal path between the interior and exterior surface of the unit casing at all locations. Criteria to evaluate requirement for thermal break system shall be based upon scheduled unit performance and ambient conditions anticipated around the units. The preferred method for a thermal break shall consist of a minimum ½" structural epoxy bridge.

G. Any equipment flashing, internal partitions or other attachments to the casing shall be made in such a way as to ensure a permanent leak-tight connection. Attachments that are bolted, screwed, or welded to or through the casing creating air bypass, air leakage or rust propagation areas are not acceptable.

H. All ductwork penetrations through unit enclosure shall be provided with framed openings of size indicated on drawing. Openings to be provided with flanged duct connections of same material as casing interior extending a minimum of 4" from surface of unit casing. All piping and conduit penetrations shall be provided with sleeves sealed watertight to unit casing; pipe penetrations through the unit casings shall be by the unit manufacturer and be properly sealed prior to leaving the factory. Penetrations created by cutting through panels, compromising panel integrity, will not be acceptable. Penetrations made in the field shall be made under the supervision of the factory air handling units representative.

I. Provide minimum 24” wide access doors for access to all internal components. Access doors shall be installed to open against the greatest pressure relative to air pressure on each side of access door
   1. Access doors shall be of the same construction as panels described above. Corners shall be seal welded for rigidity and air tightness. Mitered and caulked corners are unacceptable.
   2. The access doors shall be guaranteed tight closing by the means of two continuous separate gasket seals around the entire periphery of the door or panel set at a beveled 45° angle to assure a true perpendicular, non-shearing compression fit. Gasket material shall be UV-resistant, closed cell neoprene; gaskets shall be attached by adhesive and not be mechanically held in place. Single gasket seals or 90º gasket configurations will not be accepted.
   3. Each access door shall contain a thermopane tempered safety glass window (min. 10” square). Window assembly shall have a vacuum between panes to prevent condensation
   4. Each access door shall have a built-in static pressure probe port with cap plug for ease of pressure readings across various internal components. Provide minimum 1” dia. test ports with screwed caps on casing upstream and downstream of all coils and filters for pressure and temperature measurement.
   5. Each access door shall be mounted with stainless steel fully adjustable hinges, and shall have a least two (2) non-corrosive handles operable from either side. The door handles shall include self-locking nuts and stainless steel hardware to assure a long term proper door operation. Door handle striker plates shall be non-metallic high impact nylon with a notched “center position” to lock the handle in place. No moving parts shall contact the casing materials. Door tie backs shall be provided on all doors.
   6. Removable access panels shall be provided as indicated on the drawings for service and maintenance. Access panels shall be of the same construction as panels described above. Removable access panels shall be designed and constructed such that removal and replacement may be accomplished without disturbing adjacent panels. Airtight integrity must be maintained.

2.5 AIR HANDLING UNIT ROOF CONSTRUCTION

A. The roof section shall be 3” thick double wall

B. The exterior skin of the roof shall be .05” thick aluminum, with .050” thick interior skin and internal channel supports

C. 3" injectable foam insulation, with an R-value of 6.2 per inch, shall be used over the entire roof. Insulation shall meet all NFPA 90A requirements

D. All panel seams shall be caulked with sealant.

E. When a unit is split into sections, 2" x 1/4" perimeter companion channel with ridge cap shall be provided.

2.6 MOTORS

A. REFER TO DIVISION 23 SECTION “COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT”

2.7 AIR HANDLING UNIT ELECTRICAL:

A. Provide non-corroding vaportight cold weather LED light fixtures in each AHU compartment suitable for use in wet and damp locations.
   1. Lights shall have 120V cold weather ballasts with emergency backup power pack and shall comply with UL Standard #1570 and shall carry the UL label.
   2. Wiring shall be #12 copper type THHN in liquid tight conduct. Wire to cast watertight switch boxes with 60 minute timer switch, and trim plate on exterior of casing at each access door. Each timer switch shall energize lights in adjoining section of casing.
   3. Conduit and wiring to light fixtures and convenience outlets shall be brought back to a single NEMA 3R junction box at the exterior of the air handling unit for single source power connection. Provide circuiting per NEC (1600 watts max per circuit).
   4. Provide two (2) 1 ¼" liquid tight raceways along the entire top length of each unit section. Provide an internal junction box and conduit connection to allow for routing of temperature controls wiring and tubing through air handling unit.

B. Provide duplex 120V, GFI, service outlet (outdoor use) in all accessible sections. Conduit and wiring to outlets shall be brought back to a single junction box (not same as lighting) for single source power connection.

C. Extend motor leads to an external NEMA 1 service fused disconnect switch for each fan.

D. The AHUs shall be wired 100% by manufacturer for connection by electrical contractor with separate main junction boxes for 120v and 460v power feeds for each VFD/fan motor. Electric work shall be in accordance with National Electrical Code and requirements of Section 26000.

2.8 PLUG/PLENUM FANS (SUPPLY)

A. Fan shall be a single width, single inlet backward inclined centrifugal airfoil, direct driven plenum blowers as specified.

B. The fans shall be of bolted and welded construction utilizing corrosion resistant fasteners. The inlet panel shall be constructed from minimum 10-gauge steel with a spun aluminum inlet cone. Bearings shall be supported on a welded assembly constructed of minimum ¼' x 2 ½" steel. The inlet panel and bearing support structure shall be attached to a frame constructed of 2"x2"x ¼: steel tubing with continuously welded joints

C. Wheel shall be aluminum, non-overloading, centrifugal backward inclined, airfoil type. Blades on all sizes shall be continuously welded to the backplate and deep spun inlet shroud. All sizes shall be securely keyed to the fan shaft. Wheel shall overlap an aerodynamic aluminum inlet cone to provide maximum performance and efficiency. Wheel shall be factory balanced in accordance with AMCA standard 204-96, Balance Quality and Vibration Levels for Fans after the fan and motor have been mounted on the factory provided inertia pads.

D. Blower shaft shall be AISI C-1045 hot rolled and accurately turned, ground and polished. Shafting shall be sized for a critical speed of at least 125% of maximum RPM.

E. Provide OSHA screened enclosures for plenum fans

F. Plenum fans shall be as manufacturer by Twin Cities and include Piezometer air flow monitoring stations. Pneumatic lines from air flow stations shall extend through unit casing for use by ATC

G. All fans shall be mounted on spring isolators. The base shall be of sufficient size and thickness for the fan and motor size as scheduled.

H. Bearings are to be heavy duty, grease lubricated, anti-friction ball or roller self aligning, pillow block type and selected for minimum average bearing life (AFBMA L-50) in excess of 200,000 hours at the maximum class RPM. All bearings shall be equipped with re-greasable Zerk fittings. Grease fittings shall be at the fan and not extended to the exterior casing.

I. The unit manufacturer shall provide flexible connection between fan and fan wall. Fan assembly shall be provided with thrust arrestors as required to prevent damage to the flex connection. Flex connection shall be flame retardant fabric suitable for intended use meeting the requirements of NFPA 90A.

2.9 FILTER SECTIONS:

A. Provide all prefilters and final filters of number, size and capacity as required for air handling system indicated on drawings and as stated in these specifications

B. Filters shall have nominal rating of 500 fpm. Each cell shall be 24" x 24", or 12” x 24”. Initial pressure drop shall not exceed that indicated. Filter media efficiency will be tested in accordance with ASHRAE Test Standard 52-76. Filters will be listed by Underwriters Laboratory (UL) as Class 2.

C. Media shall be approved and listed as Underwriters Laboratories Class 2 when tested according to UL Standard 900 and as described below:
   1. Filters (MERV 8 Prefilter):
      a. Shall be UL Class 2, 2" thick MERV 8 pleated fabric filter for supply filters.
      b. Filter shall have welded steel wire grid support
      c. Filters shall not unload or collapse under high velocity or static pressure.
      d. Efficiency shall be MERV 8 as measured by ASHRAE Test Standard 52-76.
      e. Initial pressure drop shall be more than 0.28" at a velocity of 500 fpm. Filters shall be designed to operate at up to 500 fpm for the 2" thick filter.
      f. Provide 2 sets of prefilters
      g. Filters shall be Farr 30/30 or equivalent by AAF or Aerostar
   2. Final HEPA filters (downstream of supply fan section) OR units only: 12” rigid separator style pleated filter.
      a. HEPA filters shall be extended media separator type filters with a minimum efficiency of 99.97% on 0.30 micrometer particles.
      b. Filters shall be UL900 Class 2.
      c. The separator style filter pack shall be constructed by pleating a continuous sheet of non-woven water resistant fiberglass media around hemmed-edge corrugated aluminum separators.
      d. The filter pack shall be sealed into a galvanized frame with a fire retardant sealant

3. Final filters (Downstream of supply fan section) PACU and Bed floor units only; 12” rigid mini pleat type MERV 16 rigid disposable filter.
   a. Filter media shall be of ultra-fine fiberglass formed into a thin paper-like mat with a water repellant binder. Construction shall be dual density, consisting of coarser fibers on the air entering side and finer fibers on the air leaving side, to enhance full depth particle collection. The rigid media pack shall consist of media pleats, structurally bonded one to the other, in order to maximize media area while minimizing pack depth. Corrugated media separators or wire media support grids shall not be required. The eight mini-pleats shall be arranged in a series of four Vs, with an overall filter depth of 12"
   b. The media pack shall be contained within the frame of rigid polystyrene plastic or galvanized steel for high wet strength and moisture resistance. The pack shall be bonded inside the double wall frame on all four edges to prevent leakage and increased rigidity

D. Filters shall be upstream removable.

E. Filter frames shall be aluminum or stainless steel construction with associated clips required to hold filter cells. Pre filter and final filter frames to be provided with closed cell neoprene gasketing.

F. Filter holding frames shall be installed and individually sealed to prevent leakage around frames. Filter banks shall be reinforced with vertical stiffeners to assure rigidity. Unit manufacturer shall provide flashing between filter banks and unit casings to prevent air leakage or bypass around the frames. Installation techniques, sealing methods, and structural reinforcement eliminate unfiltered air bypass and assure system cleanliness based on filter efficiencies specified.

G. For the HEPA filter frames, provide 11 gauge welded filter racks, using swing arm bolts to secure filters.

H. Provide filter gauges for each filter as follows:
   1. Dwyer Magnahelic Type 2002 AF dry air filter gauge, with scale of 0 to 2" across filter, with appropriate static pressure tips, vent valves, and tubing with flag suitably marked to indicate need to change filter for prefilters and final filters.

2.10 AIR BLENDER UNITS

A. Acceptable Manufacturers: Blender Products, Inc. -Series IV AIR BLENDER® static mixer

B. Static mixing devices shall be installed where shown on plans to enhance the mixing of outside air with return air to a mixing effectiveness required to eliminate Freeze stat trips, minimize sensor error and enhance outdoor air distribution. Furthermore the air mixing device shall provide even airflow across filters, coils and control sensors.

C. The pressure drop rating for static air mixers shall include the pressure loss due to the mixer design and the mixer-to- plenum area ratio.

D. Detailed documentation of performance testing shall be made available upon request

E. Static air mixers shall be geometrically scaled to ensure consistent performance across full range of sizes offered. Mixers that are not geometrically scaled are not acceptable. Mixers shall be of counter rotational design.

F. Construction: Static air mixers shall be welded and mechanically fastened .080” or .125” thk. Aluminum. Static air mixers shall have Bare finish.

G. Installation: Installation shall be in accordance with the manufacturer’s written installation instructions and SMACNA plenum construction guidelines. If necessary, provide reinforcing in plenum where the Mixing Device Is Installed To Eliminate Excess Vibration or Deflection of Blank off Plenum.

2.11 AIR CONTROL DAMPERS

A. Dampers shall be low leakage, opposed blade design capable of withstanding 8” wg differential pressure at 2,000 fpm approach velocity. Leakage rate not to exceed 6 CFM per ft.^{2} at 4” wg differential pressure and 2,000 fpm approach velocity.

B. Damper frames shall be made of extruded aluminum. Damper blades shall be extruded aluminum airfoil shape to withstand high velocities and static pressures. Leakage not to exceed 8 cfm per square foot through a 36 inch by 36 inch damper at 4" w.g. pressure differential
   1. Frames: .080” extruded aluminum. Damper frame is 4 inches deep and is insulated with polystyrofoam. Frame is assembled using type 316 stainless steel screws.
   2. Blades: Airfoil shaped extruded aluminum, maximum 48 inches long. Blades shall be insulated with polyurethane foam and thermally broken.
   3. Bearings: Celcon inner bearing fixed to a 7/16 inch aluminum hexagon blade pin, rotating with a polycarbonate outer bearing inserted in the frame.
   4. Blade Seals: Extruded silicone secured in an integral slot within the aluminum extrusions
   5. Damper shall be selected on the basis of the pressure class. Linkage hardware is installed in the frame side. All aluminum linkage hardware parts are clear anodized. All non-aluminum linkage hardware parts are type 316 stainless steel.
   6. All dampers shall be provided with jack shafts
   7. Control actuators shall be provided by ATC contractor

C. Acceptable dampers: TAMCO Series 9000 thermally insulated series.

2.12 INJECTION TYPE HUMIDIFIER PANELS:

A. Each panel shall consist of a steam supply header/separator, a condensate collection header and a bank of closely spaced steam dispersion tubes spanning the distance between the two headers. Each steam outlet in tubes shall contain a steam orifice sized for its required steam capacity. The humidifier shall provide absorption characteristics that preclude water accumulation on any in-duct surface within 36″ downstream of the humidifier tube panel while maintaining conditions of 90% (maximum) relative humidity at a minimum temperature of 55°F in the duct air stream. Air pressure loss across humidifier panel shall not exceed 0.10″ W.C. at a duct air velocity of 500 FPM. Humidifiers in air handling units shall have assemblies sized to match the unit's cooling coil casing size. Humidifiers shall be Ultra-Sorb by Dri-Steem. Humidifiers shall be purchased locally.

B. Each packaged humidifier panel assembly of tubes and headers shall be contained within a stainless steel metal casing to allow convenient duct mounting or to facilitate the stacking of and/or the end-to-end mounting of multiple panels in ducts or air handler casings.

C. All tubes and headers shall be of 304 stainless steel and joints shall be heli-arc welded. Tubes shall be joined to headers with slip fit couplers.

D. Insulated dispersion tubes. Dispersion tubes shall be insulated with a plenum−approved insulating material for in−duct installation and have an R−value not less than 0.5 at a thickness not more than 0.125" (3.2 mm), for minimal increase in dispersion tube diameter.
   1. Airstream heat gain shall not exceed the values as scheduled; the values shall be supported by the manufacturer's published data.
   2. Insulating material shall meet the following criteria at 0.125" (3.2 mm) thickness:
      a. Fire/smoke index shall be 0/0 per any of the following test procedures: − UL 723 fire/smoke index (Test for Surface Burning Characteristics of Building Materials) − NFPA 255 (Standard Method of Test of Surface Burning Characteristics of Building Materials) − ASTM E84 (Surface Burning Characteristics for Materials Used in Plenums).
      b. Stable up to 300 °F (148 °C) continuous − to prevent material degradation, hardening, or crumbling at high temperatures
      c. Closed−cell construction does not absorb water or support microbial growth − to negate the need for vapor barriers and jackets
      d. Non−toxic and pure as documented in manufacturer's data − to prevent off−gassing and to facilitate use in clean rooms, pharmaceutical applications, and food industries
      e. Will not degrade when exposed to UVC light − to negate the need for UV wraps
      f. Continuous, seam−welded, and held in place without bands or clamps − to minimize surfaces for the accumulation of particulate matter

2.13 MOTORIZED CONTROL SMOKE DAMPERS

A. Dampers shall be UL555S rates as manufactured by Ruskin Inc. or approved equal.

B. Leakage characteristics shall be based upon test procedures per AMCA Standard 500 that shows air leakage at 6 cfm per sq. ft at 4″ wg differential pressure. Dampers shall be suitable for 9″ w.c. static pressure and 6000 FPM free velocities.

C. Frames and blades to be minimum 13 ga. Galvanized steel. Blades to be of single unit design.

D. Provide overlapping blades and seals (not just overlap seals) to assure minimum air leakage. Provide extruded silicone seals fit into a ribbed groove insert in blades with a formed stainless steel, spring steel at the jamb.

E. Rod bearings shall be designed so that there shall be no metal-to-metal or metal-to-bearing riding surfaces. Interconnecting linkage to have separate Celcon bearing to eliminate friction in linkage.

F. Blade linkage hardware shall be of non-corrosive reinforced material or cadmium plated steel.

G. All dampers shall be parallel blade type.

2.14 STEAM COILS

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

1. Aerofin Corporation.
2. Luvata
3. Heatcraft Refrigeration Products LLC; Heat Transfer Division.
4. Trane.

B. Performance Ratings: Tested and rated according to AHRI 410 and ASHRAE 33.

C. Minimum Working-Pressure/Temperature Ratings: 100 psig (690 kPa), 400 deg F (204 deg C).

D. Source Quality Control: Factory tested to 300 psig (2070 kPa).

E. Tubes: ASTM B 743 seamless copper, minimum 0.025 inch (0.635 mm) thick.

F. Fins: Aluminum plate fins, minimum 0.006 inch (0.152 mm) thick. Fin collars are drawn, belled, and firmly bonded to the tubes by mechanical expansion of the tubes.

G. **Headers and tubes: Cast Iron with tubes expanded into header, seamless copper tube with silver brazed joints. Coil shall be drainable, with threaded plugs for drain and vent, threaded plugs in return bends and in headers opposite each tube, sloped within frame to condensate drain connection.**~~Red Brass with cleaning plugs, and drain and air vent tappings~~

H. Tube Type: ~~Steam coils are internally pitched for proper drainage of steam condensate from coils. Inner tubes have orifices that ensure even steam distribution across the coil face. Orifices are directed towards the return connections to ensure that the steam condensate is adequately removed from the coil.~~

~~I. Frames: ASTM A 666, Type 304 stainless steel, minimum 0.0625 inch (1.6 mm) thick for flanged mounting.~~

J. **Casings shall be 16 gauge, continuous coated galvanized steel with fins recessed into channels to minimize air bypass, with 3/8" holes on 3" centers in top and bottom channels for mounting.**

2.15 COOLING COILS.

A. Acceptable manufacturers subject to compliance with the specification shall be as follows:
   1. Aerofin
   2. Heat Craft
   3. Marlo
   4. Luvata

B. Primary surface shall be round seamless 0.025" thick, 5/8" o.d. copper tubes on 1 1/2" centers, staggered in the direction of airflow. All joints shall be brazed. Tube bends shall be 0.035 thick.

C. Secondary surface shall consist of aluminum plate type fins for higher capacity and structural strength. Fins shall have a minimum thickness of 0.0095" with full drawn collars to provide a continuous surface cover over the entire tube for maximum heat transfer with a maximum (10) fins per inch. Bare copper tube shall not be visible between fins. Fins shall have no openings punched in them so as to accumulate lint and dirt. Tubes shall be mechanically expanded into fins to provide a continuous primary to secondary compression bond over the entire finned length for maximum heat transfer rates. Tubes that have been expanded through the use of hydraulic expansion methods will not be acceptable.

D. Cooling coil casing and tube supports shall be constructed of stainless steel with 3/8" diameter bolt holes for mounting on 8" centers. Casing shall be a minimum of 16 gauge, 304 stainless steel, reinforced flange of a minimum of 1½" deep flange.

E. Coil header shall be of copper materials using seamless copper tubing with intruded tube holes to permit expansion and contraction without creating undue stress or strain. Coil size shall be determined by coil manufacturer based upon the most efficient coil circuiting. Vent connections at the highest point to ensure proper venting and drain connections shall be provided at the lowest point to ensure complete drainage and prevent freeze-up.

F. Coils shall have foam sealing strip located between casing channels and fins along top and bottom to arrest air bypass and water carryover.

G. The complete coil core shall be pressure tested with 315 lbs. air pressure under warm water and shall be suitable for operation at 250 psig working pressure. Individual tube test and core tests before installation of headers will not be considered acceptable. Coils shall be circuited for drainability and for service without removing individual plugs from each tube. Use of internal restrictive devices to obtain turbulent flow will not be acceptable since they prevent complete draining of the coil.

H. The manufacturer shall furnish coil capacities as outlined in the tabulation. Capacities shall be verified with an ARI approved computer selection method.

I. The unit manufacturer shall provide separate drains from pan under each coil section. Drains from multiple, stacked coil pans shall be routed individually to drain outlet, not cascaded from one coil pan to the next lower pan.

J. Coils shall be mounted to allow removal of any coil individually without disturbing any other coils, and shall be bolted off for removal.

K. Drain pans and support members shall be stainless steel. Coil drain pans shall allow for condensate removal 3 inch upstream and 24 inch downstream of all coils.

L. Each individual coil module shall have a limited height of up to 36".

M. Coils shall be fully drainable with bottom of coil drain.

2.16 UVC EMITTERS

A. General:
1. Acceptable Manufacturers:
a. Steril-Aire, Inc. Model DE Series as shown on Schedule or Drawings.
b. Substitutions: (10) day prior approval is required and is to include documentation by a recognized Industry Independent Testing Lab on UVC Emitter performances. Performance results must meet or exceed the performance for Emitters in an HVAC environment as detailed in Paragraphs A, 2.b, Paragraph B, Item 2, and Paragraph C, Items 3, 4 and 5.
2. Quality Assurance:
a. Qualifications: Each component and product is to be inbound and outbound tested before shipment under Mil Standard 105E and ANSI/ASQCZ 1.4
b. Output Verification: When tested in accordance with the general provisions of IES Lighting Handbook, 1981 Applications Volume, total output per one inch arc length shall not be less than 10 μW/cm2, at one meter, in a 400 fpm airstream of 45° F
3. Warranty:
a. Fixture and Emitter shall be warranted to be free from defects for a period of one year

B. Design Requirements:
1. Irradiation - Emitters and fixtures are to be installed in sufficient quantity and in such an arrangement so as to provide an equal distribution of UVC energy on the coil and in the drain pan. To maintain energy efficiency, the UVC energy produced shall be of the lowest possible reflected and shadowed losses.
2. Intensity - The minimal UVC energy striking the leading edge of all the coil fins shall not be less than 1400 μW/cm2. This sets the quantity of fixtures to be installed and their placement.
3. Installation - Emitters and fixtures shall be installed downstream of the cooling coil at right angles to the coil fins, such that UVC energy bathes all surfaces of the coil and drain pan

C. Equipment:

1. Units shall be high output, HVAC-type, germicidal UVC light sources, factory assembled and tested. Components shall include a housing, reflector, high efficiency electronic power source, Emitter sockets and boots, and Emitter tube, all constructed to withstand HVAC environments.
2. DE Unit housings shall be made of 304 stainless steel, with DE Units having electrical connectors on both ends to simplify gang wiring and wiring to power. They shall include mounting holes to assist in securing the fixtures.
3. DE reflectors shall be constructed of high spectral finished aluminum alloy with a minimum 85% reflectance of 254-nm UVC energy.
4. High efficiency electronic power sources shall be 115 Vac/60/1. They shall be UL listed to comply with UL Standard 1995 and capable of igniting each Emitter at temperatures from 35 - 170° F in airflow velocities to 1000 fpm. They shall be equipped with RF and line noise suppression.
5. Emitter tube shall be of the high output, hot cathode, T5 (15mm) diameter, and medium bi-pin type. They shall produce 95% of their energy at 254 nm and be capable of producing the specified output at airflow velocities to 1000 fpm at temperatures of 35 - 170° F. UVC Emitters shall produce no ozone or other secondary contamination.

D. Installation of UVC Emitters
1. Emitters shall be installed and wired at the AHU manufacturer using an aluminum framing system provided by Steril-Aire.
2. Provide an interlock switch on the access to the UVC Emitters to turn the lights off when the access is opened.
3. Install provided Caution Labels on all accesses to the Emitters

2.17 OUTSIDE AIR MONITOR

A. The monitor/controller shall be capable of direct measurement of airflow through an outside air inlet and provide an input to the building automation system that is linear to the measured airflow rate.

B. The monitor/controller shall measure inlet airflow with an accuracy of ±0.5% of reading over a range of and within ± 5% for operating ranges as low as 100 fpm.

C. The monitor/controller shall interface with existing building management systems, accepting inputs for fan system start, economizer mode operation, and an external controller setpoint, and provide flow deviation alarm outputs.

D. The sensors shall be constructed of materials that resist corrosion due to the presence of salt or chemicals in the air; all non-painted surfaces shall be constructed of stainless steel. The electronics enclosure shall be NEMA 1.

E. The airflow measurement system shall be tested in accordance with AMCA Standard 610-06, Figure 4 and AMCA Standards 611-06 Certified Ratings program. The airflow measurement system shall bear the AMCA International certified ratings seal for airflow measurement station performance.

F. Airflow monitor shall be by Ebtron or approved equal using Thermal Dispersion Technology.

2.18 UNIT DISCHARGE SECTION

A. Discharge section with exit velocities exceeding 1500 fpm shall be complete with aerodynamically designed framed discharge openings or spun bellmouth fittings in order to reduce overall system static pressures.

B. Bellmouth fittings shall have minimum radius equal to 20% of the diameter (round or oval) or shortest side (rectangular) to provide optimum performance. Bellmouths with radius less than 2” are not acceptable. Bellmouth to be mounted flush with unit interior edge to minimize exit loss.

C. Openings shall conform to the size and configuration of the ductwork where shown

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of AHUs.

B. Examine roughing-in for AHUs to verify actual locations of piping and duct connections before equipment installation

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

3.2 CONNECTIONS

A. Install condensate drain, minimum connection size, with trap and indirect connection to nearest roof drain or area drain, sized with proper trap size per drawing details to ensure proper drainage.

B. Install piping adjacent to AHU’s to allow service and maintenance.

C. Duct installation requirements are specified in other Division 15 Sections. Drawings indicate the general arrangement of ducts. The following are specific connection requirements

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. Report results in writing.

B. Perform tests and inspections and prepare test reports
   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. Report results in writing.

C. Tests and Inspections:
   1. After installing AHUs and after electrical circuitry has been energized, test units for compliance with requirements.
   2. Inspect for and remove shipping bolts, blocks, and tie-down straps.

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
5. Test unit and controls under winter and summer conditions.

D. Remove and replace malfunctioning units and retest as specified above.

3.4 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

B. Complete installation and startup checks according to manufacturer's written instructions and do the following:
1. Inspect for visible damage to unit casing.
2. Inspect for visible damage to compressor, coils, and fans.
3. Inspect internal insulation.
4. Verify that labels are clearly visible.
5. Verify that clearances have been provided for servicing.
6. Verify that controls are connected and operable.
7. Verify that filters are installed.
8. Remove packing from vibration isolators.
9. Retain first subparagraph below for barometric relief dampers
10. Verify lubrication on fan and motor bearings.
11. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
12. Start unit according to manufacturer's written instructions
    a. Complete startup sheets and attach copy with Contractor's startup report.
13. Inspect and record performance of interlocks and protective devices; verify sequences.
14. Operate unit for an initial period as recommended or required by manufacturer.
15. Calibrate thermostats.
16. Adjust and inspect high-temperature limits.
17. Inspect outdoor-air dampers for proper stroke and interlock with return-air dampers.
18. Inspect controls for correct sequencing of heating, dampers, cooling, and normal and emergency shutdown.
19. Measure and record the following minimum and maximum airflows. Plot fan volumes on fan curve
    a. Supply-air volume, return air volume.
20. Verify operation of remote panel including pilot-light operation and failure modes. Inspect the following:
    a. Low-temperature safety operation.
    b. Filter high-pressure differential alarm.
    c. Smoke and firestat alarms.
21. After startup and performance testing and prior to Substantial Completion, replace existing filters with new filters

3.5 CLEANING AND ADJUSTING

A. After completing system installation and testing, adjusting, and balancing AHU and air-distribution systems, clean filter housings and install new filters.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain AHUs. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION

This page is intentionally left blank.

SECTION 23 81 23

COMPUTER-ROOM AIR-CONDITIONERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
1. Floor-mounted computer-room air conditioners, 6 tons and larger.
2. Floor-mounted computer-room air conditioners, 5 tons and smaller.
3. Ceiling-mounted computer-room air conditioners.
4. Console computer-room air conditioners.

1.3 DEFINITION

A. BAS: Building automation system.

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 and the unit will be fully operational after the seismic event."

1.5 SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. LEED Submittals:
1. Product Data for Credit EA 4: Documentation required by Credit EA 4 indicating that equipment and refrigerants comply.
2. Product Data for Prerequisite EQ 1: Documentation indicating that units comply with ASHRAE 62.1, Section 5 - "Systems and Equipment."

C. 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.

D. Coordination Drawings: Plans, elevations, and other details, drawn to scale, using input from Installers of the items involved.

E. 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.

F. Field quality-control reports.

G. Operation and Maintenance Data: For computer-room air conditioners to include in emergency, operation, and maintenance manuals.

H. Warranty: Sample of special warranty.

1.6 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.

1.7 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 sizes and locations of concrete bases with actual equipment provided.

1.8 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 Humidifiers: Manufacturer's standard, but not less than three years from date of Substantial Completion.

3. Warranty Period for Control Boards: Manufacturer's standard, but not less than three years from date of Substantial Completion.

1.9 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Fan Belts: One set(s) for each belt-driven fan.
   2. Filters: One set(s) of filters for each unit.

PART 2 - PRODUCTS

2.1 FLOOR-MOUNTED UNITS 6 TONS AND LARGER

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Liebert Corporation.
   2. Stulz-ATS.
   3. Data Aire

B. Description: Packaged, factory assembled, prewired, and prepiped; consisting of cabinet, fans, filters, humidifier, and controls.

C. Cabinet and Frame: Welded steel, braced for rigidity, and supporting compressors and other mechanical equipment and fittings.
   1. Doors and Access Panels: Galvanized steel with polyurethane gaskets, hinges, and concealed fastening devices.
   2. Insulation: Thermally and acoustically insulate cabinet interior with 1-inch-thick duct liner.
   3. Finish of Interior Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
   4. Finish of Exterior Surfaces: Baked-on, textured vinyl enamel; color as selected from manufacturer's standard colors

D. Supply-Air Fan(s):
   1. Double-inlet, forward-curved centrifugal fan(s); statically and dynamically balanced.
   2. Drive: V-belt, with steel shaft with self-aligning ball bearings and cast-iron or steel sheaves, variable- and adjustable-pitch motor sheave, minimum of two matched belts, with drive rated at a minimum of two times the nameplate rating of motor.

E. Cooling System:
   1. Hydronic Cooling Coil: Seamless copper tubes expanded into aluminum fins with modulating three-way control valve. Materials of construction exposed to condenser water to be cupronickel
      a. Cooling Medium: 30% propylene glycol solution.
      b. Control Valve: Class 125 body with Belimo actuator.
      c. Maximum Pressure Drop: 5 psig at design flow rate.
      d. Close-Off (Differential) Pressure Rating: 100 percent of pressure differential across valve or 100 percent of total system (pump) head.

2. 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.

F. Hot-Water Heating Coil: Seamless copper tubes expanded into aluminum fins with two-way modulating control valve and strainer.
   1. Control Valve: Class 125 body with Belimo actuator.
      a. Maximum Pressure Drop: 5 psig at design flow rate.
      b. Close-Off (Differential) Pressure Rating: 100 percent of pressure differential across valve or 100 percent of total system (pump) head.

G. Extended-Surface, Disposable, Panel Filter: Pleated, lofted, nonwoven, reinforced cotton fabric; supported and bonded to welded-wire grid; enclosed in cardboard frame with 2-inch-thick, disposable, glass-fiber prefilter.
   1. Thickness: 2 inches
   2. Arrestance (ASHRAE 52.1): 90 percent.
   3. Merv (ASHRAE 52.2): 7

H. Electrode Steam Humidifier: Self-contained, microprocessor-controlled unit with disposable, polypropylene-plastic cylinders, and having field-adjustable steel electrodes and stainless-steel steam dispersion tube.
   1. Plumbing Components and Valve Bodies: Plastic, linked by flexible rubber hosing, with water fill with air gap and solenoid valve incorporating built-in strainer, pressure-reducing and flow-regulating orifice, and drain with integral air gap.
   2. Control: Fully modulating to provide gradual 0 to 100 percent capacity with field-adjustable maximum capacity; with high-water probe.
   3. Drain Cycle: Field-adjustable drain duration and drain interval.

I. Integral Electrical Controls: Unit-mounted electrical enclosure with piano-hinged door, grounding lug, combination magnetic starters with overload relays, circuit breakers and cover interlock, and fusible control-circuit transformer.

J. Disconnect Switch: Nonautomatic, molded-case circuit breaker with handle accessible when panel is closed and capable of preventing access until switched to off position.

K. Microprocessor-Control System: Continuously monitors operation of process cooling system; continuously displays room temperature and room relative humidity; sounds alarm on system malfunction and simultaneously displays problem. If more than one malfunction occurs, system displays fault in sequence with room temperature and continues to display fault when malfunction is cleared until system is reset.
   1. Malfunctions:
      a. Power loss.
      b. Loss of airflow.
      c. Clogged air filter.
      d. High room temperature.
      e. Low room temperature.
      f. High humidity.
      g. Low humidity.
      h. Smoke/fire.
      i. Water under floor.
      j. Supply fan overload.
   2. Digital Display:

a. Control power on.
b. Humidifying.
c. Dehumidifying.
d. Heat operating.
e. or No. 1 - Operating.
f. Economy cooling.

3. Push buttons shall stop and start process cooling system, silence audible alarm, test indicators, and display room's relative humidity.
4. BAS Interface: Factory-installed hardware and software to enable the BAS to monitor, and display unit status and alarms.
   a. Hardwired Points:
      1) Monitoring: On-off status, common trouble alarm space temperature and space relative humidity
   b. ASHRAE 135 (BACnet) communication interface with the BAS shall enable the BAS operator to remotely control and monitor the unit from an operator workstation. Control features and monitoring points displayed locally at unit control panel shall be available through the BAS.

2.2 FLOOR-MOUNTED UNITS 5 TONS AND SMALLER

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Liebert Corporation.
   2. Stulz-ATS.
   3. Data Aire

B. Description: Self-contained, factory assembled, prewired, and prepiped; consisting of cabinet, fan, filters, and controls; for vertical floor mounting in upflow or downflow configuration.

C. Cabinet and Frame: Welded tubular-steel frame with removable steel panels with baked-enamel finish, insulated with 1-inch-thick duct liner.
   1. 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 with adjustable V-belt drive.

E. Cooling System:

F. Hydronic Cooling Coil: Seamless copper tubes expanded into aluminum fins with modulating three-way control valve. Materials of construction exposed to condenser water to be cupronickel
   1. Cooling Medium: 30% propylene glycol solution.
   2. 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.
   3. Disconnect Switch: Nonautomatic, molded-case circuit breaker with handle accessible when panel is closed and capable of preventing access until switched to off position.

G. Filter: 2-inch-thick, disposable, glass-fiber media.
   1. Arrestance (ASHRAE 52.1): 90 percent.
   2. Merv (ASHRAE 52.2): 7

H. Electrode Steam Humidifier: Self-contained, microprocessor-controlled unit with disposable, polypropylene-plastic cylinders and having field-adjustable steel electrodes and stainless-steel steam dispersion tube.
   1. Plumbing Components and Valve Bodies: Plastic, linked by flexible rubber hosing, with water fill with air gap and solenoid valve incorporating built-in strainer, pressure-reducing and flow-regulating orifice, and drain with integral air gap.
   2. Control: Fully modulating to provide gradual 0 to 100 percent capacity with field-adjustable maximum capacity; with high-water probe.
   3. Drain Cycle: Field-adjustable drain duration and drain interval.

I. Disconnect Switch: Nonautomatic, molded-case circuit breaker with handle accessible when panel is closed and capable of preventing access until switched to off position.

J. 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, 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.

2.3 CEILING-MOUNTED UNITS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Liebert Corporation.
   2. Stulz-ATS.
   3. Data Aire

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. Cooling System:

F. Hydronic Cooling Coil: Seamless copper tubes expanded into aluminum fins with two-way control valve. Materials of construction exposed to condenser water to be cupronickel
   1. Cooling Medium: 30% propylene glycol solution.
   2. 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.

G. Filter: 1-inch-thick, disposable, glass-fiber media.
   1. Arrestance (ASHRAE 52.1): 90 percent.

2. Merv (ASHRAE 52.2): 7

H. Electrode Steam Humidifier: Self-contained, microprocessor-controlled unit with disposable, polypropylene-plastic cylinders, and having field-adjustable steel electrodes and stainless-steel steam dispersion tube.
   1. Plumbing Components and Valve Bodies: Plastic, linked by flexible rubber hosing, with water fill with air gap and solenoid valve incorporating built-in strainer, pressure-reducing and flow-regulating orifice, and drain with integral air gap.
   2. Control: Fully modulating to provide gradual 0 to 100 percent capacity with field-adjustable maximum capacity; with high-water probe.
   3. Drain Cycle: Field-adjustable drain duration and drain interval.

I. Disconnect Switch: Nonautomatic, molded-case circuit breaker with handle accessible when panel is closed and capable of preventing access until switched to off position.

J. 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.

2.4 FAN MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "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 Division 26 Sections.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for 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.

3.2 INSTALLATION

A. Install computer-room air conditioners level and plumb, maintaining manufacturer's recommended clearances.

B. Computer-Room Air-Conditioner Mounting: Comply with requirements for vibration isolation devices specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."
   1. Minimum Deflection: 1 inch .

C. 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 Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment." Fabricate brackets or supports as required.
   2. Comply with requirements for hangers and supports specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to machine to allow service and maintenance.

C. Water and Drainage Connections: Comply with applicable requirements in Division 22 Section "Domestic Water Piping." Provide adequate connections for water-cooled units, condensate drain, and humidifier flushing system.

D. Hot-Water and Heating and chilled water cooling Piping: Comply with applicable requirements in Division 23 Section "Hydronic Piping." Provide shutoff valves in inlet and outlet piping to heating coils.

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. 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.

3.5 ADJUSTING

A. Adjust initial temperature and humidity set points.

B. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain computer-room air conditioners.

END OF SECTION

This page is intentionally left blank.

SECTION 23 82 19

FAN COIL UNITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes fan-coil units and accessories.

1.3 DEFINITIONS

A. BAS: Building automation system.

1.4 SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   1. Wiring Diagrams: Power, signal, and control wiring.

C. 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, based on input from installers of the items involved:
   1. Ceiling suspension components.
   2. Structural members to which fan-coil units 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.
   6. Perimeter moldings for exposed or partially exposed cabinets.

D. Manufacturer Seismic Qualification Certification: Submit certification that fan-coil units, accessories, and components will withstand seismic forces defined in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment." Include the following:
   1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified."
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 Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

E. Field quality-control test reports.

F. Operation and Maintenance Data: For fan-coil units to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Maintenance schedules and repair part lists for motors, coils, integral controls, and filters.

G. Warranty: Special warranty specified in this Section.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.6 COORDINATION

A. Coordinate layout and installation of fan-coil units and suspension system components with other construction that penetrates or is supported by ceilings, including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.

B. Coordinate size and location of wall sleeves for outdoor-air intake.

1.7 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of condensing units that fail in materials or workmanship within specified warranty period.
1. Warranty Period: Five years from date of Substantial Completion.

1.8 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Fan-Coil-Unit Filters: Furnish spare filters for each filter installed.
2. Fan Belts: Furnish spare fan belts for each unit installed.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

B. In the Fan-Coil-Unit Schedule where titles below are column or row headings that introduce lists, the following requirements apply to product selection:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
   2. Basis-of-Design Product: The design for each fan-coil unit is based on the product named. Subject to compliance with requirements, provide either the named product or a comparable product by one of the other manufacturers specified.

2.2 FAN-COIL UNITS

A. Manufacturers:
   1. Trane.
   2. YORK International Corporation.

B. Description: Factory-packaged and -tested units rated according to AHRI 440, ASHRAE 33, and UL 1995.

C. Coil Section Insulation: 1-inch thick, foil-covered, closed-cell foam complying with ASTM C 1071 and attached with adhesive complying with ASTM C 916.
   1. Fire-Hazard Classification: Insulation and adhesive shall have a combined maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84.

D. Main and Auxiliary Drain Pans: Stainless steel formed to slope from all directions to the drain connection as required by ASHRAE 62.

E. Chassis: Galvanized steel where exposed to moisture. Floor-mounting units shall have leveling screws.

F. Cabinet: Steel with factory prime coating, ready for field painting
   1. Vertical Unit Front Panels: Removable, steel, with integral stamped steel discharge grille and channel-formed edges, cam fasteners, and insulation on back of panel.
   2. Horizontal Unit Bottom Panels: Fastened to unit with cam fasteners and hinge and attached with safety chain; with integral stamped discharge grilles.
   3. Stack Unit Discharge and Return Grille: Aluminum double-deflection discharge grille, and louvered- or panel-type return grille; color as selected by Architect from manufacturer's standard colors. Return grille shall provide maintenance access to fan-coil unit.
   4. Steel recessing flanges for recessing fan-coil units into ceiling or wall.

G. Filters: Minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
   1. Pleated Cotton-Polyester Media: 90 percent arrestance and 7 MERV.

H. Hydronic Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, rated for a minimum working pressure of 200 psig and a

maximum entering-water temperature of 220 deg F. Include manual air vent and drain valve.

I. Fan and Motor Board: Removable.
   1. Fan: Forward curved, double width, centrifugal; directly connected to motor. Thermoplastic or painted-steel wheels, and aluminum, painted-steel, or galvanized-steel fan scrolls.
   2. Motor: Permanently lubricated, multispeed; resiliently mounted on motor board. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
   3. Wiring Termination: Connect motor to chassis wiring with plug connection.

J. Control devices and operational sequences are specified in Division 23 Sections "Instrumentation and Control for HVAC" and "Sequence of Operations for HVAC Controls" and

K. DDC Terminal Controller:
   1. Scheduled Operation: Occupied and unoccupied periods on seven-day clock with a minimum of four programmable periods per day.
   2. Unoccupied Period Override Operation: Two hours.
   3. Unit Supply-Air Fan Operation:
      a. Occupied Periods: Fan runs continuously.
      b. Unoccupied Periods: Fan cycles to maintain room setback temperature.
   4. Hydronic-Cooling-Coil Operation:
      a. Occupied Periods: Modulate control valve to maintain room temperature.
      b. Unoccupied Periods: Close control valve.
   5. Heating-Coil Operation:
      a. Occupied Periods: Modulate control valve to provide heating if room temperature falls below thermostat set point.
      b. Unoccupied Periods: Start fan and open control valve if room temperature falls below setback temperature.

L. BAS Interface Requirements:
   1. Interface relay for scheduled operation.
   2. Interface relay to provide indication of fault at the central workstation.
   3. Provide BACnet interface for central BAS workstation for the following functions:
      a. Adjust set points.
      b. Fan-coil-unit start, stop, and operating status.
      c. Data inquiry, including -supply- and room-air temperature
      d. Occupied and unoccupied schedules.

M. Electrical Connection: Factory wire motors and controls for a single electrical connection.

2.3 DUCTED FAN-COIL UNITS

A. Basis-of-Design Product: or a comparable product by one of the following:

B. Manufacturers:
   1. Trane.
   2. YORK International Corporation.

C. Description: Factory-packaged and -tested units rated according to AHRI 440, ASHRAE 33, and UL 1995.

D. Coil Section Insulation: 1-inch thick foil-faced glass fiber complying with ASTM C 1071 and attached with adhesive complying with ASTM C 916.
   1. Fire-Hazard Classification: Insulation and adhesive shall have a combined maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84.

E. Drain Pans: Stainless steel formed to slope from all directions to the drain connection as required by ASHRAE 62.

F. Chassis: Galvanized steel where exposed to moisture, with baked-enamel finish and removable access panels.

G. Cabinets: Steel with baked-enamel finish in manufacturer's standard paint color.
   1. Supply-Air Plenum: Sheet metal plenum finished and insulated to match the chassis
   2. Return-Air Plenum: Sheet metal plenum finished to match the chassis.
   3. Dampers: Galvanized steel with extruded-vinyl blade seals, flexible-metal jamb seals, and interlocking linkage.

H. Filters: Minimum arrestance according to ASHRAE 52.1, and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
   1. Pleated Cotton-Polyester Media: 90 percent arrestance and 7 MERV.

I. Hydronic Coils: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch, rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain.

J. Direct-Driven Fans: Double width, forward curved, centrifugal; with permanently lubricated, multispeed motor resiliently mounted in the fan inlet. Aluminum or painted-steel wheels, and painted-steel or galvanized-steel fan scrolls.
   1. Motors: Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."

K. DDC Terminal Controller:
   1. Scheduled Operation: Occupied and unoccupied periods on seven-day clock with a minimum of four programmable periods per day.
   2. Unoccupied Period Override Operation: Two hours.
   3. Unit Supply-Air Fan Operation:
      a. Occupied Periods: Fan runs continuously.
      b. Unoccupied Periods: Fan cycles to maintain room setback temperature.
   4. Hydronic-Cooling-Coil Operation:
      a. Occupied Periods: Modulate control valve to maintain room temperature.
      b. Unoccupied Periods: Close control valve.
   5. Heating-Coil Operation:
      a. Occupied Periods: Modulate control valve to provide heating if room temperature falls below thermostat set point.
      b. Unoccupied Periods: Start fan and open control valve if room temperature falls below setback temperature.

L. BAS Interface Requirements:
   1. Interface relay for scheduled operation.
   2. Interface relay to provide indication of fault at the central workstation.

3. Provide BACnet interface for central BAS workstation for the following functions:
   a. Adjust set points.
   b. Fan-coil-unit start, stop, and operating status.
   c. Data inquiry including supply- and room-air temperature
   d. Occupied and unoccupied schedules.

M. Electrical Connection: Factory wire motors and controls for a single electrical connection.

2.4 CEILING-MOUNTED UNITS

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

B. Description: Self-contained, factory assembled, prewired, and prepiped; consisting of cabinet, fan, filters, and controls; for horizontal ceiling mounting.

C. Cabinet: Galvanized steel with baked-enamel finish, insulated with 1 inch-thick duct liner.

   1. Integral factory-supplied supply and return grille 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 three-speed motor.

E. Hydronic Cooling Coil: Seamless copper tubes expanded into aluminum fins with two-way control valve.

   1. Cooling Medium: Chilled Water
      a. Mount coil assembly over injected molded polystyrene drain pan complying with ASHRAE 62.1

F. Filter: 1-inch-thick, disposable, glass-fiber media.

G. Control System: Units shall include a terminal block that is capable of incorporating a 24 volt, field supplied, hard wired thermostat.

2.5 WALL MOUNTED UNITS

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

B. Description: Self-contained, factory assembled, prewired, and prepiped; consisting of cabinet, fan, filters, and controls; for wall mounting.

C. Evaporator Cabinet: Composed of high impact polymers internally insulated for quiet operation.

D. Supply fan: Dynamically balanced and driven by three speed, direct drive motor.

E. Hydronic Cooling Coil: Seamless copper tubes expanded into aluminum fins with modulating control valve. Materials of construction exposed to condenser water to be cupronickel

1. Cooling Medium: Chilled Water
2. Mount coil assembly over high impact polymer drain pan complying with ASHRAE 62.1 The drain pan shall be insulated to prevent condensation, and shall contain a flexible drain tube that is accessible from the back of the unit.

F. Filter: Cleanable.

G. Filter: Washable filter.

H. Control System: Controls shall include a circuit board, room sensor, indoor coil thermistor, transformer and wireless remote.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive fan-coil units for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in for piping and electrical connections to verify actual locations before fan-coil-unit installation.

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

3.2 INSTALLATION

A. Install fan-coil units level and plumb.

B. Install fan-coil units to comply with NFPA 90A.

C. Suspend fan-coil units from structure with elastomeric hangers. Vibration isolators are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

D. Verify locations of thermostats, humidistats, and other exposed control sensors with Drawings and room details before installation. Install devices 48 inchesabove finished floor.

E. Install new filters in each fan-coil unit within two weeks after Substantial Completion.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties. Specific connection requirements are as follows:
   1. Install piping adjacent to machine to allow service and maintenance.
   2. Connect condensate drain to indirect waste.
      a. Install condensate trap of adequate depth to seal against the pressure of fan. Install cleanouts in piping at changes of direction.

B. Connect supply and return ducts to fan-coil units with flexible duct connectors specified in Division 23 Section "Air Duct Accessories." Comply with safety requirements in UL 1995 for duct connections.

C. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

D. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections. Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:
   1. Operational Test: After electrical circuitry has been energized, start units to confirm proper 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.

C. Remove and replace malfunctioning units and retest as specified above.

3.5 ADJUSTING

A. Adjust initial temperature and humidity set points.

3.6 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain fan-coil units. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION

SECTION 23 82 33

CONVECTORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:
   1. Hydronicfinned-tube radiators.

1.3 SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for each type of product indicated.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

   1. Plans, elevations, sections, and details.
   2. Details of custom-fabricated enclosures indicating dimensions.
   3. Location and size of each field connection.
   4. Location and arrangement of piping valves and specialties.
   5. Location and arrangement of integral controls.
   6. Enclosure joints, corner pieces, access doors, and other accessories.

C. Coordination Drawings: Floor plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

   1. Structural members, including wall construction, to which convection units will be attached.
   2. Method of attaching convection units to building structure.
   3. Penetrations of fire-rated wall and floor assemblies.

D. Color Samples for Initial Selection: For units with factory-applied color finishes.

E. Color Samples for Verification: For each type of exposed finish required.

F. Field quality-control test reports.

G. Operation and Maintenance Data: For convection heating units to include in emergency, operation, and maintenance manuals.

1.4 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.

PART 2 - PRODUCTS

2.1 HOT-WATER FINNED-TUBE RADIATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Rittling, a div. of Hydro-Air Components.
   2. Slant/Fin.
   3. Trane.
   4. Vulcan

B. Performance Ratings: Rate finned-tube radiators according to Hydronics Institute's "I=B=R Testing and Rating Standard for Finned-Tube (Commercial) Radiation."

C. Heating Elements: Copper tubing mechanically expanded into flanged collars of evenly spaced aluminum fins resting on element supports. One tube end shall be belled.

D. Element Supports: Ball-bearing cradle type to permit longitudinal movement on enclosure brackets.

E. Support Brackets: Locate at maximum 36-inch spacing to support front panel and element.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive convection heating units for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in for hydronic-pipingconnections to verify actual locations before convection heating unit installation.

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

3.2 FINNED-TUBE RADIATOR INSTALLATION

A. Install units level and plumb.

B. Install finned-tube radiators according to Guide 2000 - Residential Hydronic Heating.

C. Install access doors for access to valves.

D. Terminate enclosures with manufacturer's end caps, except where enclosures are indicated to extend to adjoining walls.

E. Install valves within reach of access door provided in enclosure.

F. Install air-seal gasket between wall and recessing flanges or front cover of fully recessed unit.

G. Install piping within pedestals for freestanding units.

3.3 CONNECTIONS

A. Piping installation requirements are specified in Division 23 Section "Hydronic Piping Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect hot-water units and components to piping according to Division 23 Section "Hydronic Piping."

1. Install shutoff valves on inlet and outlet, and balancing valve on outlet.

C. Install control valves as required by Division 23 Section "Instrumentation and Control for HVAC."

D. Install piping adjacent to convection heating units to allow service and maintenance.

3.4 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:

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 convection heating unit operation.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Remove and replace convection heating units that do not pass tests and inspections and retest as specified above.

END OF SECTION

SECTION 23 82 39

UNIT HEATERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
1. Cabinet unit heaters with centrifugal fans and hot-water coils.
2. Propeller unit heaters with hot-water coils.

1.3 DEFINITIONS

A. BAS: Building automation system.

B. CWP: Cold working pressure.

C. PTFE: Polytetrafluoroethylene plastic.

D. TFE: Tetrafluoroethylene plastic.

1.4 SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for each product indicated.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
1. Plans, elevations, sections, and details.
2. Location and size of each field connection.
3. Details of anchorages and attachments to structure and to supported equipment.
4. Equipment schedules to include rated capacities, operating characteristics, furnished specialties, and accessories.
5. Location and arrangement of piping valves and specialties.
6. Location and arrangement of integral controls.
7. Wiring Diagrams: Power, signal, and control wiring.

C. 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, based on input from installers of the items involved:
1. Suspended ceiling components.
2. Structural members to which 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. Perimeter moldings for exposed or partially exposed cabinets.

D. Samples for Verification: Finish colors for each type of cabinet unit heater and wall and ceiling heaters indicated with factory-applied color finishes.

E. Manufacturer Seismic Qualification Certification: Submit certification that cabinet unit heaters, accessories, and components will withstand seismic forces defined in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment." Include the following:
1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
a. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."
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.

F. Field quality-control test reports.

G. Operation and Maintenance Data: For cabinet unit heaters to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.6 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Cabinet Unit Heater Filters: Furnish one spare filter(s) for each filter installed.

PART 2 - PRODUCTS

2.1 CABINET UNIT HEATERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

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

C. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
1. Sterling Hydronics.

2. Modine
3. Airtherm
4. Trane.

D. Description: A factory-assembled and -tested unit complying with AHRI 440.
1. Comply with UL 2021.

E. Coil Section Insulation: ASTM C 1071; surfaces exposed to airstream shall be aluminum-foil facing to prevent erosion of glass fibers.
1. Thickness: 1/2 inch.
2. Thermal Conductivity (k-Value): 0.26 Btu x in./h x sq. ft. at 75 deg F mean temperature.
3. Fire-Hazard Classification: Maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E 84.
4. Adhesive: Comply with ASTM C 916 and with NFPA 90A or NFPA 90B.

F. Cabinet: Steel with baked-enamel finish with manufacturer's standard paint, in color selected by Architect
1. Vertical Unit, Exposed Front Panels: Minimum 0.0528-inch-thick, galvanized, sheet steel, removable panels with channel-formed edges secured with tamperproof cam fasteners.
2. Horizontal Unit, Exposed Bottom Panels: Minimum 0.0528-inch-thick, galvanized, sheet steel, removable panels secured with tamperproof cam fasteners and safety chain.
3. Recessing Flanges: Steel, finished to match cabinet.
4. Control Access Door: Key operated.
5. Base: Minimum 0.0528-inch-thick steel, finished to match cabinet, 4 inches high with leveling bolts.
6. Extended Piping Compartment: 8-inch-wide piping end pocket.
7. False Back: Minimum 0.0428-inch-thick steel, finished to match cabinet.

G. Filters: Minimum arrestance according to ASHRAE 52.1 and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2.
1. Pleated: 90 percent arrestance and 7 MERV.

H. Hot-Water Coil: Copper tube, with mechanically bonded aluminum fins spaced no closer than 0.1 inch and rated for a minimum working pressure of 200 psig and a maximum entering-water temperature of 220 deg F. Include manual air vent and drain.

I. Fan and Motor Board: Removable.
1. Fan: Forward curved, high static, double width, centrifugal; directly connected to motor. Thermoplastic or painted-steel wheels, and aluminum, painted-steel, or galvanized-steel fan scrolls.
2. Motor: Permanently lubricated, ECM Motor; resiliently mounted on motor board. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
3. Wiring Terminations: Connect motor to chassis wiring with plug connection.

J. Control devices and operational sequences are specified in Division 23 Sections "Instrumentation and Control for HVAC" and "Sequence of Operations for HVAC Controls."

K. DDC Terminal Controller:

1. Scheduled Operation: Occupied and unoccupied periods on seven-day clock with a minimum of four programmable periods per day.
2. Unoccupied Period Override: Two hours.
3. Unit Supply-Air Fan Operations:
   a. Occupied Periods: Fan runs continuously.
   b. Unoccupied Periods: Fan cycles to maintain setback room temperature.
4. Heating Coil Operations:
   a. Occupied Periods: Open control valve to provide heating if room temperature falls below thermostat set point.
   b. Unoccupied Periods: Start fan and open control valve if room temperature falls below setback temperature.

L. BAS Interface Requirements:
1. Interface relay for scheduled operation.
2. Interface relay to provide indication of fault at central workstation.
3. Interface shall be BAC-net compatible for central BAS workstation and include the following functions:
   a. Adjust set points.
   b. Cabinet unit heater start, stop, and operating status.
   c. Data inquiry, including room-air temperature.
   d. Occupied and unoccupied schedules.

M. Electrical Connection: Factory wire motors and controls for a single field connection.

2.2 PROPELLER UNIT HEATERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Airtherm; a Mestek Company.
2. Trane
3. Modine
4. Sterling Hydronics

C. Description: An assembly including casing, coil, fan, and motor in horizontal discharge configuration with adjustable discharge louvers.

D. Comply with UL 2021.

E. Comply with UL 823.

F. Cabinet: Removable panels for maintenance access to controls.

G. Cabinet Finish: Manufacturer's standard baked enamel applied to factory-assembled and -tested propeller unit heater before shipping.

H. Discharge Louver: Adjustable fin diffuser for horizontal units and conical diffuser for vertical units.

I. General Coil Requirements: Test and rate hot-water propeller unit heater coils according to ASHRAE 33.

J. 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 200 psig and a maximum entering-water temperature of 325 deg F, with manual air vent. Test for leaks to 350 psig underwater.

K. Fan: Propeller type with aluminum wheel directly mounted on motor shaft in the fan venturi.

L. Fan Motors: Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
   1. Motor Type: Permanently lubricated, ECM motor

M. Control Devices:

   1. Wall-mounting thermostat.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance.

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 wall boxes in finished wall assembly; seal and weatherproof. Joint-sealant materials and applications are specified in Division 07 Section "Joint Sealants."

B. Install cabinet unit heaters to comply with NFPA 90A.

C. Install propeller unit heaters level and plumb.

D. Suspend cabinet unit heaters from structure with elastomeric hangers and seismic restraints. Vibration isolators and seismic restraints are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

E. Suspend propeller unit heaters from structure with all-thread hanger rods and spring hangers Hanger rods and attachments to structure are specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment." Vibration hangers are specified in Division 23 Section "Vibration and Seismic Controls for HVAC Piping and Equipment."

F. Install wall-mounting thermostats and switch controls in electrical outlet boxes at heights to match lighting controls. Verify location of thermostats and other exposed control sensors with Drawings and room details before installation.

G. Install new filters in each fan-coil unit within two weeks of Substantial Completion.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Install piping adjacent to machine to allow service and maintenance.

C. Connect supply and return ducts to cabinet unit heaters with flexible duct connectors specified in Division 23 Section "Air Duct Accessories."

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 unit heater. Hydronic specialties are specified in Division 23 Section "Hydronic Piping."

F. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

G. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections .Report results in writing.

B. Perform the following field tests and inspections and prepare test reports:
   1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
   2. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.

C. Remove and replace malfunctioning units and retest as specified above.

3.5 ADJUSTING

A. Adjust initial temperature set points.

END OF SECTION

SECTION 23 83 16

HYDRONIC RADIANT IN FLOOR HEATING AND SNOW MELT SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. The work covered by this section includes materials required to supply, install and pressure test Engel Method cross-linked polyethylene (PEX-A as shown on drawings or as specified herein. The radiant in floor heating and snow melt systems shall include, but not limited to, all piping, manifolds, valves, pumps, pressure relief valves, and controls to provide a complete and operational heating system. The applicable installation method(s) shall comply with published installation instructions from the tubing manufacturer.

1.3 DEFINITIONS

A. EPDM: Ethylene-propylene-diene terpolymer rubber.

B. PEX: Crosslinked polyethylene.

C. PEX/AL/PEX: Crosslinked polyethylene/aluminum/crosslinked polyethylene.

1.4 SUBMITTALS

A. Product Data: For each type of radiant heating pipe, fitting, manifold, specialty, and control.
   1. For radiant piping and manifolds, include pressure and temperature rating, oxygen-barrier performance, fire-performance characteristics, and water flow and pressure drop characteristics.

B. Shop Drawings:
   1. Provide installation drawings indicating tubing layout, manifold locations, zoning requirements and manifold schedules with details required for installation of the system
   2. Provide mechanical schematic indicating heat source, mechanical piping and accessories from heat source to manifolds, circulators, water tempering and zone controls. Indicate supply water temperatures and flow rates to manifolds.
   3. Layout Drawing Scale: 1/4 inch = 1 foot.

C. Operation and Maintenance Data: For radiant piping valves and equipment to include in operation and maintenance manuals.

D. Quality Assurance and Control Submittals: Submit the following.
   1. Test Reports: Upon request, submit test reports from recognized testing laboratories.

2. Documentation: Submit the following.
   a. Manufacturer's certificate indicating products comply with specified requirements
   b. Manufacturer's detailed heat-loss analysis for the snow melt and in floor radiant systems.
   c. Documentation indicating the installer is trained to install the manufacturer's products

E. Closeout Submittals: Submit the following.
   1. Warranty documents specified herein
   2. Operation and maintenance data
   3. Manufacturer's field reports specified herein
   4. Final as-built tubing layout drawing

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Use an installer with demonstrated experience on projects of similar size and complexity and possessing documentation proving successful completion of radiant floor heating or snow melt training by the PEX tubing manufacturer.

B. Certifications: Provide letters of certification as follows.
   1. Installer is trained by the PEX tubing manufacturer to install radiant floor heating or snow melt systems.
   2. Installer uses skilled workers holding a trade qualification license or equivalent, or apprentices under the supervision of a licensed tradesperson.

C. Pre-installation Meetings
   1. Verify project requirements, substrate conditions, floor coverings, manufacturer's installation instructions and warranty requirements.
   2. Review project construction timeline to ensure compliance or discuss modifications as required.
   3. Interface with other trade representatives to verify areas of responsibility.
   4. Establish the frequency and construction phrase the project engineer intends for site visits and inspections by the PEX tubing manufacturer's representative.

1.6 DELIVERY, STORAGE AND HANDLING

A. General: Comply with Division 1 Product Requirements Section.

B. Comply with manufacturer's ordering instructions and lead-time requirements to avoid construction delays.

C. Delivery: Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact.

D. Storage and Protection: Store materials protected from exposure to harmful environmental conditions and at temperature and humidity conditions recommended by the manufacturer.
   1. Store PEX tubing in cartons or under cover to avoid dirt or foreign material from entering the tubing.
   2. Do not expose PEX tubing to direct sunlight for more than 30 days. If construction delays are encountered, cover the tubing that is exposed to direct sunlight.

1.7 WARRANTY

A. Project Warranty: Refer to Conditions of the Contract for project warranty provisions.

B. Manufacturer's Warranty: Submit, for Owner's acceptance, manufacturer's standard warranty document executed by authorized company official. Manufacturer's warranty is in addition to, and not a limitation of, other rights Owner may have under contract documents.
   1. Warranty covers the repair or replacement of any tubing or fittings proven defective.
   2. Warranty may transfer to subsequent owners.
   3. Warranty Period for PEX Tubing: 30-year, non-prorated warranty against failure due to defect in material or workmanship, beginning with date of substantial completion.
   4. Warranty Period for Manifolds and Fittings: 5-year, non-prorated warranty against failure due to defect in material or workmanship, beginning with date of substantial completion.
   5. Warranty Period for Controls and Electrical Components: 2-year, non-prorated warranty against failure due to defect in material or workmanship, beginning with date of substantial completion.

1.8 OWNER'S TRAINING

A. Instruct Owner's personnel about operation and maintenance of installed system. Provide manufacturer's installation, operation and maintenance instructions for installed components within the system.

PART 2 - PRODUCTS

2.1 PEX PIPE AND FITTINGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Uponor Co.
   2. Watts Radiant, Inc.; a division of Watts Water Technologies, Inc.

B. Pipe Material: PEX plastic according to ASTM F 876.

C. Oxygen Barrier: Limit oxygen diffusion through the tube to maximum 0.10 mg per cu. m/day at 104 deg F according to DIN 4726.

D. Fittings: ASTM F 1807, metal insert and copper crimp rings.

E. Pressure/Temperature Rating: Minimum 100 psig and 180 deg F.

2.2 DISTRIBUTION MANIFOLDS

A. Manifold: Minimum NPS 2 INCH, Type L copper.

B. Main Shutoff Valves:
   1. Factory installed on supply and return connections.
   2. Two-piece body.
   3. Body: Brass or bronze.
   4. Ball: Chrome-plated bronze.

5. Seals: PTFE.
6. CWP Rating: 150 psig.
7. Maximum Operating Temperature: 225 deg F.

C. Manual Air Vents:
1. Body: Bronze.
2. Internal Parts: Nonferrous.
3. Operator: Key furnished with valve, or screwdriver bit.
4. Inlet Connection: NPS 1/2.
5. Discharge Connection: NPS 1/8.
6. CWP Rating: 150 psig.
7. Maximum Operating Temperature: 225 deg F.

D. Balancing Valves:
1. Body: Plastic or bronze, ball or plug, or globe cartridge type.
2. Ball or Plug: Brass or stainless steel.
3. Globe Cartridge and Washer: Brass with EPDM composition washer.
4. Seat: PTFE.
5. Differential Pressure Gage Connections: Integral seals for portable meter to measure loss across calibrated orifice.
6. Handle Style: Lever or knob, with memory stop to retain set position if used for shutoff.
7. CWP Rating: Minimum 125 psig.
8. Maximum Operating Temperature: 250 deg F.

E. Zone Control Valves:
1. Body: Plastic or bronze, ball or plug, or globe cartridge type.
2. Ball or Plug: Brass or stainless steel.
3. Globe Cartridge and Washer: Brass with EPDM composition washer.
4. Seat: PTFE.
5. Actuator: Replaceable electric motor.
6. CWP Rating: Minimum 125 psig.
7. Maximum Operating Temperature: 250 deg F.

F. Thermometers:
1. Mount on supply and return connections.
2. Case: Dry type, metal or plastic, 2-inch diameter.
3. Element: Bourdon tube or other type of pressure element.
4. Movement: Mechanical, connecting element and pointer.
5. Dial: Satin-faced, nonreflective aluminum with permanently etched scale markings.
6. Pointer: Black metal.
7. Window: Plastic.
8. Connector: Rigid, back type.
9. Thermal System: Liquid- or mercury-filled bulb in copper-plated steel, aluminum, or brass stem.
10. Accuracy: Plus or minus 1 percent of range or plus or minus 1 scale division to maximum of 1.5 percent of range.

G. Mounting Brackets: Copper, or plastic or copper-clad steel, where in contact with manifold.

2.3 PIPING SPECIALTIES

A. Cable Ties:

1. Fungus-inert, self-extinguishing, 1-piece, self-locking, Type 6/6 nylon cable ties.
2. Minimum Width: 1/8 inch.
3. Tensile Strength: 20 lb, minimum.
4. Temperature Range: Minus 40 to plus 185 deg F.

2.4 CONTROLS

A. Supply Fluid Temperature Control (automatic control strategy) for the snow melt system
   1. Temper the supply fluid temperature to the snow and ice melt panel by means of a variable speed injection pump controlled by the Uponor SNOWpro™ 411, or an approved equal.
   2. The snow melt controller shall have the ability to reset the supply fluid temperature as it relates to outdoor temperature. Install the outdoor temperature sensor (S4) on the north face of the building out of direct sunlight.
   3. Run time shall be programmed by the snow melt controller for between 30 minutes to 17 hours or infinity. The control operates in snow-melt mode as long as there is moisture present on the sensor.
   4. Provide one snow and ice detector per well (total of 3) to monitor the presence of moisture on the sensor (snow-melt mode) and slab temperature.
   5. The snow melt controller shall have the ability to idle the snow-melt slab at a given temperature and automatically accelerates to a higher slab temperature during snow-melting mode.
      a. The snow melt controller will automatically switch from snow-melt mode to idle mode once the snow and ice detector indicates the lack of moisture on the sensor.
   6. When there is a call for snow melt, the snow melt controller shall:
      a. Activate the variable speed injection pump (P4)
      b. Initiate the heat exchanger

B. Refer to 230993 for the Sequence of Operations regarding the in floor radiant heating system.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces and substrates to receive radiant snow melt piping for compliance with requirements for installation tolerances and other conditions affecting performance.
   1. Ensure that surfaces and pipes in contact with radiant snow melt piping are free of burrs and sharp protrusions.
   2. Ensure that surfaces and substrates are level and plumb.
   3. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicate piping locations and arrangements if such were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Shop or Coordination Drawings.

B. Install radiant piping continuous from the manifold through the heated panel and back to the manifold without piping joints in heated panels.

C. Connect radiant piping to manifold in a reverse-return arrangement to ensure self balancing.

D. Do not bend pipes in radii smaller than manufacturer's minimum bend radius dimensions.

E. Install manifolds in accessible locations, or install access panels to provide maintenance access as required in Division 08 Section "Access Doors and Frames."

F. Refer to Division 23 Section "Hydronic Piping" for pipes and connections to hydronic systems and for glycol-solution fill requirements.

G. Fire- and Smoke-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials according to Division 07 Section "Penetration Firestopping."

H. Piping in Slab Over Existing Slab Construction with Edge and Under-slab Insulation
   1. Provide 2 inch thick high-density foam insulation board, install the tubing by stapling the tubing to the insulation board with Foam Staples.
   2. Install the vertical edge insulation along the perimeter of the slab and down to a depth equal to the bottom of the horizontal under-slab insulation.
   3. Refer to the snow melt schedule for the tubing on-center distance(s) and loop lengths.
   4. Do not install tubing closer than 6 inches (152mm) from the edge of the heated slab.
   5. Install the tubing at a consistent depth below the surface elevation as determined by the project engineer. Tubing installation will ensure sufficient clearance for all control joint cuts.
   6. Fibrous expansion joints may be penetrated following the PEX tubing manufacturer’s and structural engineer’s recommendation.
   7. Metal or plastic bend supports will be used to support the tubing when departing from the slab in a 90 degree bend.

I. Slab Sensor:
   1. Install slab sensor and wire in 3/4 inch PEX tubing conduit embedded in the concrete floor slab. Extend conduit out of floor slab to allow for sensor replacement.
   2. Install sensor equally spaced between radiant tubing with a 1 inch minimum cover.

J. Revise locations and elevations from those indicated as required to suit field conditions and ensure integrity of piping and as approved by Architect.

K. After system balancing has been completed, mark balancing valves to permanently indicate final position.

L. Perform the following adjustments before operating the system:

1. Open valves to fully open position.
2. Check operation of automatic valves.
3. Set temperature controls so all zones call for full flow.
4. Purge air from piping.

M. After the concrete floor has cured as recommended by concrete supplier, operate radiant heating system as follows:
   1. Start system heating at a maximum of 10 deg F above the ambient floor temperature, and increase 10 deg F each following day until design temperature is achieved.

3.3 FIELD QUALITY CONTROL

A. Tests and Inspections:
   1. Leak Test: After installation, charge system and test for leaks. Subject piping to hydrostatic test pressure that is not less than 1.5 times the design pressure but not more than 100 psig. Repair leaks and retest until no leaks exist.
   2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Remove and replace malfunctioning radiant heating piping components that do not pass tests, and retest as specified above.

C. Prepare a written report of testing.

END OF SECTION

This page is intentionally left blank.

SECTION 23 83 23

RADIANT-HEATING PANELS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes prefabricated radiant-heating hot water panels.

1.3 SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for each type of product indicated.

B. Shop Drawings: For radiant heating panels. Include plans, sections, details, and attachments to other work.

C. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
   1. Ceiling suspension assembly members.
   2. Method of attaching hangers to building structure.
   3. Structural members to which heating panels and suspension systems will be attached.
   4. Size and location of initial access modules for acoustical tile.
   5. Items installed in finished ceiling, including the following:
      a. Lighting fixtures.
      b. Air outlets and inlets.
      c. Speakers.
      d. Sprinklers.
      e. Access panels.
      f. Perimeter moldings.

D. Field quality-control test reports.

1.4 COORDINATION

A. Coordinate layout and installation of radiant panels and suspension system components with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, fire-suppression system, and partition assemblies.

PART 2 - PRODUCTS

2.1 RADIANT HOT WATER PANELS

A. General
1. Provide a radiant heating panel system as indicated on the drawings and connect to hot water piping.
2. Acceptable manufacturers subject to compliance with the specifications shall be as follows:
   a. Price
   b. Aero Tech
   c. Sun-El
   d. Sterling
   e. Airtex
   f. Rosemex
   g. Airtite
3. Performance data and dimensional specifications shall be available from the manufacturer for all products. Performance and capacity data shall be bases on testing performed by the manufacturer and confirmed by a testing laboratory recognized in the Industry.

B. Radiant Panels/Extrusions
1. Radiant panel shall be manufactured utilizing extruded aluminum strips of approximately 0.115 overall thickness. The strips shall have a minimum 0.495 I.D. copper tube firmly attached to aluminum extrusion under all operating temperature conditions. Ends of tubes shall be swaged to 0.569 I.D. for proper soldering fit of ½ inch Type “L” soft copper tubing.
2. Panel sizes shall fit into a ceiling inverted T-bar linear system and as called for in the drawings and specifications. Lengths shall be as shown on the drawings. Finish on the face of the panel shall be of a color selected by the Architect. Finish shall be powder coated and suitable for temperatures up to 350ºF.
3. Face configuration shall be fluted, with recessed 1/8 inch linear flutes on ½ inch centers.
4. Circuiting of the tubes on the back of the panel shall be straight tubes with ends slightly pulled up for ease of soldering.
5. Panel thermal performance shall be as specified on the mechanical drawings.
6. The panel manufacturer shall provide a 2 inch thick glass fiber pad insulation on the upper side of the radiant panels to minimize heat loss to the ceiling plenum.
7. Insulation shall be attached to the panel.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces and substrates to receive electric heating panels for compliance with requirements for installation tolerances and other conditions affecting performance.
1. Ensure surfaces and substrates are level and plumb.
2. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Install radiant-heating panels level and plumb.

B. Support for Radiant-Heating Panels in or on Grid-Type Suspended Ceilings: Use grid as a support element.
   1. Install a minimum of four ceiling support system rods or wires for each panel. Locate not more than 6 inches (150 mm) from panel corners.
   2. Support Clips: Fasten to panel and to ceiling grid members at or near each panel corner with clips designed for the application.
   3. Panels of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support panels independently with at least two 3/4-inch (19-mm) metal channels spanning and secured to ceiling tees.
   4. Install at least one independent support rod or wire from structure to a tab on panel. Wire or rod shall have breaking strength of the weight of panel at a safety factor of 3.

C. Verify locations of thermostats with Drawings and room details before installation. Install devices 48 inches (1220 mm) above finished floor.

3.3 CLEANING

A. After construction is completed, including painting, clean exposed surfaces of units.

B. Touch-up marred or scratched surfaces of factory-finished cabinets, using finish materials furnished by manufacturer.

END OF SECTION

This page is intentionally left blank.

SECTION 23 84 13

HUMIDIFIERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following humidifiers:
   1. Steam injection.

1.3 DEFINITION

A. 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.

1.4 SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings: Detail fabrication and installation of humidifiers. Include piping details, plans, elevations, sections, details of components, manifolds, and attachments to other work.
   1. Wiring Diagrams: Power, signal, and control wiring.

C. Coordination Drawings: Detail humidifiers and adjacent equipment. Show support locations, type of support, weight on each support, required clearances, and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For humidifiers 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, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with ARI 640, "Commercial and Industrial Humidifiers."

1.6 COORDINATION

A. Coordinate location and installation of humidifiers with manifolds in ducts and air-handling units or occupied space. Revise locations and elevations to suit field conditions and to ensure proper humidifier operation.

PART 2 - PRODUCTS

2.1 STEAM-INJECTION HUMIDIFIERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Carel
   2. DRI-STEEM Humidifier Company.
   3. Pure Humidifier

B. The steam dispersion panel shall directly inject pressurized boiler steam or evaporative, non−pressurized steam into ducted air for humidification. The factory−assembled steam dispersion panel shall include the following components:
   1. Steam supply header/separator
   2. Condensate collection header
   3. Closely−spaced steam dispersion tubes spanning the distance between the two headers

C. Each dispersion tube shall be fitted with two rows of steam discharge tubelets inserted into the tube wall, centered on the diametric line, and spaced 1.5" (38 mm) apart. Each tubelet shall be made of a thermal−resin material designed for high steam temperatures. The two rows of tubelets in each dispersion tube shall discharge steam in diametrically opposite directions, perpendicular to airflow.

D. Each tubelet shall extend through the wall of and into the center of the dispersion tube and contain a steam orifice sized for its required steam capacity.

E. All tubes and headers shall be 304 stainless steel, and joints shall be Heli−arc welded. Casing shall be 304 stainless steel.

F. Steam valve and actuator: Valve shall be a normally closed modulating type with modified linear flow. Valve trim shall be stainless steel and valve maximum flow rate shall not exceed specified humidifier capacity by more than 20%. Actuator shall be a electric type to modulate the steam valve in response to a variable signal demand and be direct acting.

G. Steam trap(s): Humidifier shall have one or two float/thermostatic trap(s) for applications equal to or below 15 psi steam, or one or two inverted bucket steam trap(s) for applications above 15 psi steam.

H. Dispersion tubes shall be insulated with a plenum−approved insulating material for in−duct installation and have an R−value not less than 0.5 at a thickness not more than 0.125" (3.2 mm), for minimal increase in dispersion tube diameter.

I. HUMIDIFIER CONTROL OPTIONS
   1. Control input accessory options:
   2. Humidistat, electronic, room: Electronic humidistat shall be room−mounted and produce a modulated DC signal output, field−selectable 0 to 10 VDC or 6 to 9 VDC with control action field−selectable to be direct or reverse acting.

Set point range 20% to 80% RH, supply voltage 24 DC or 24 AC. Maximum ambient temperature 122 °F (50 °C).

3. Airflow proving switch, sail type: Airflow proving switch shall be a sail−operated electric switch for field installation. Switch makes at 250 fpm (1.3 m/s), and breaks at 75 fpm (0.4 m/s). Maximum operating temperature for sail: 170 °F (77 °C). Maximum operating temperature for switch: 125 °F (52 °C)

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine ducts, air-handling units, and conditions for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in for piping systems to verify actual locations of piping connections before humidifier installation.

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

3.2 INSTALLATION

A. Install humidifiers with required clearance for service and maintenance.

B. Seal humidifier manifold duct or plenum penetrations with flange.

C. Install humidifier manifolds in metal ducts and casings constructed according to SMACNA's "HVAC Duct Construction Standards, Metal and Flexible."

D. Install manifold supply piping pitched to drain condensate back to humidifier.

E. Install drip leg upstream from steam trap a minimum of 12 inches tall for proper operation of trap.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
   1. Install piping adjacent to humidifiers to allow service and maintenance.

B. Install electrical devices and piping specialties furnished by manufacturer but not factory mounted.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.

B. Perform tests and inspections and prepare test reports.
   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.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain humidifiers. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION

SECTION 26 00 00

GENERAL PROVISIONS FOR ELECTRICAL WORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The Contractor, Subcontractors, and/or suppliers providing goods or services referenced in or related to this Section shall also be bound by the Documents identified in Division 01 Section “Summary”, Paragraph 1.01A, entitled “Related Documents.”

1.2 WORK INCLUDED

A. Work in this Section includes the providing of labor, materials, equipment and services necessary for a complete and safe installation in accordance with the contract documents and all applicable codes and authorities having jurisdiction for the following:
   1. Electrical work covered by all Sections within DIVISION 16 of the Specifications, including, but not limited to electrical systems and equipment.
   2. RACEWAY
   3. WIRE AND CABLE
   4. LOW VOLTAGE DISTRIBUTION EQUIPMENT
   5. GROUNDING SYSTEM
   6. DEVICES
   7. LIGHTING FIXTURES
   8. TELEPHONE CONDUIT SYSTEM
   9. ELECTRICAL PROVISIONS FOR SECURITY AND BUILDING AUTOMATION SYSTEMS
   10. FIRE ALARM SYSTEM
   11. TESTING
   12. UNIT PRICES
   13. ALTERNATE PRICES
   14. ALLOWANCES

B. Provide cutting and patching, except as noted in "AIA document A201" and "Supplementary Condition for Mechanical and Electrical Work".

C. Related Work and Requirements
   1. Requirements of GENERAL CONDITIONS and Division No. 1.
   2. Requirements noted under HVAC, Plumbing, Fire Protection, Transportation and Automated Monitoring & Control Division of Work.

1.3 WORK NOT INCLUDED:

A. Providing temporary light and power.

B. Providing finished painting.

C. Providing access doors and filler.

D. Installing access doors and providing filler.

E. Cutting and patching, except as noted in "AIA Document A210" and "Supplementary Conditions for Mechanical and Electrical Work."

F. Supplying and setting motors.

G. Excavating and backfilling under building.

H. Excavating and backfilling.

1.4 DESCRIPTION OF BID DOCUMENTS

A. Specifications describe quality and character of materials and equipment.

B. Drawings are diagrammatic and indicate general arrangement of systems and work. Follow drawings in laying out work and check drawings of other trades to verify space conditions. Maintain headroom and space conditions.

C. Scaled and figured dimensions are approximate and are for estimate purposes only. Before proceeding with work, check and verify all dimensions.

D. Make adjustments that may be necessary or requested in order to resolve space problems, preserve headroom, and avoid architectural openings, structural members and work of other trades.

E. Typical details, where shown on the drawings, apply to each item of the project where such items are applicable. Typical details are not repeated on the plans.

F. If Specifications or Drawings appear unclear or contradictory, consult the Architect and/or Engineer for interpretation as early as possible during bidding period. Do not proceed with work without Architect's and/or Engineer's decision.

1.5 DEFINITIONS

A. "Provide": to supply, install, and make complete, safe, and operable, the particular work referred to unless specifically indicated otherwise.

B. "Install": to erect, mount, and make complete with all related accessories.

C. "Furnish" or "supply": to purchase, procure, acquire, and deliver complete with related accessories.

D. "Work": labor, materials, equipment, services, and all related accessories necessary for the proper and complete installation of complete systems.

E. "Piping": pipe, tube, fittings, flanges, valves, controls, strainers, hangers, supports, unions, traps, drains, insulation and all related accessories.

F. "Wiring": raceway, fittings, wire, boxes and all related accessories.

G. "Concealed": not in view, installed in masonry or other construction, within furred spaces, double partitions, hung ceilings, trenches, crawl spaces, or enclosures.

H. "Exposed": in view, not installed underground or "concealed" as defined above.

I. "Indicated," "shown," or "noted": as indicated, shown, or noted on drawings or specifications.

J. "Similar" or "equal": of base bid manufacture, equal in quality materials, weight, size, performance, design, and efficiency of specified product, conforming with "Base Bid Manufacturers."

K. "Reviewed" "satisfactory," "accepted," or "directed": as reviewed, satisfactory, accepted, or directed by Architect and/or Engineer.

L. "Motor Controllers": manual or magnetic starters with or without switches, individual pushbuttons or hand-off-automatic (HOA) switches controlling the operation of motors.

M. "Control or Actuating Devices": automatic sensing and switching devices such as thermostats, pressure, float, flow, operation of equipment.

1.6 QUALITY ASSURANCE

A. All work shall combine with National Electrical Code and all applicable local codes.

B. Furnish all materials and equipment new, free from defects and with listings or labels of Underwriter's Laboratories, Inc. or other nationally approved testing laboratory.

C. All items of a given type shall be the product of the same manufacturer.

D. All materials and equipment shall be the product of manufacturers regularly engaged in their manufacture.

E. Current characteristics:
   1. Provide the following service:
      a. 120/208 volt, 3 phase, 4 wire, 60 Hz with grounded neutral.
   2. Provide the following distribution:
      a. 120/208 volt, 3 phase, 4 wire, 60 Hz with grounded 4W distribution.

F. Equipment ampere ratings shall be for continuous operation in 104°F (40°C) ambient temperature unless otherwise indicated.

G. Provide the following heights of outlets and verify with Architect and/or Engineer prior to installation:
   1. From finished floor to centerline of outlets for:

a.	Receptacles and telephones:	
	1) Generally	1'-6"
	2) Over work benches	3'-6"
b.	Wall switches:	
	1) Generally	4'-0"
c.	Wall fixtures	7'-0"
d.	Motor controllers	5'-0"
e.	Fire alarm stations	3'-6"
f.	Strobe lights	6'-8" or 6 in below ceiling (whichever is lower)

   2. The following are exceptions to specified height of outlets:
      a. At junction of different wall finish materials.
      b. On molding or break in wall surface.
      c. In violation of Code.
      d. As noted or directed.

1.7 JOB CONDITIONS

A. Inspection of Site Conditions.
   1. Before starting work, visit the site and examine the conditions under which the work has to be performed. Report in writing any conditions which might adversely affect the work.

B. Connections to existing work:
   1. Install new work and connect to existing work with minimum interference to existing facilities.
   2. Provide temporary shutdowns of existing services at no additional charges and only with written consent of Owner. Schedule shutdowns not to interfere with normal operation of existing facilities.
   3. Alarm and emergency systems shall not be interrupted.
   4. Maintain continuous operation of existing facilities as required with necessary temporary connections between new and existing work.
   5. Connect new work to existing work in neat and acceptable manner. Restore existing disturbed work to original condition including maintenance of wiring continuity required.

C. Hazardous locations:
   1. Provide required material, equipment and installation for hazardous locations.
   2. Provide material, equipment, and installation as required for Class, Division and Group noted.
   3. Provide material, equipment, and installation meeting requirements of National Electric Code Class, Division and Group, except Division 1 requirements apply to Division 2.

1.8 REFERENCE STANDARDS

A. Published specifications, standards, tests, or recommended methods of trade, industry or governmental organizations apply to work in all sections as noted below:
   1. NEMA - National Electrical Manufacturers' Association.
   2. ANSI - American National Standard Institute.
   3. IEEE - Institute of Electrical & Electronics Engineers.
   4. NFPA - National Fire Protection Association
   5. UL - Underwriter's Laboratories, Inc.
   6. OSHA - Occupational Safety and Health Administration Regulations.

1.9 SUBMITTAL

A. Submit shop drawings and samples in accordance with "AIA Document 201" and "Supplementary Conditions for Mechanical and Electrical Work."

B. Operating instructions, equipment maintenance manuals and parts lists.
   1. Before requesting acceptance of work, submit one set for review by the Architect and/or Engineer.
   2. Provide sets of manufacturers' equipment brochures and service manuals consisting of the following:
      a. Descriptive literature for equipment and components.
      b. Model number and performance data.
      c. Installation and operating instructions.
      d. Maintenance and repair instructions.
      e. Recommended spare parts lists.
   3. Assemble manufacturers' equipment manuals in chronological order following the specifications alpha-numerical system using heavy duty three ring binders.
   4. Submit three detailed and simplified one line, color coded wiring diagrams.
   5. Submit field test reports.

6. Scale drawings for each dwelling unit type including hearing impaired units, indicating dimensioned layout of receptacles, switches, fire alarm devices, hearing impaired devices, and other devices to indicate compliance with the requirements of the electrical code and the applicable accessibility regulations (MAAB, FHA, etc.) Drawings shall be prepared at a minimum of 1/4 inch = 1 foot and shall be submitted to allow adequate time for review by the design team and owner prior to commencement of electrical work within the dwelling units.

1.10 ELECTRONIC COPIES OF AKF DRAWINGS

A. Upon award of contract, contractor shall submit list of drawings that they will require. AKF will provide drawings in (.PDF) format only.

B. If the contractor requires (.dwg) format, after preparation the drawings will be forwarded only upon receipt of signed acceptance of terms form. Permission from the architect must first be obtained for AKF to include the architectural background as reference. The contractor is to obtain the architects latest drawings directly from the architect.

C. These files are being issued for the convenience of the contractor and the contractor remains responsible for all contract requirements related to the normal shop drawing preparation process.

1.11 SUBMISSIONS:

A. Provide all coordination drawings and shop drawings in 'AutoCad" format, version compatible with owner. All catalog cuts and submittals to be provided in electronic "PDF" format the architect will forward all submissions to the engineer.

B. If paper submissions are to be provided the following shall be adhered to.
   1. Submissions 11 in. X 17 in. or smaller: If the submission is a catalog cut, then the contractor shall submit one original and one copy. Otherwise, they shall submit two copies. The architect will forward the original and one copy (two copies when no original is received) to the engineer. All catalog cuts shall be complete.
   2. Submissions larger than 11 in. X 17 in.: submit two copies to the architect. The architect will forward to the engineer.

C. Indicate on each submission: project name and location, architect and engineer, item identification and approval stamp of prime contractor, subcontractor names and phone numbers, reference to the applicable design drawing or specification article, date and scale.

D. The work described in all shop drawing submission shall be carefully checked for all clearances (including those required for maintenance and servicing), field conditions, maintenance of architectural conditions and proper coordination with all trades on the job.

E. Each submitted shop drawing is to include a certification that all related job conditions have been checked and verified and that there are no conflicts.

F. All shop drawings are to be submitted to allow ample time for checking in advance of field requirements. All submittals to be complete and contain all required and detailed information. Shop drawings with multiple parts shall be submitted as a package.

G. If submittals differ from the contract document requirements, make specific mention of such difference in a letter of transmittal, with request for substitution, together with reasons for same.

1.12 AS-BUILTS AND EQUIPMENT OPERATION INSTRUCTIONS

A. Provide all coordination drawings and shop drawings in AutoCad format, version compatible with owner. All catalog cuts and submittals to be provided in electronic “PDF” format the architect will forward all submissions to the engineer.

B. On completion and acceptance of work, this contractor shall furnish written instructions, equipment manuals and demonstrate to the owner the proper operation and maintenance of all equipment and apparatus furnished under this contract.

C. The contractor shall give one copy of the instructions to the owner and one copy to the engineer.

D. Final “as-built” drawings indicating as installed conditions shall be provided to the architect and engineer after completion of the installation.

1.13 PRODUCT DELIVERY, HANDLING, AND STORAGE

A. Ship materials and equipment in crated sections of sizes to permit passing through available space, where required.

B. Receive and accept materials and equipment at the site, properly handle, house, and protect them from damage and the weather until installation. Replace equipment damaged in the course of handling without additional charge.

C. Arrange for and provide storage space or area at the job site for all materials and equipment to be received and/or installed in this project.

1.14 ACCESSIBILITY

A. Install all work so that parts requiring periodic inspection, operation, maintenance, and repair are readily accessible. Minor deviations from the drawings may be made to accomplish this, but changes of substantial magnitude shall not be made without written approval.

B. Install equipment requiring access so as to be freely accessible through access doors.

1.15 CUTTING AND PATCHING:

A. Provide all carpentry, cutting and patching required for proper installation of material and equipment specified. Do not cut or drill structural members without consent of architect and structural engineer.

B. All cutting and patching will be performed under General Construction Work, except as noted in "AIA Document A201" and "Supplementary Conditions for Mechanical and Electrical Work."

1.16 PROTECTION OF MATERIALS

A. Protect from damage, water, dust, etc. all material, equipment and apparatus provided under this trade both in storage and installed.

1.17 GUARANTEE

A. The Contractor shall furnish a written guarantee to replace or repair promptly and assume responsibility for all expenses incurred for any workmanship and equipment in which defects develop within one year from the date of final certificate for payment and/or from date or actual use of equipment or occupancy of spaces by Owner included under the various parts of the work, whichever date is earlier. This work shall be done as directed by the Owner. This guarantee shall also provide that where defects occur, the Contractor will assume responsibility for all expenses incurred in repairing and replacing work of other trades affected by defects, repairs or replacements in equipment supplied by the Contractor.

1.18 PERMITS AND FEES

A. The Contractor shall give necessary notice, file drawings and specifications with the department having jurisdiction, obtain permits or licenses necessary to carry out this work and pay all fees therefor. The Contractor shall arrange for inspection and tests of any or all parts of the work if so required by authorities and pay all charges for same. The Contractor shall pay all costs for, and furnish to the Owner before final billing, all certificates necessary as evidence that the work installed conforms with all regulations where they apply to this work.

1.19 INSPECTIONS / TESTING

A. Independent testing and inspections shall be provided by this contractor who shall hire the inspector or testing agency

PART 2 - PRODUCTS

2.1 BASE BID MANUFACTURERS

A. Base bid on materials or equipment are specified by name of manufacturer, brand or trade name and catalog reference.

B. The choice will be optional with bidder where two or more manufacturers are named.

C. Manufacturers, other than specified, will only be considered if at the time of bid, manufacturers' names and proposed substitutions are named and stated and the difference in base bid is indicated including changes in the cost of all affected work.

D. Submission of equipment of manufacturers other than specified shall detail equality and difference item by item. Delay in ordering of equipment will not be considered a valid cause for substitution.

E. The following are base bid manufacturers for items under this Section:
   1. Access doors: Karp Associates, Inc., Higgins Mfg. Co., Milcor Steel Co. and Walsh-Spencer Co.
   2. Inserts: F and S Mfg. Co., Fee and Mason and Grinnell.

2.2 INSERTS AND SUPPORTS

A. Inserts:
   1. Inserts will be provided under General Construction Work.
   2. Provide additional acceptable means of support attachments as required, after review.
   3. Provide cutting and patching required to install additional attachments.

B. Support all electrical work from building construction by providing inserts, beam clamps, steel fishplates (in concrete fill only), and acceptable brackets. Submit all methods for review. Inserts shall be steel slotted type, factory painted.
   1. Single rod shall be similar to Grinnell Fig. 281.
   2. Multi-rod shall be similar to Fee Mason Series 9000 with end caps and closure strips.
   3. Clip form nails flush with inserts.
   4. Maximum loading including conduit, contents and covering shall not exceed 75% of rated insert capability.

C. Provide smooth wall, non-self-drilling internal plug expansion type anchors constructed of AISC 12L14 steel and zinc plated in accordance with Fed. Spec. QQ-A-325 Type 1, Class 3.

D. Provide trapeze hangers of bolted angles or channels for grouped lines and services.

E. Provide additional framing where building construction is inadequate. Submit for review.

F. Do not exceed 1/4 of average valves for a specific anchor size using 2000 psig (13,800 kpa) concrete only, for maximum working loads.

G. Provide spacing and install anchors in accordance with the manufacturer's recommendations.

H. Provide supports from building construction including inserts, beam clamps steel fishplates (in concrete fill only) cantilever brackets or other means. Submit for review.

2.3 SUPPLEMENTARY STEEL, CHANNELS AND SUPPORTS

A. Furnish supplementary steel, channels, and supports required for proper installations, mounting, and support of electrical work.

B. Connect supplementary steel and channels firmly to building construction in an accepted manner.

C. Determine type and size of supporting channels and supplementary steel. Supplementary steel and channels shall be of sufficient strength and size to allow only a minimum deflection in conformance with manufacturers' requirements of loading.

D. Install supplementary steel and channels in a neat and workmanlike manner parallel to walls, floors, and ceiling construction.

E. All supplementary steel, channels and supports shall be submitted to the Structural Engineer for review.

2.4 ACCESS DOORS

A. Access doors will be provided under General Construction Work.

B. Supply access doors as required for complete access. Installation shall be under General Construction Work. Minimum size shall be 12 in. x 12 in. Locating and setting will be performed after review.

C. Provide for access doors as required for complete access. Minimum size shall be 12 in. x 12 in. Locating and setting will be performed after review.

D. Flush type access doors shall be similar to Karp Type DSC-211 for wall installation, with No. 13 USSG steel doors and trim and No. 15 USSG steel frame, metal wings for keying into construction, concealed hinges and screwdriver operated stainless steel cam lock. Lift off type access door shall be similar to Karp Type DSC-212 where door cannot swing open.

E. Factory finished white access doors shall be similar to Karp Type DSC-210 in acoustic tile ceilings, with NO. 13 USSG steel frame, No. 16 USSG steel pan door suitable for receiving tile thickness and hinges that are not visible when door is closed. Access doors shall be screwdriver operated, stainless steel cam locks finishing flush with tile with a minimum of (2) per door.

F. Access doors shall be similar to Karp DSC-210-PL in plaster ceilings, with recess to receive plaster.

G. Fire rated access doors shall be similar to Karp KRP-150-FR, in accordance with applicable code requirements.

H. Access doors shall be shop-painted zinc chromate primer.

2.5 ACCESS TILE IDENTIFICATION:

A. Provide buttons, tabs or markers in removable ceiling tiles to identify location of concealed work. Submit for review.

2.6 GUARDS AND RAILINGS

A. Guards and railings will be provided under General Construction Work.

B. Provide guards and railings as indicated and/or as required by OSHA and authorities having jurisdiction.

C. Provide removable type guards with clearances for motor adjustments, for belt driven and rotating equipment, with No. 18 USSG steel frames and NO. 20 USSG galvanized perforated steel fronts with covered test opening to permit rpm readings without removal. Provide galvanized steel angle or channel supports braced to maintain clearances of moving parts.

D. Provide removable type railings constructed of 1 1/4 in. pipe and rail fittings.

2.7 NAMEPLATES:

A. Provide nameplates with inscriptions, subject to review, indicating equipment and fasten with epoxy cement and engrave black Lamicoid sheet with white lettering.

B. Provide nameplates for the following:
   1. Disconnect switches.
   2. Individual circuit breakers.
   3. Panels.

4. Cabinets

PART 3 - EXECUTION

3.1 EXCAVATION AND BACKFILL

A. Excavate, backfill and restore surfaces inside building.

B. Excavate, backfill and restore surfaces inside and outside building.

C. Excavate, backfill and restore surfaces outside building.

D. If rock is encountered, excavate to 6 inches below bottom of piping and refill with well tamped sand and gravel.

E. Bank excavated materials adjacent to trench and properly support with sheet-pile and brace.

F. Install and maintain guards and keep excavation free of water with attended pumping equipment.

G. No extra compensation will be provided for quicksand, hardpan, or other material encountered in excavating, except rock on unit price basis.

H. Remove bog or other swampy conditions encountered in excavating to 1 ft below bottom of piping and backfill with well tamped sand, finely crushed stone, or gravel.

I. Immediately after piping is installed, inspected, tested, and accepted, remove sheet piping with special care to solidly fill voids without damage to piping. Backfill in a manner to prevent future settlement with only good clean loam, clay, sand, or gravel that is free from frozen materials, lumps of clay, rocks, boulders, cinders, slag ashes, vegetable or organic materials, or building or other debris, or refuse.
   1. Hand fill in 4 inch layers up to 2 ft above pipe and remainder; fill in with 1 ft layers.
   2. Tamp and puddle each layer before placing next layer.
   3. Allow no stones larger than 2 in. diameter in fill up to 2 ft above piping and allow no stones larger than 4 in. diameter in fill over 2 ft above piping.

J. Restore surfaces, sidewalks, pavements, curbing, lawns, and shrubs that are disturbed or damaged.

K. Dispose of acceptable surplus excavation on site and remove surplus and unsuitable excavated materials from site as directed.

3.2 PAINTING

A. Provide labor, materials and equipment necessary for field prime painting and apply in accordance with manufacturers' instructions.

B. Apply zinc based primer with finish to match surroundings, to marred surfaces of steel equipment and raceways.

C. Apply galvanized iron primer on panel and pull boxes, after fabrication.

D. Apply hot dip galvanizing or dip in zinc based primer: outlet boxes, junction boxes, conduit hangers, rods, inserts, and supports.

E. Field apply zinc based primer coat on non-galvanized steel and iron work.

3.3 FOUNDATIONS

A. Foundations will be provided under General Construction Work.

B. Provide foundations utilizing concrete as specified herein:
   1. Provide one ortland cement, two parts fine aggregate, and four parts course aggregate.
   2. Provide concrete of the same consistency as specified under General Construction Work.
   3. Provided concrete, pouted in place on roughened concrete floor, cleaned and flushed with coat of cement grout. Do not pour grout until concrete has set. Foundation shall be puddled and finished smooth with reinforcing as noted.
   4. Provide floor free foundation forms and special foundations as noted.

C. Hold vibration isolation and anchor bolts in position during pour. Set anchor bolts in oversized sleeves with washers and nuts at bottom. Finish flush with nuts on top.

D. Foundations shall extend 6 in. beyond equipment, except as noted, with a minimum height of 4 in.

E. Forms:
   1. Forms will be provided under General Construction Work.
   2. Provide moisture-resistant commercial standard fir with non-staining mineral oil interior surface coating with rounded or chamfered edges.
   3. Provide galvanized NO. 18 USSG steel forms with welded seams & joints with bent top and bottom edges to form 2 in. integral internal angles (bend back exposed edges) and metal cross-strip bracing, welded to top and bottom angle edges, and intermediate bracing welded or riveted to sides as required.
      a. Bottoms for floor free foundations.

F. Provide foundations for the following:
   1. Switchboards.
   2. Engine Generators
   3. Outdoor lighting fixture standards.
   4. As noted.

3.4 FIELD QUALITY CONTROL

A. Perform tests as noted, and in the presence of the Architect and/or Engineer in accordance with authorities having jurisdiction.

B. Repair or replace defective work, as directed and pay for restoring or replacing damaged work of others, due to tests, as directed.

3.5 CLEANING

A. Brush and clean work prior to concealing, painting and acceptance. Perform in stages if directed.

B. Clean and repair painted exposed work, soiled or damaged, to match adjoining work before final acceptance.

C. Remove debris from inside and outside of materials and equipment.

END OF SECTION

SECTION 26 00 01

SUPPLEMENTARY CONDITIONS FOR MECHANICAL, ELECTRICAL, PLUMBING AND FIRE PROTECTION WORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The "GENERAL CONDITIONS OF THE CONTRACT FOR CONSTRUCTION", AIA Document A201-1997, is part of this Contract.

PART 2 - SUPPLEMENTARY CONDITIONS

These SUPPLEMENTARY CONDITIONS amend or supplement the GENERAL CONDITIONS and other provisions of the Contract Documents as indicated below. All provisions which are not so amended or supplemented remain in full force and effect. AIA document A201-1997 Edition is referenced.

2.1 GENERAL PROVISIONS SUMMARY

A. Section Includes:
1. Rubber expansion joints.
2. Flexible-hose expansion joints.
3. Pipe bends and loops.
4. Alignment guides and anchors.

2.2 CORRELATION AND INTENT OF CONTRACT DOCUMENTS

A. No reassignment of division of responsibility for work as specified for the respective trades shall be made without prior written acceptance by Engineer.

2.3 SUPERINTENDENT

A. Contractor shall arrange for Subcontractors for Heating, Ventilation and Air Conditioning work, Electrical Work, Fire Protection Work, Plumbing Work, or any other division of work, to each supply services of a competent project manager who shall act as assistants to the Superintendent and who shall be in attendance at the Project site during the progress of the Work. Such project managers shall be satisfactory to the Engineer, and shall not be changed except with the consent of the Architect

2.4 DOCUMENTS AND SAMPLES AT THE SITE

A. Dimension underground utilities from permanent identifiable benchmarks on Record Drawings.

2.5 RECORD DRAWINGS

A. Before commencing work, procure complete reproducible set of Contract Drawings

B. Conspicuously indicate major deviations in Mecnanical Equipment Rooms by specific reference to shop drawings of these rooms and submit reproducibles of such shop drawings

C. Submit up-to-date "in progress" prints, to Architect when requesting 25 percent, 50 percent, 75 percent and 95 percent payment of work installed

D. Upon completion of work, submit signed certified reproducibles of Record and reference shop drawings, along with marked-up prints of in-progress drawing to Architect for acceptance. Also provide an electronic version of the as-built drawings

2.6 SHOP DRAWINGS, PRODUCT DATA AND SAMPLES

A. Any Shop Drawing, Product Data or Sample submitted without Contractor's approval will not be processed for approval by the Architect, but will be returned to the Contractor for his compliance with the above procedures, in which event it will be deemed that the Contractor has not complied with the provisions herein specified and the Contractor shall bear risk of all delays as if no Shop Drawing, Product Data or Sample had been submitted.

B. Check the Shop Drawings, Product Data, and Samples for complete dimensional accuracy; that he has checked to insure that work contiguous with and having bearing on the work shown on the Shop Drawings is accurately and clearly shown, that he has checked the Shop Drawings against the Composite Drawings prepared by the Contractor, and that the work has been coordinated and that the equipment will fit into the assigned spaces.

C. Prior to shop drawings and sample submissions, and within 30 days after award of contract, submit lists of proposed manufacturers names, shop drawings and samples with proposed schedule of submission dates referenced by Specification Section, Article Numbers and Contract Drawing Number. Contractor shall be responsible for any delays resulting from failure to submit such lists

D. Submit shop drawings and samples for materials, equipment and systems as noted in each respective specification section for each trade

E. Any construction and/or design changes as a result of any approved substitution shall be made at no additional cost to the Owner

F. Composite Drawings:
   1. In the interest of coordination and to expedite the work in critical areas, the Contractor shall prepare and submit, to the Architect for review, Composite Drawings incorporating the work of the various trades and/or subcontractor involved. After review, the Contractor shall distribute prints of reviewed Composite Drawings to affected trades and/or subcontractors. The Contractor shall require that the involved trades and/or subcontractors cooperate in preparation of the Composite Drawings to assure proper coordination between trades and/or subcontractors. The participating parties shall indicate their approval on these drawings, in addition to the Contractor

G. Provide composite shop drawings 1:33 (3/8 inch per foot) scale or as approved of areas where contractors proposed installation is at variance with the Contract Drawings or Specifications. Ductwork, piping layout and distribution drawings are not required if they conform to the Contract Drawings, except as required below for specific areas
   1. Equipment Rooms.
   2. Plenums.
   3. Shafts.
   4. Roof Level

H. Indicate dimensioned layouts, elevations and sections of the following, on composite shop drawings
   1. Piping and valves.
   2. Raceways.
   3. Pull boxes.
   4. Lighting.
   5. Equipment.
   6. Connections.
   7. Access for servicing.
   8. Building construction (floor, ceiling, beams and columns).

I. Plan work to allow sufficient time for coordination and for compliance with construction schedule

J. Catalog, model and serial numbers will be assumed to represent equipment complying with Contract Drawings and Specifications, unless otherwise noted

K. Submit additional shop drawings (other than noted) when directed, during progress of project

L. Shop drawing resubmissions are required within 30 days of receipt of review comments from Architect

M. Replace all material and equipment which was installed prior to shop drawing review when directed by Architect

N. Before submitting shop drawings and samples, check material and equipment against drawings for clearance, connections, accessibility, servicing and maintenance

O. Submit shop drawings with:
   1. Marked notation of any deviations from the Contract Documents and reasons for same. Indicate such deviations in a conspicuous manner including component, material and system variations, additions and deletions revised equipment locations, hung ceiling heights and headroom conditions.
   2. Manufacturer's specifications including: materials, type, performance characteristics, voltage, phase and capacity. Specifications for project shall be tailored to reflect the requirements of the contract documents.
   3. Certified dimensional drawings, indicating sizes, component parts and installation details.
   4. Wiring diagrams when applicable
   5. Identify with:

a. Project name and number
b. Names of Architect and Engineer
c. Identification of applicable items on each submission
d. Applicable Contract Specification Section and Article Numbers
e. Applicable Contract Drawing Numbers

6. Minimum copies of shop drawing submissions:
   a. 8-1/2 inch by 14 inch and smaller: 2 copies
   b. Larger than 8-1/2 inch by 14 inch: 1 reproducible plus 1 print
7. All fire walls and smoke partitions must be highlighted on the sheet metal drawings for appropriate coordination

2.7 Cleaning Up

1. Remove broken or scratched glass and replace with new glass, remove paint drippings, spots, stains, and dirt from finished surfaces and clean fixtures, hardware, floors and equipment. Contractor shall keep interior of the building free of stored or unattended combustible material

2.8 INDEMNIFICATION

1. Relieve Owner of all claims in connection with use of facilities, conveniences or services supplied by other parties

2.9 ADMINISTRATION OF THE CONTRACT

A. Whenever the word "Architect" occurs, the word "Engineer" shall be substituted, and shall mean the firm of Atkinson Koven Feinberg, LLP or its authorized representative.

2.10 PROTECTION OF PERSONS AND PROPERTY

A. SAFETY OF PERSONS AND PROPERTY
   1. Close open ends of work with temporary covers or plugs during construction to prevent entry of obstructing materials
   2. Storage areas will be designated by Architect or Building Owner

B. USE OF PERMANENT INSTALLATION
   1. No equipment intended for permanent installation shall be operated for temporary purposes without written permission of, and complete agreement with stipulation as set forth by, the Architect

2.11 INSURANCE AND BONDS

A. The Contractor shall procure and maintain, at his own expense, until final acceptance of all the work covered by this Contractor, the following kinds of insurance:
   1. Workmen's Compensation Insurance: A policy complying with the requirements of the laws of the State of Maine
   2. The contractor shall obtain all specific insurance requirements FROM the owner
   3. Contractor's Comprehensive General Liability and Property Damage Insurance: A standard comprehensive general liability insurance policy, with contractual and completed operations coverage, issued to and covering the liability of the Contractor for all work and operations under this Contract.

The coverage under such a policy shall be in accordance with the Owner's requirements

4. Automobile Liability and Property Damage Insurance. A policy covering the use in connection with the work covered by Contract Documents of all owned, non-owned and hired vehicles bearing, or, under the circumstances under which they are being used, required by the Motor Vehicles Laws of the State of New York to bear license plates. The coverage under such policy shall be in accordance with Owner's requirements
5. Before commencing the performance of any work covered by the Contract, the Contractor shall furnish to Owner a certificate of the insurance required under the foregoing provisions
6. If at any time any of the above required insurance policies should be canceled, terminate or modified so that insurance is not in effect as above required, then, if the Owner shall so direct, the Contractor shall suspend performance of the work covered in the Contract. If the said work is so suspended, no extension of time shall be due on account thereof. If said work is not suspended the Owner may, at its option, obtain insurance affording coverage equal to that above required, the cost of such insurance to be payable by the Contractor to the Owner

2.12 DEVIATIONS

A. When deviations to Contract Documents are requested by the Contractor and accepted by the Architect, Contractor shall be responsible for all affected work and costs, including that of other contracts.

B. Interference With Owner's Operations
1. Contractors shall take whatever action is necessary to avoid interference with owner's use of the building or damage to existing facilities equipment
2. Except as otherwise specified herein, contractors may work during normal working hours. In the event that noisy work interferes with owner's operations, owner may direct contractor to stop that work. If the workers involved cannot be used on other work, Contractor shall be paid for the lost time in accordance with a schedule of hourly rates to be included in the contract. Owner's representative will determine the duration of the stoppage and whether compensation therefor is warranted
3. Contractor shall include with his proposal a schedule of hourly rates and overtime premiums
4. Maintain building services in operation

2.13 PROJECT CLOSEOUT PROCEDURES

A. General
1. The requirements of this section are in addition to and supplement the requirements outlined in Division 1.
2. It shall be each contractor's responsibility to personally hand-deliver all of the required project closeout checklist items and to obtain Owner's authorized representative(s) signed receipt on all items requiring Owner sign-off

2.14 Project Closeout Checklist

1. Review requirements of each section of the specifications and submit for approval to Architect the sign-off forms which shall become the project closeout checklist. These, at a minimum, shall include the following information shown in attached Project Closeout Checklist Example. The Architect and/or Owner may incorporate additional specific items to the following checklist which shall become part of the project requirements

2.15 Closeout Checklist Example:

PROJECT CLOSETOUT			
PROJECT:			
DIVISION NO.:			
CONTRACTOR:			
ITEM [1]	DATES		OWNER'S SIGN-OFF
	COMPLETED	RECEIVED BY OWNER	
Permits			
City and County Inspection			
Manufacturer's warranties			
Contractor's Warranties			
State Fire Rating Data			
Copy of Final Shop Drawings			
List and Possession of Spare Parts			
Pressure Tests			
Equipment Tests Required by Specs			
O & M Manuals			
Record Documents			
Coordination Drawings			
Sanitization Reports			
Commissioning reports/Letters/Forms			
On-Site Training Complete			
Protective Device Settings			
Valve Tags and Charts			
Final ATC Installation Drawings			
Insurance Underwriters Approvals			
Final Punch List (Initialed by contractor that items are complete)			
Building Certificate of Occupancy (C.O.)			
24-Hour Phone No. for Service During Guarantee Period			

END OF SECTION

This page is intentionally left blank

SECTION 26 05 00

COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The Contractor, Subcontractors, and/or suppliers providing goods or services referenced in or related to this Section shall also be bound by the Documents identified in Division 01 Section “Summary”, Paragraph 1.01A, entitled “Related Documents.”

1.2 SUMMARY

A. Section Includes:
1. Electrical equipment coordination and installation.
2. Sleeves for raceways and cables.
3. Sleeve seals.
4. Grout.
5. Common electrical installation requirements.

1.3 DEFINITIONS

A. EPDM: Ethylene-propylene-diene terpolymer rubber.

B. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS

A. Product Data: For sleeve seals.

1.5 COORDINATION

A. Coordinate arrangement, mounting, and support of electrical equipment:
1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
3. To allow right of way for piping and conduit installed at required slope.
4. So connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.

B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

C. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in "Access Doors and Frames."

D. Coordinate sleeve selection and application with selection and application of fire stopping specified in “Penetration Fire stopping.”."

PART 2 - PRODUCTS

2.1 SLEEVES FOR RACEWAYS AND CABLES

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral water stop, unless otherwise indicated.

C. Sleeves for Rectangular Openings: Galvanized sheet steel.
   1. Minimum Metal Thickness:
      a. For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and no side more than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).
      b. For sleeve cross-section rectangle perimeter equal to, or more than, 50 inches (1270 mm) and 1 or more sides equal to, or more than, 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).

2.2 SLEEVE SEALS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.
   1. Basis-of-Design Product: Subject to compliance with requirements, comparable product by one of the following:
      a. Advance Products & Systems, Inc.
      b. Calpico, Inc.
      c. Metraflex Co.
      d. Pipeline Seal and Insulator, Inc.
      e. Link-Seal
   2. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
   3. Pressure Plates: Stainless steel. Include two for each sealing element.
   4. Connecting Bolts and Nuts: Carbon with corrosion-resistant coating of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.3 GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, non-staining, mixed with water to consistency suitable for application and a 30-minute working time.

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

A. Comply with NECA 1.

B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.

C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.

D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.

E. Right of Way: Give to piping systems installed at a required slope.

3.2 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Electrical penetrations occur when raceways, cables, wireways, cable trays, or busways penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.

B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.

C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with fire stop system used are fabricated during construction of floor or wall.

E. Cut sleeves to length for mounting flush with both surfaces of walls.

F. Extend sleeves installed in floors 2 inches (50 mm) above finished floor level.

G. Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and raceway or cable, unless indicated otherwise.

H. Seal space outside of sleeves with grout for penetrations of concrete and masonry
   1. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.

I. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in "Joint Sealants."

J. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with fire stop materials. Comply with requirements in "Penetration Fire stopping."

K. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

L. Aboveground, Exterior-Wall Penetrations: Seal penetrations using cast iron pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.

M. Underground, Exterior-Wall Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch (25-mm) annular clear space between raceway or cable and sleeve for installing mechanical sleeve seals.

3.3 SLEEVE-SEAL INSTALLATION

A. Install to seal exterior wall penetrations.

B. Use type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.4 FIRE STOPPING

A. Apply fire stopping to penetrations of fire-rated floor and wall assemblies for electrical installations to restore original fire-resistance rating of assembly. Fire stopping materials and installation requirements are specified in "Penetration Fire stopping."

END OF SECTION

SECTION 26 05 13

MEDIUM-VOLTAGE CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes cables and related splices, terminations, and accessories for medium-voltage electrical distribution systems.

1.3 DEFINITIONS

A. NETA ATS: Acceptance Testing Specification.

1.4 SUBMITTALS

A. Product Data: For each type of cable indicated. Include splices and terminations for cables and cable accessories.

B. Samples: 16-inch (400-mm) lengths of each type of cable indicated.

C. Qualification Data: For Installer and testing agency.

D. Material Certificates: For each cable and accessory type, signed by manufacturers.

E. Source quality-control test reports.

F. Field quality-control test reports.

1.5 QUALITY ASSURANCE

A. Installer: Engage a cable splicer, trained and certified by splice material manufacturer, to install, splice, and terminate medium-voltage cable.

B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

C. Source Limitations: Obtain cables and accessories through one source from a single manufacturer.

D. 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.

E. Comply with IEEE C2 and NFPA 70.

1.6 PROJECT CONDITIONS

A. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
   1. Notify Owner no fewer than seven days in advance of proposed interruption of electric service.
   2. Do not proceed with interruption of electric service without Owner's written permission.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Cables:
      a. Kerite Co. (The); Hubbell Incorporated.
      b. Okonite Company (The).
      c. Pirelli Cables & Systems NA.
      d. Rome Cable Corporation.
      e. Southwire Company.
   2. Cable Splicing and Terminating Products and Accessories:
      a. G&W Electric Company.
      b. MPHusky.
      c. Raychem Corp.; Telephone Energy and Industrial Division; Tyco International Ltd.
      d. RTE Components; Cooper Power Systems, Inc.
      e. Scott Fetzer Co. (The); Adalet.
      f. Thomas & Betts Corporation.
      g. Thomas & Betts Corporation/Elastimold.
      h. 3M; Electrical Products Division.

2.2 CABLES

A. Cable Type: MV105.

B. Comply with UL 1072, AEIC CS 8, ICEA S-93-639, and ICEA S-97-682.

C. Conductor: Copper.

D. Conductor Stranding: Compact round, concentric lay, Class B.

E. Strand Filling: Conductor interstices are filled with impermeable compound.

F. Conductor Insulation: Crosslinked polyethylene.

G. Conductor Insulation: Ethylene-propylene rubber.
   1. Voltage Rating: 15 kV.
   2. Insulation Thickness: 133 percent insulation level.

H. Shielding: Copper tape helically applied over semiconducting insulation shield.

I. Shielding and Jacket: Corrugated copper drain wires embedded in extruded, chlorinated, polyethylene jacket.

1. Circuit Identification: Color-coded tape (bl shielding.

J. Cable Jacket: Sunlight-resistant PVC listed for Cable tray use.

2.3 SPLICE KITS

A. Connectors and Splice Kits: Comply with IEEE 404; type as recommended by cable or splicing kit manufacturer for the application.

B. Splicing Products: As recommended, in writing, by splicing kit manufacturer for specific sizes, ratings, and configurations of cable conductors. Include all components required for complete splice, with detailed instructions.
   1. Combination tape and cold-shrink-rubber sleeve kit with rejacketing by cast-epoxy-resin encasement or other waterproof, abrasion-resistant material.
   2. Heat-shrink splicing kit of uniform, cross-section, polymeric construction with outer heat-shrink jacket.
   3. Premolded, cold-shrink-rubber, in-line splicing kit.
   4. Premolded EPDM splicing body kit with cable joint sealed by interference fit of mating parts and cable.

2.4 SOLID TERMINATIONS

A. Shielded-Cable Terminations: Comply with the following classes of IEEE 48. Insulation class is equivalent to that of cable. Include shield ground strap for shielded cable terminations.
   1. Class 1 Terminations: Modular type, furnished as a kit, with stress-relief tube; multiple, molded-silicone rubber, insulator modules; shield ground strap; and compression-type connector.
   2. Class 1 Terminations: Heat-shrink type with heat-shrink inner stress control and outer nontracking tubes; multiple, molded, nontracking skirt modules; and compression-type connector.
   3. Class 1 Terminations: Modular type, furnished as a kit, with stress-relief shield terminator; multiple-wet-process, porcelain, insulator modules; shield ground strap; and compression-type connector.
   4. Class 1 Terminations, Indoors: Kit with stress-relief tube, nontracking insulator tube, shield ground strap, compression-type connector, and end seal.
   5. Class 2 Terminations, Indoors: Kit with stress-relief tube, nontracking insulator tube, shield ground strap, and compression-type connector. Include silicone-rubber tape, cold-shrink-rubber sleeve, or heat-shrink plastic-sleeve moisture seal for end of insulation whether or not supplied with kits.
   6. Class 3 Terminations: Kit with stress cone and compression-type connector.

2.5 SEPARABLE INSULATED CONNECTORS

A. Description: Modular system, complying with IEEE 386, with disconnecting, single-pole, cable terminators and with matching, stationary, plug-in, dead-front terminals designed for cable voltage and for sealing against moisture.

B. Terminations at Distribution Points: Modular type, consisting of terminators installed on cables and modular, dead-front, terminal junctions for interconnecting cables.

C. Load-Break Cable Terminators: Elbow-type units with 200-A load make/break and continuous-current rating; coordinated with insulation diameter, conductor size, and material of cable being terminated. Include test point on terminator body that is capacitance coupled.

D. Dead-Break Cable Terminators: Elbow-type ur rating; designed for de-energized disconnecting and connecting; coordinated with insulation diameter, conductor size, and material of cable being terminated. Include test point on terminator body that is capacitance coupled.

E. Dead-Front Terminal Junctions: Modular bracket-mounted groups of dead-front stationary terminals that mate and match with above cable terminators. Two-, three-, or four-terminal units as indicated, with fully rated, insulated, watertight conductor connection between terminals and complete with grounding lug, manufacturer's standard accessory stands, stainless-steel mounting brackets, and attaching hardware.
   1. Protective Cap: Insulating, electrostatic-shielding, water-sealing cap with drain wire.
   2. Portable Feed-Through Accessory: Two-terminal, dead-front junction arranged for removable mounting on accessory stand of stationary terminal junction.
   3. Grounding Kit: Jumpered elbows, portable feed-through accessory units, protective caps, test rods suitable for concurrently grounding three phases of feeders, and carrying case.
   4. Standoff Insulator: Portable, single dead-front terminal for removable mounting on accessory stand of stationary terminal junction. Insulators suitable for fully insulated isolation of energized cable-elbow terminator.

2.6 SOURCE QUALITY CONTROL

A. Test and inspect cables according to ICEA S-97-682 ICEA S-94-649 before shipping.

B. Test strand-filled cables for water-penetration resistance according to ICEA T-31-610, using a test pressure of 5 psig (35 kPa).

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install cables according to IEEE 576.

B. Pull Conductors: Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.
   1. Where necessary, use manufacturer-approved pulling compound or lubricant that will not deteriorate conductor or insulation.
   2. Use pulling means, including fish tape, cable, rope, and basket-weave cable grips that will not damage cables and raceways. Do not use rope hitches for pulling attachment to cable.

C. Install exposed cables parallel and perpendicular to surfaces of exposed structural members and follow surface contours where possible.

D. Support cables according to Division 26 Section "Common Work Results for Electrical."

E. Install direct-buried cables on leveled and tamped bed of 3-inch- (75-mm-) thick, clean sand. Separate cables crossing other cables or piping by a minimum of 4 inches (100 mm) of tamped earth. Install permanent markers at ends of cable runs, changes in direction, and buried splices.

F. Install "buried-cable" warning tape 12 inches (30

G. In manholes, handholes, pull boxes, junction boxes, and cable vaults, train cables around walls by the longest route from entry to exit and support cables at intervals adequate to prevent sag.

H. Install cable splices at pull points and elsewhere as indicated; use standard kits.

I. Install terminations at ends of conductors and seal multiconductor cable ends with standard kits.

J. Install separable insulated-connector components as follows:
   1. Protective Cap: At each terminal junction, with one on each terminal to which no feeder is indicated to be connected.
   2. Portable Feed-Through Accessory: Three.
   3. Standoff Insulator: Three.

K. Arc Proofing: Unless otherwise indicated, arc proof medium-voltage cable at locations not protected by conduit, cable tray, direct burial, or termination materials. In addition to arc-proofing tape manufacturer's written instructions, apply arc proofing as follows:
   1. Clean cable sheath.
   2. Wrap metallic cable components with 10-mil (250-micrometer) pipe-wrapping tape.
   3. Smooth surface contours with electrical insulation putty.
   4. Apply arc-proofing tape in one half-lapped layer with coated side toward cable.
   5. Band arc-proofing tape with 1-inch- (25-mm-) wide bands of half-lapped, adhesive, glass-cloth tape 2 inches (50 mm) o.c.

L. Seal around cables passing through fire-rated elements according to Division 07 Section "Penetration Firestopping."

M. Install fault indicators on each phase where indicated.

N. Ground shields of shielded cable at terminations, splices, and separable insulated connectors. Ground metal bodies of terminators, splices, cable and separable insulated-connector fittings, and hardware.

O. Identify cables according to Division 26 Section "Identification for Electrical Systems."

3.2 FIELD QUALITY CONTROL

A. Testing: Engage a qualified testing and inspecting agency to perform the following field tests and inspections and prepare test reports:

B. Perform the following field tests and inspections and prepare test reports:
   1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters.
   2. Each cable shall be tested in the field on three (3) separate occasions: 1) on the reel at the site; 2) after installation but before connection to the system and; 3) after final connection to the system, in accordance with this specification.
   3. The Electrical Subcontractor shall furnish certified copies, on a standardized test report form, of actual test results. The Electrical Subcontractor shall adopt an identification scheme relating each test report with the reel of cable that it represents.

4. For tests requiring tabulation of data, t provide copies of the tabulation when so requested.
5. The certified test reports for the field tests shall be forwarded to the Owner.
6. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION

SECTION 26 05 19

LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:
   1. Building wires and cables rated 600 V and less.
   2. Connectors, splices, and terminations rated 600 V and less.
   3. Sleeves and sleeve seals for cables.

1.3 DEFINITIONS

A. EPDM: Ethylene-propylene-diene terpolymer rubber.

B. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS

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

B. Qualification Data: For testing agency.

C. Field quality-control test reports.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
   1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

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 NFPA 70.

1.6 COORDINATION

A. Set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. American Insulated Wire Corp.; a Leviton Company.
   2. Encore Wire Corporation.
   3. General Cable Corporation.
   4. Senator Wire & Cable Company.
   5. Southwire Company.
   6. AFC Cable Systems, Inc.

B. Copper Conductors: Comply with NEMA WC 70.

C. Conductor Insulation: Comply with NEMA WC 70 for Types THW, THHN-THWN and XHHW.

D. Multiconductor Cable: Comply with NEMA WC 70 for armored cable, Type AC, metal-clad cable, Type MC and mineral-insulated, metal-sheathed cable, Type MI.
   1. Type MC cable shall be high strength, lightweight galvanized steel armor equal to AFC Cable Systems, Inc. "MC TUFF."
   2. Conductors shall be copper with thermoplastic insulation, type THHN/THWN. Insulation shall be color coded for 120/208 volt systems and 480/277 volt systems as specified in Section 26 – "Identification for Electrical Systems."
   3. Hospital Grade type AC cable shall be high strength galvanized steel armor with green stripe equal to AFC Cable Systems, Inc. "HCF – 90."
   4. Type AC conductors shall be copper with thermoplastic insulation, type THHN. Each conductor shall be paper wrapped. There shall be a bare # 16 AWG integral bond conductor and separated insulated # 12 AWG ground conductor. Insulation shall be color coded as specified in Section 26 – "Identification for Electrical Systems."

2.2 CONNECTORS AND SPLICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. AFC Cable Systems, Inc.
   2. Hubbell Power Systems, Inc.
   3. O-Z/Gedney; EGS Electrical Group LLC.
   4. 3M; Electrical Products Division.
   5. Tyco Electronics Corp.

B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

2.3 SLEEVES FOR CABLES

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

B. Sleeves for Rectangular Openings: Galvanized sheet steel with minimum 0.052- or 0.138-inch (1.3- or 3.5-mm) thickness as indicated and of length to suit application.

C. Coordinate sleeve selection and application with selection and application of firestopping specified in "Penetration Firestopping."

2.4 SLEEVE SEALS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:
   1. Advance Products & Systems, Inc.
   2. Calpico, Inc.
   3. Metraflex Co.
   4. Pipeline Seal and Insulator, Inc.
   5. Link Seal

B. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and cable.
   1. Sealing Elements: NBR interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
   2. Pressure Plates: Stainless steel. Include two for each sealing element.
   3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

PART 3 - EXECUTION

3.1 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 Crawlspaces: Type THHN-THWN, single conductors in raceway. Type MI Cable where indicated on schedules and drawings.

D. Feeders Concealed in Concrete, below Slabs-on-Grade, and Underground: Type XHHW-2, single conductors in raceway.

E. Exposed Branch Circuits, Including in Crawlspaces: Type THHN-THWN, single conductors in raceway.

F. Branch Circuits Concealed in Ceilings, Walls, and Partitions Metal-clad cable, Type MC. Type AC (hospital grade) or type MC may be used for branch circuit wiring. All homerun wiring shall be in raceway. All emergency circuits shall be in non flexible conduit.

G. Branch circuits in patient care areas and surgical areas: Armored cable type AC-Hospital grade "HCF-90".

H. Branch Circuits from essential branch (Healthcare Article 517), Type THHN-THWN, single conductors in non-flexible metallic raceway.

I. Branch Circuits Concealed in Concrete, below Slabs-on-Grade, and Underground: Type THHN-THWN, single conductors in raceway.

J. Branch Circuits in Operating Rooms: Low Leakage type XLP, single conductors in raceway.

K. Class 1 Control Circuits: Type THHN-THWN, in raceway.

L. Class 2 Control Circuits: Type THHN-THWN, in raceway.

M. Type AC and/or type MC cable shall be installed in the best and shortest route for each cable run. Long runs of spider wed type routing is unacceptable. Support cables with approved supports within 12" of every termination and type AC cable every 4 1/2" and type MC cable every 6". When terminating or splicing, cut cable so that 6 inches of free conductor is left for connection or splices. Use an approved connector and insure a proper bond by firmly tightening the connector to both the box and the cable. When terminating cable, provide and insert an approved anti-short bushing.

3.2 INSTALLATION OF CONDUCTORS AND CABLES

A. Conceal cables in finished walls and ceilings for floor mounted devices run conduit and cable in ceiling below.

B. 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.

C. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

D. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

E. Support cables according to Division 26 Section "Hangers and Supports for Electrical Systems."

F. Identify and color-code conductors and cables according to Division 26 Section "Identification for Electrical Systems."

3.3 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 and UL 486B.

B. Make splices 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 (150 mm) of slack.

3.4 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Coordinate sleeve selection and application with selection and application of firestopping specified in "Penetration Firestopping."

B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.

C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

D. Rectangular Sleeve Minimum Metal Thickness:
   1. For sleeve rectangle perimeter less than 50 inches (1270 mm) and no side greater than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).
   2. For sleeve rectangle perimeter equal to, or greater than, 50 inches (1270 mm) and 1 or more sides equal to, or greater than, 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).

E. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

F. Cut sleeves to length for mounting flush with both wall surfaces.

G. Extend sleeves installed in floors 2 inches (50 mm) above finished floor level.

H. Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and cable unless sleeve seal is to be installed or unless seismic criteria require different clearance.

I. Seal space outside of sleeves with grout for penetrations of concrete and masonry and with approved joint compound for gypsum board assemblies.

J. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and cable, using joint sealant appropriate for size, depth, and location of joint according to "Joint Sealants."

K. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at cable penetrations. Install sleeves and seal with firestop materials according to Section "Penetration Firestopping."

L. Roof-Penetration Sleeves: Seal penetration of individual cables with flexible boot-type flashing units applied in coordination with roofing work.

M. Aboveground Exterior-Wall Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Size sleeves to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.

N. Underground Exterior-Wall Penetrations: Install cast-iron "wall pipes" for sleeves. Size sleeves to allow for 1-inch (25-mm) annular clear space between cable and sleeve for installing mechanical sleeve seals.

3.5 SLEEVE-SEAL INSTALLATION

A. Install to seal underground exterior-wall penetrations.

B. Use type and number of sealing elements recommended by manufacturer for cable material and size. Position cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

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 "Penetration Firestopping."

3.7 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections and prepare test reports.

B. Tests and Inspections:
   1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and all feeder conductors for compliance with requirements.
   2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
   3. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each splice in cables and conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner.
      a. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each splice 11 months after date of Substantial Completion.
      b. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
      c. Record of Infrared Scanning: Prepare a certified report that identifies splices checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

C. Test Reports: Prepare a written report to record the following:
   1. Test procedures used.
   2. Test results that comply with requirements.
   3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

D. Remove and replace malfunctioning units and retest as specified above.

END OF SECTION

SECTION 26 05 26

GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes methods and materials for grounding systems and equipment.

1.3 SUBMITTALS

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

B. Other Informational Submittals: Plans showing dimensioned as-built locations of grounding features specified in Part 3 "Field Quality Control" Article, including the following:
   1. Grounding arrangements and connections for separately derived systems.
   2. Grounding for sensitive electronic equipment.

C. Qualification Data: For testing agency and testing agency's field supervisor.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For grounding to include the following in emergency, operation, and maintenance manuals:
   1. Instructions for periodic testing and inspection of grounding features at grounding connections for separately derived systems based on NFPA 70B.
      a. Tests shall be to determine if ground resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if they do not.
      b. Include recommended testing intervals.

1.4 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
   1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association to supervise on-site testing specified in Part 3.

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 UL 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.1 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 Jumper: Copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.

C. Bare Grounding Conductor and Conductor Protector for Wood Poles:
   1. No. 4 AWG minimum, soft-drawn copper.
   2. Conductor Protector: Half-round PVC

D. Grounding Bus: Rectangular bars of annealed copper, 4 inches by 1/4 inches x 24 or as indicated on plans.

2.2 CONNECTORS

A. Listed and labeled by a nationally recognized testing laboratory 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, bolted pressure-type, with at least two bolts.
   1. Pipe Connectors: Clamp type, sized for pipe.

C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions. Use for bonding to steel and as indicated.

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Conductors: Install solid conductor for No. 10 AWG and smaller, and stranded conductors for No. 8 AWG and larger, unless otherwise indicated.

B. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.

C. Grounding Bus: Install in electrical rooms, and elsewhere as indicated. Length 24" or as indicated in drawings.
   1. Install bus on insulated spacers 1 inch (25 mm), minimum, from wall 6 inches (150 mm) above finished floor, unless otherwise indicated.
   2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, down to specified height above floor, and connect to horizontal bus.

3.2 EQUIPMENT GROUNDING

A. 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. Armored and metal-clad cable runs.
   8. Computer and Rack-Mounted Electronic Equipment Circuits: Install insulated equipment grounding conductor in branch-circuit runs from equipment-area power panels and power-distribution units.
   9. X-Ray Equipment Circuits: Install insulated equipment grounding conductor in circuits supplying x-ray equipment.

3.3 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. 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 so vibration is not transmitted to rigidly mounted equipment.
   3. Use exothermic-welded connectors for outdoor locations, but if a disconnect-type connection is required, use a bolted clamp.

C. 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.

3.4 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing and inspecting agency to perform the following field tests and inspections and prepare test reports:

B. Perform the following tests and inspections and prepare test reports:
   1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.

2. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal. Make tests at ground rods before any conductors are connected.
   a. Perform tests by fall-of-potential method according to IEEE 81.

C. Report measured ground resistances that exceed the following values:
   1. Power and Lighting Equipment or System with Capacity 500 kVA and Less: 10 ohms.
   2. Power and Lighting Equipment or System with Capacity 500 to 1000 kVA: 5 ohms.
   3. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 ohms.
   4. Power Distribution Units or Panelboards Serving Electronic Equipment: 3 ohm(s).

D. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

END OF SECTION

SECTION 26 05 29

HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:
   1. Hangers and supports for electrical equipment and systems.
   2. Construction requirements for concrete bases.

~~B. Related Sections include the following:~~
   ~~1. Division 26 Section "Vibration And Seismic Controls For Electrical Systems" for products and installation requirements necessary for compliance with seismic criteria.~~

1.3 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. RMC: Rigid metal conduit.

1.4 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design supports for multiple raceways, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.

C. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

D. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project,.

1.5 SUBMITTALS

A. Product Data: For the following:
   1. Steel slotted support systems.

B. Shop Drawings: Show fabrication and installation details and include calculations for the following:
   1. Trapeze hangers. Include Product Data for components.
   2. Steel slotted channel systems. Include Product Data for components.

3. Equipment supports.

C. Welding certificates.

1.6 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Comply with NFPA 70.

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.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Section "Roof Accessories."

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, provide products by one of the following:
      a. Allied Tube & Conduit.
      b. Cooper B-Line, Inc.; a division of Cooper Industries.
      c. ERICO International Corporation.
      d. Thomas & Betts Corporation.
      e. Unistrut; Tyco International, Ltd.
      f. Wesanco, Inc.
   2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
   3. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.
   4. Channel Dimensions: Selected for applicable load criteria.

B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

C. Conduit and Cable Support Devices: Steel hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for 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, provide products by one of the following:
      1) Hilti Inc.
      2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
      3) MKT Fastening, LLC.
      4) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.
2. Mechanical-Expansion Anchors: Insert-wedge-type, stainless 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, provide products by one of the following:
      1) Cooper B-Line, Inc.; a division of Cooper Industries.
      2) Empire Tool and Manufacturing Co., Inc.
      3) Hilti Inc.
      4) ITW Ramset/Red Head; a division of 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.

B. Materials: Comply with requirements in Division 05 Section "Metal Fabrications" for steel shapes and plates.

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, and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch (6 mm) 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 two-bolt conduit clamps .

D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch (38-mm) and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.

B. Raceway Support Methods: In addition to methods described in NECA 1, EMT and RMC may be supported by openings through structure members, as permitted in NFPA 70.

C. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb (90 kg).

D. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
   1. To Wood: Fasten with lag screws or through bolts.
   2. To 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 (100 mm) thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches (100 mm) 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.

E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Comply with installation requirements in Section "Metal Fabrications" for site-fabricated metal supports.

B. Cut, fit, and place miscellaneous metal supports accurately in location, alignment, and elevation to support and anchor electrical materials and equipment.

C. Field Welding: Comply with AWS D1.1/D1.1M.

3.4 CONCRETE BASES

A. Construct concrete bases of dimensions indicated but not less than 4 inches (100 mm) larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.

B. Use 3000-psi (20.7-MPa), 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Division 03 Section "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 2.0 mils (0.05 mm).

B. Touchup: Comply with requirements in painting Sections for cleaning and touchup painting of 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

This page is intentionally left blank.

SECTION 26 05 33

RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

B. Related Sections include the following:
   1. Division 26 Section "Underground Ducts and Raceways for Electrical Systems" for exterior ductbanks, manholes, and underground utility construction.

1.3 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. EPDM: Ethylene-propylene-diene terpolymer rubber.

C. FMC: Flexible metal conduit.

D. LFMC: Liquidtight flexible metal conduit.

E. LFNC: Liquidtight flexible nonmetallic conduit.

F. NBR: Acrylonitrile-butadiene rubber.

G. RNC: Rigid nonmetallic conduit.

1.4 SUBMITTALS

A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

B. Shop Drawings: For the following raceway components. Include plans, elevations, sections, details, and attachments to other work.
   1. Custom enclosures and cabinets.
   2. For handholes and boxes for underground wiring, including the following:
      a. Duct entry provisions, including locations and duct sizes.
      b. Frame and cover design.
      c. Grounding details.
      d. Dimensioned locations of cable rack inserts, and pulling-in and lifting irons.
      e. Joint details.

C. Samples for Initial Selection: For wireways and surface raceways with factory-applied texture and color finishes.
   1. Size: As requested by Owner or Architect minimum of 4 samples.

D. Samples for Verification: For each type of exposed finish required for wireways and surface raceways, prepared on Samples of size indicated below.
   1. Size: As requested by Owner or Architect minimum of 4 samples.

E. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
   1. Structural members in the paths of conduit groups with common supports.
   2. HVAC and plumbing items and architectural features in the paths of conduit groups with common supports.

F. Manufacturer Seismic Qualification Certification: Submit certification that enclosures and cabinets and their mounting provisions, including those for internal components, will withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems." 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 cabinet or enclosure will remain in place without separation of any parts when subjected to the seismic forces specified and the unit will retain its enclosure characteristics, including its interior accessibility, after the seismic event."
   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.

G. Qualification Data: For professional engineer and testing agency.

H. Source quality-control test reports.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 METAL CONDUIT AND TUBING

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. AFC Cable Systems, Inc.
   2. Alflex Inc.
   3. Allied Tube & Conduit; a Tyco International Ltd. Co.
   4. Anamet Electrical, Inc.; Anaconda Metal Hose.
   5. Electri-Flex Co.
   6. NUCOR Tubular Products.

7. Republic Conduit.
8. O-Z Gedney; a unit of General Signal.
9. Zekmond / Western and Wheatland Tube Company

B. Rigid Steel Conduit: ANSI C80.1.

C. Aluminum Rigid Conduit: ANSI C80.5.

D. IMC: ANSI C80.6.

E. PVC-Coated Steel Conduit: PVC-coated rigid steel conduit.
1. Comply with NEMA RN 1.
2. Coating Thickness: 0.040 inch (1 mm), minimum.

F. EMT: ANSI C80.3., Color coded to MMC Standards.

G. FMC: Zinc-coated steel or aluminum.

H. LFMC: Flexible steel conduit with PVC jacket.

I. Fittings for Conduit (Including all Types and Flexible and Liquidtight), EMT, and Cable: NEMA FB 1; listed for type and size raceway with which used, and for application and environment in which installed.
1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886.
2. Fittings for EMT: Steel or die-cast, set-screw or compression type.
3. Coating for Fittings for PVC-Coated Conduit: Minimum thickness, 0.040 inch (1 mm), with overlapping sleeves protecting threaded joints.

J. Joint Compound for Rigid Steel Conduit: Listed for use in cable connector assemblies, and compounded for use to lubricate and protect threaded raceway joints from corrosion and enhance their conductivity.

2.2 NONMETALLIC CONDUIT AND TUBING

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. AFC Cable Systems, Inc.
2. Anamet Electrical, Inc.; Anaconda Metal Hose.
3. Arnco Corporation.
4. CANTEX Inc.
5. CertainTeed Corp.; Pipe & Plastics Group.
6. Condux International, Inc.
7. ElecSYS, Inc.
8. Electri-Flex Co.
9. Lamson & Sessions; Carlon Electrical Products.
10. RACO; a Hubbell Company.
11. Thomas & Betts Corporation.

B. RNC: NEMA TC 2, Type EPC-40-PVC, unless otherwise indicated.

C. LFNC: UL 1660.

D. Fittings for and RNC: NEMA TC 3; match to conduit or tubing type and material.

E. Fittings for LFNC: UL 514B.

2.3 METAL WIREWAYS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Cooper B-Line, Inc.
   2. Hoffman.
   3. Square D; Schneider Electric.

B. Description: Sheet metal sized and shaped as indicated, NEMA 250, Type 1, unless otherwise indicated.

C. Fittings and Accessories: Include 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, Flanged-and-gasketed type where indicated or required by code or location of installation.

E. Finish: Manufacturer's standard enamel finish.

2.4 NONMETALLIC WIREWAYS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Hoffman.
   2. Lamson & Sessions; Carlon Electrical Products.

B. Description: PVC plastic, extruded and fabricated to size and shape indicated, with snap-on cover and mechanically coupled connections with plastic fasteners.

C. Fittings and Accessories: Include 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.

2.5 SURFACE RACEWAYS

A. Surface Metal Raceways: Galvanized steel with snap-on covers. Manufacturer's standard enamel finish in color selected by Architect.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Thomas & Betts Corporation.
      b. Walker Systems, Inc.; Wiremold Company (The).
      c. Wiremold Company (The); Electrical Sales Division.

2.6 BOXES, ENCLOSURES, AND CABINETS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.
   2. EGS/Appleton Electric.
   3. Erickson Electrical Equipment Company.
   4. Hoffman.
   5. Hubbell Incorporated; Killark Electric Manufacturing Co. Division.
   6. O-Z/Gedney; a unit of General Signal.
   7. RACO; a Hubbell Company.

8. Thomas & Betts Corporation.
9. Walker Systems, Inc.; Wiremold Company (The).

B. Sheet Metal Outlet and Device Boxes: NEMA OS 1.

C. Cast-Metal Outlet and Device Boxes: NEMA FB 1, ferrous alloy or aluminum, Type FD, with gasketed cover.

D. Nonmetallic Outlet and Device Boxes: NEMA OS 2.

E. Metal Floor Boxes: Cast or sheet metal, fully adjustable, rectangular.

F. Nonmetallic Floor Boxes: Nonadjustable, round.

G. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

H. Cast-Metal Access, Pull, and Junction Boxes: NEMA FB 1, cast aluminum or galvanized, cast iron with gasketed cover.

I. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous-hinge cover with flush latch, unless otherwise indicated.
1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.
2. Nonmetallic Enclosures: Plastic, finished inside with radio-frequency-resistant paint.

J. Cabinets:
1. NEMA 250, Type 1, galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
2. Hinged door in front cover with flush latch and concealed hinge.
3. Key latch to match panelboards.
4. Metal barriers to separate wiring of different systems and voltage.
5. Accessory feet where required for freestanding equipment.

2.7 SLEEVES FOR RACEWAYS

A. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

B. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop, unless otherwise indicated.

C. Sleeves for Rectangular Openings: Galvanized sheet steel with minimum 0.052- or 0.138-inch (1.3- or 3.5-mm) thickness as indicated and of length to suit application.

D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

2.8 SLEEVE SEALS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Advance Products & Systems, Inc.
2. Calpico, Inc.
3. Metraflex Co.
4. Pipeline Seal and Insulator, Inc.

B. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and cable.
   1. Sealing Elements: NBR interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway or cable.
   2. Pressure Plates: Stainless steel. Include two for each sealing element.
   3. Connecting Bolts and Nuts: Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.9 SOURCE QUALITY CONTROL FOR UNDERGROUND ENCLOSURES

A. Handhole and Pull-Box Prototype Test: Test prototypes of handholes and boxes for compliance with SCTE 77. Strength tests shall be for specified tier ratings of products supplied.
   1. Tests of materials shall be performed by a independent testing agency.
   2. Strength tests of complete boxes and covers shall be by either an independent testing agency or manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
   3. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012, and traceable to NIST standards.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

A. Outdoors: Apply raceway products as specified below, unless otherwise indicated:
   1. Exposed Conduit: Rigid steel conduit.
   2. Concealed Conduit, Aboveground: Rigid steel conduit.
   3. Underground Conduit: RNC, Type EPC-~~80~~40-PVC.
   4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC or LFNC.
   5. Boxes and Enclosures, Aboveground: NEMA 250, Type 4.
   6. Application of Handholes and Boxes for Underground Wiring:
      a. Pull Boxes in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Fiberglass enclosures with polymer-concrete frame and cover, SCTE 77, Tier 15 structural load rating.
      b. Pull Boxes in Sidewalk and Similar Applications with a Safety Factor for Nondeliberate Loading by Vehicles: Heavy-duty fiberglass units with polymer-concrete frame and cover, SCTE 77, Tier 8 structural load rating.
      c. Pull Boxes Subject to Light-Duty Pedestrian Traffic Only: Fiberglass-reinforced polyester resin, structurally tested according to SCTE 77 with 3000-lbf (13 345-N) vertical loading.

B. Comply with the following indoor applications, 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: Rigid steel conduit. Includes raceways in the following locations:
      a. Loading dock.

b. Corridors used for traffic of mechanized carts, forklifts, and pallet-handling units.
c. Mechanical rooms.

4. Concealed in Ceilings and Interior Walls and Partitions: EMT.
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: Rigid steel conduit
7. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4, stainless steel in damp or wet locations.

C. Minimum Raceway Size: 3/4-inch (21-mm) 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.
2. PVC Externally Coated, Rigid Steel Conduits: Use only fittings listed for use with that material. Patch and seal all joints, nicks, and scrapes in PVC coating after installing conduits and fittings. Use sealant recommended by fitting manufacturer.

E. Install nonferrous conduit or tubing for circuits operating above 60 Hz. Where aluminum raceways are installed for such circuits and pass through concrete, install in nonmetallic sleeve.

F. Do not install aluminum conduits in contact with concrete.

3.2 INSTALLATION

A. Comply with NECA 1 for installation requirements applicable to products specified in Part 2 except where requirements on Drawings or in this Article are stricter.

B. Keep raceways at least 6 inches (150 mm) 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. Support raceways as specified in Division 26 Section "Hangers and Supports for Electrical Systems."

E. Arrange stub-ups so curved portions of bends are not visible above the finished slab.

F. Install no more than the equivalent of three 90-degree bends in any conduit run except for communications conduits, for which fewer bends are allowed.

G. Conceal conduit and EMT within finished walls, ceilings, and floors, unless otherwise indicated.

H. Raceways Embedded in Slabs:
1. Run conduit larger than 1-inch (27-mm) trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support.
2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.

3. Change from RNC, Type EPC-40-PVC, to rigid steel conduit, or before rising above the floor

I. 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.

J. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors, including conductors smaller than No. 4 AWG.

K. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 12 inches (300 mm) of slack at each end of pull wire.

L. Raceways for Optical Fiber and Communications Cable: Install raceways, metallic and nonmetallic, rigid and flexible, as follows:
1. 3/4-Inch (19-mm) Trade Size and Smaller: Install raceways in maximum lengths of 50 feet (15 m).
2. 1-Inch (25-mm) Trade Size and Larger: Install raceways in maximum lengths of 75 feet (23 m).
3. Install with a maximum of two 90-degree bends or equivalent for each length of raceway unless Drawings show stricter requirements. Separate lengths with pull or junction boxes or terminations at distribution frames or cabinets where necessary to comply with these requirements.

M. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:
1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
2. Where otherwise required by NFPA 70.

N. Expansion-Joint Fittings for RNC: Install in each run of aboveground conduit that is located where environmental temperature change may exceed 30 deg F (17 deg C), and that has straight-run length that exceeds 25 feet (7.6 m).
1. Install expansion-joint fittings for each of the following locations, and provide type and quantity of fittings that accommodate temperature change listed for location:
   a. Outdoor Locations Not Exposed to Direct Sunlight: 125 deg F (70 deg C) temperature change.
   b. Outdoor Locations Exposed to Direct Sunlight: 155 deg F (86 deg C) temperature change.
   c. Indoor Spaces: Connected with the Outdoors without Physical Separation: 125 deg F (70 deg C) temperature change.
   d. Attics: 135 deg F (75 deg C) temperature change.
2. Install fitting(s) that provide expansion and contraction for at least 0.00041 inch per foot of length of straight run per deg F (0.06 mm per meter of length of straight run per deg C) of temperature change.
3. Install each expansion-joint fitting with position, mounting, and piston setting selected according to manufacturer's written instructions for conditions at specific location at the time of installation.

O. Flexible Conduit Connections: Use maximum of 72 inches (1830 mm) of flexible conduit for recessed and semirecessed lighting fixtures normal branch lighting only,

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 or LFNC in damp or wet locations not subject to severe physical damage.

P. 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.

Q. Set metal floor boxes level and flush with finished floor surface.

R. Set nonmetallic floor boxes level. Trim after installation to fit flush with finished floor surface.

3.3 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping."

B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.

C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

D. Rectangular Sleeve Minimum Metal Thickness:
1. For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and no side greater than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).
2. For sleeve cross-section rectangle perimeter equal to, or greater than, 50 inches (1270 mm) and 1 or more sides equal to, or greater than, 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).

E. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

F. Cut sleeves to length for mounting flush with both surfaces of walls.

G. Extend sleeves installed in floors 2 inches (50 mm) above finished floor level.

H. Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and raceway unless sleeve seal is to be installed or unless seismic criteria require different clearance.

I. Seal space outside of sleeves with grout for penetrations of concrete and masonry and with approved joint compound for gypsum board assemblies.

J. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway, using joint sealant appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.

K. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway penetrations. Install sleeves and seal with firestop materials. Comply with Division 07 Section "Penetration Firestopping."

L. Roof-Penetration Sleeves: Seal penetration of individual raceways with flexible, boot-type flashing units applied in coordination with roofing work.

M. Aboveground, Exterior-Wall Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.

N. Underground, Exterior-Wall Penetrations: Install cast-iron "wall pipes" for sleeves. Size sleeves to allow for 1-inch (25-mm) annular clear space between raceway and sleeve for installing mechanical sleeve seals.

3.4 SLEEVE-SEAL INSTALLATION

A. Install to seal underground, exterior wall penetrations.

B. Use type and number of sealing elements recommended by manufacturer for raceway material and size. Position raceway in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.5 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."

3.6 PROTECTION

A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.
   1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.
   2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

END OF SECTION

SECTION 26 05 43

UNDERGROUND DUCTS AND RACEWAYS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:
   1. Conduit, ducts, and duct accessories for direct-buried, concrete-encased duct banks, and in single duct runs.
   2. Handholes and boxes.

1.3 DEFINITION

A. RNC: Rigid nonmetallic conduit.

1.4 SUBMITTALS

A. Sustainable Design Submittals: Comply with Division 01 Section 018113 "Sustainable Design Requirements" and provide the following in addition to other action submittals:
   1. Product Data for Credit IEQ.4: For adhesives and sealants, documentation including printed statement of VOC content.
   2. Product Data for Credit IEQ 4: For paints and coatings, including printed statement of VOC content.

B. Product Data: For the following:
   1. Duct-bank materials, including separators and miscellaneous components.
   2. Ducts and conduits and their accessories, including elbows, end bells, bends, fittings, and solvent cement.
   3. Accessories for handholes.
   4. Warning tape.
   5. Warning planks.

C. Shop Drawings for Factory-Fabricated Handholes and Boxes Other Than Precast Concrete: Include dimensioned plans, sections, and elevations, and fabrication and installation details, including the following:
   1. Duct entry provisions, including locations and duct sizes.
   2. Cover design.
   3. Grounding details.
   4. Dimensioned locations of cable rack inserts, and pulling-in and lifting irons.

D. Duct-Bank Coordination Drawings: Show duct profiles and coordination with other utilities and underground structures.
   1. Include plans and sections, drawn to scale, and show bends and locations of expansion fittings.

E. Product Certificates: For concrete and steel used in precast concrete handholes, as required by ASTM C 858.

F. Source quality-control test reports.

G. Field quality-control test reports.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.

B. Comply with ANSI C2.

C. Comply with NFPA 70.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver ducts to Project site with ends capped. Store nonmetallic ducts with supports to prevent bending, warping, and deforming.

B. Store precast concrete and other factory-fabricated underground utility structures at Project site as recommended by manufacturer to prevent physical damage. Arrange so identification markings are visible.

C. Lift and support precast concrete units only at designated lifting or supporting points.

1.7 PROJECT CONDITIONS

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 Construction Manager no fewer than two days in advance of proposed interruption of electrical service.
   2. Do not proceed with interruption of electrical service without Construction Manager's written permission.

1.8 COORDINATION

A. Coordinate layout and installation of ducts, manholes, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field.

B. Coordinate elevations of ducts and duct-bank entrances into manholes, handholes, and boxes with final locations and profiles of ducts and duct banks as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations from those indicated as required to suit field conditions and to ensure that duct runs drain to manholes and handholes, and as approved by Architect.

1.9 EXTRA MATERIALS

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

B. Furnish cable-support stanchions, arms, insulators, and associated fasteners in quantities equal to 5 percent of quantity of each item installed.

PART 2 - PRODUCTS

2.1 CONDUIT

A. Rigid Steel Conduit: Galvanized. Comply with ANSI C80.1.

B. RNC~~: NEMA TC 2, Type EPC-40-PVC, UL 651, with matching fittings by same manufacturer as the conduit, complying with NEMA TC 3 and UL 514B~~. NEMA TC 2, Type EPC-40-PVC and Type EPC-80-PVC, UL 651, with matching fittings by same manufacturer as the conduit, complying with NEMA TC 3 and UL 514B.

2.2 NONMETALLIC DUCTS AND DUCT ACCESSORIES

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

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

C. Basis-of-Design Product: Subject to compliance with requirements, provide a comparable product by one of the following:
1. ARNCO Corp.
2. Beck Manufacturing.
3. Cantex, Inc.
4. CertainTeed Corp.; Pipe & Plastics Group.
5. Condux International, Inc.
6. ElecSys, Inc.
7. Electri-Flex Company.
8. IPEX Inc.
9. Lamson & Sessions; Carlon Electrical Products.
10. Manhattan/CDT; a division of Cable Design Technologies.
11. Spiraduct/AFC Cable Systems, Inc.

D. ~~Underground Plastic Utilities Duct: NEMA TC 6 & 8, Type EB-20-PVC, ASTM F 512, UL 651A, with matching fittings by the same manufacturer as the duct, complying with NEMA TC 9~~. NEMA TC 2, Type EPC-40-PVC and Type EPC-80-PVC, UL 651, with matching fittings by same manufacturer as the conduit, complying with NEMA TC 3 and UL 514B.

E. Duct Accessories:
1. Duct Separators: Factory-fabricated rigid PVC interlocking spacers, sized for type and sizes of ducts with which used, and selected to provide minimum duct spacings indicated while supporting ducts during concreting or backfilling.
2. Warning Tape: Underground-line warning tape specified in Division 26 Section "Identification for Electrical Systems."
3. Concrete Warning Planks: Nominal 12 by 24 by 3 inches (300 by 600 by 76 mm) in size, manufactured from 6000-psi (41-MPa) concrete.
   a. Color: Red dye added to concrete during batching.
   b. Mark each plank with "ELECTRIC" in 2-inch- (50-mm-) high, 3/8-inch- (10-mm-) deep letters.

2.3 HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

A. Description: Comply with SCTE 77.
   1. Color: Gray or Green.
   2. Configuration: Units shall be designed for flush burial and have closed bottom, unless otherwise indicated.
   3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure.
   4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
   5. Cover Legend: Molded lettering, "ELECTRIC."
   6. Direct-Buried Wiring Entrance Provisions: Knockouts equipped with insulated bushings or end-bell fittings, selected to suit box material, sized for wiring indicated, and arranged for secure, fixed installation in enclosure wall.
   7. Duct Entrance Provisions: Duct-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.
   8. Handholes 12 inches wide by 24 inches long (300 mm wide by 600 mm long) and larger shall have factory-installed inserts for cable racks and pulling-in irons.

B. Fiberglass Handholes and Boxes: Molded of fiberglass-reinforced polyester resin, with covers of fiberglass.
   1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   3. Basis-of-Design Product: Subject to compliance with requirements, provide a comparable product by one of the following:
      a. Carson Industries LLC.
      b. Christy Concrete Products.
      c. Nordic Fiberglass, Inc.

PART 3 - EXECUTION

3.1 UNDERGROUND DUCT APPLICATION

A. Ducts for Electrical Cables Over 600 V: RNC, NEMA Type EPC-40-PVC, in concrete-encased duct bank, unless otherwise indicated.

B. Ducts for Electrical Feeders 600 V and Less: RNC, NEMA Type EPC-40-PVC, in concrete-encased duct bank, unless otherwise indicated.

C. Ducts for Electrical Branch Circuits: RNC, NEMA Type EPC-40-PVC, in direct-buried duct bank, unless otherwise indicated.

D. Underground Ducts for Telephone, Communications, or Data Utility Service Cables: RNC, NEMA Type EPC-40-PVC, in concrete-encased duct bank, unless otherwise indicated.

3.2 EARTHWORK

A. Excavation and Backfill: Comply with Division 31 Section "Earth Moving," but do not use heavy-duty, hydraulic-operated, compaction equipment.

B. Restore surface features at areas disturbed by excavation and reestablish original grades, unless otherwise indicated. Replace removed sod immediately after backfilling is completed.

C. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Division 32 Sections "Turf and Grasses" and "Plants."

D. Cut and patch existing pavement in the path of underground ducts and utility structures according to Division 01 Section "Cutting and Patching."

3.3 DUCT INSTALLATION

A. Slope: Pitch ducts a minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope ducts from a high point in runs between two manholes to drain in both directions.

B. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of 48 inches (1220 mm, both horizontally and vertically, at other locations, unless otherwise indicated.

C. Joints: Use solvent-cemented joints in ducts and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent ducts do not lie in same plane.

D. Building Wall Penetrations: Make a transition from underground duct to rigid steel conduit at least 10 feet (3 m) outside the building wall without reducing duct line slope away from the building, and without forming a trap in the line. Use fittings manufactured for duct-to-conduit transition. Install conduit penetrations of building walls as specified in Division 26 Section "Common Work Results for Electrical."

E. Sealing: Provide temporary closure at terminations of ducts that have cables pulled. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15-psig (1.03-MPa) hydrostatic pressure.

F. Pulling Cord: Install 100-lbf- (445-N-) test nylon cord in ducts, including spares.

G. Concrete-Encased Ducts: Support ducts on duct separators.
   1. Separator Installation: Space separators close enough to prevent sagging and deforming of ducts, with not less than 4 spacers per 20 feet (6 m) of duct. Secure separators to earth and to ducts to prevent floating during concreting. Stagger separators approximately 6 inches (150 mm) between tiers. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.
   2. Concreting Sequence: Pour each run of envelope between manholes or other terminations in one continuous operation.
      a. Start at one end and finish at the other, allowing for expansion and contraction of ducts as their temperature changes during and after the pour. Use expansion fittings installed according to manufacturer's written recommendations, or use other specific measures to prevent expansion-contraction damage.
      b. If more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch (19-mm) reinforcing rod dowels extending 18

inches (450 mm) into concrete on both sides of joint near corners of envelope.

3. Pouring Concrete: Spade concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Use a plank to direct concrete down sides of bank assembly to trench bottom. Allow concrete to flow to center of bank and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-bank application.
4. Reinforcement: Reinforce concrete-encased duct banks where they cross disturbed earth and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.
5. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.
6. Minimum Space between Ducts: 3 inches (75 mm) between ducts and exterior envelope wall, 2 inches (50 mm) between ducts for like services, and 4 inches (100 mm) between power and signal ducts.
7. Depth: Install top of duct bank at least 24 inches (600 mm) below finished grade in areas not subject to deliberate traffic, and at least 30 inches (750 mm) below finished grade in deliberate traffic paths for vehicles, unless otherwise indicated.
8. Stub-Ups: Use manufactured duct elbows for stub-ups at poles and equipment and at building entrances through the floor, unless otherwise indicated. Extend concrete encasement throughout the length of the elbow.
9. Stub-Ups: Use manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.
   a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches (75 mm) of concrete.
   b. Stub-Ups to Equipment: For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches (1500 mm) from edge of base. Install insulated grounding bushings on terminations at equipment.
10. Warning Tape: Bury warning tape approximately 12 inches (300 mm) above all concrete-encased ducts and duct banks. Align tape parallel to and within 3 inches (75 mm) of the centerline of duct bank. Provide an additional warning tape for each 12-inch (300-mm) increment of duct-bank width over a nominal 18 inches (450 mm). Space additional tapes 12 inches (300 mm) apart, horizontally.

H. Direct-Buried Duct Banks:
1. Support ducts on duct separators coordinated with duct size, duct spacing, and outdoor temperature.
2. Space separators close enough to prevent sagging and deforming of ducts, with not less than 4 spacers per 20 feet (6 m) of duct. Secure separators to earth and to ducts to prevent displacement during backfill and yet permit linear duct movement due to expansion and contraction as temperature changes. Stagger spacers approximately 6 inches (150 mm) between tiers.
3. Excavate trench bottom to provide firm and uniform support for duct bank. Prepare trench bottoms as specified in Division 31 Section "Earth Moving" for pipes less than 6 inches (150 mm) in nominal diameter.
4. Install backfill as specified in Division 31 Section "Earth Moving."

5. After installing first tier of ducts, backfill and compact. Start at tie-in point and work toward end of duct run, leaving ducts at end of run free to move with expansion and contraction as temperature changes during this process. Repeat procedure after placing each tier. After placing last tier, hand-place backfill to 4 inches (100 mm) over ducts and hand tamp. Firmly tamp backfill around ducts to provide maximum supporting strength. Use hand tamper only. After placing controlled backfill over final tier, make final duct connections at end of run and complete backfilling with normal compaction as specified in Division 31 Section "Earth Moving."
6. Install ducts with a minimum of 3 inches (75 mm) between ducts for like services and 6 inches (150 mm) between power and signal ducts.
7. Depth: Install top of duct bank at least 36 inches (900 mm) below finished grade, unless otherwise indicated.
8. Set elevation of bottom of duct bank below the frost line.
9. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through the floor, unless otherwise indicated. Encase elbows for stub-up ducts throughout the length of the elbow.
10. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.
    a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches (75 mm) of concrete.
    b. For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches (1500 mm) from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.
11. Warning Planks: Bury warning planks approximately 12 inches (300 mm) above direct-buried ducts and duct banks, placing them 24 inches (600 mm) o.c. Align planks along the width and along the centerline of duct bank. Provide an additional plank for each 12-inch (300-mm) increment of duct-bank width over a nominal 18 inches (450 mm). Space additional planks 12 inches (300 mm) apart, horizontally.

3.4 INSTALLATION OF HANDHOLES AND BOXES OTHER THAN PRECAST CONCRETE

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances. Use box extension if required to match depths of ducts, and seal joint between box and extension as recommended by the manufacturer.

B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch (12.7-mm) sieve to No. 4 (4.75-mm) sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In paved areas and trafficways, set so cover surface will be flush with finished grade. Set covers of other handholes 1 inch (25 mm) above finished grade.

D. Install handholes and boxes with bottom below the frost line, below grade.

E. Install removable hardware, including pulling eyes, cable stanchions, cable arms, and insulators, as required for installation and support of cables and conductors and as indicated. Select arm lengths to be long enough to provide spare space for future cables, but short enough to preserve adequate working clearances in the enclosure.

F. Field-cut openings for ducts and conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

G. For enclosures installed in asphalt paving and subject to occasional, nondeliberate, heavy-vehicle loading, form and pour a concrete ring encircling, and in contact with, enclosure and with top surface screeded to top of box cover frame. Bottom of ring shall rest on compacted earth.
   1. Concrete: 3000 psi (20 kPa), 28-day strength, complying with Division 03 Section "Cast-in-Place Concrete," with a troweled finish.
   2. Dimensions: 10 inches wide by 12 inches deep (250 mm wide by 300 mm deep).

3.5 GROUNDING

A. Ground underground ducts and utility structures according to Division 26 Section "Grounding and Bonding for Electrical Systems."

3.6 FIELD QUALITY CONTROL

A. Perform the following tests and inspections and prepare test reports:
   1. Demonstrate capability and compliance with requirements on completion of installation of underground ducts and utility structures.
   2. Pull aluminum or wood test mandrel through duct to prove joint integrity and test for out-of-round duct. Provide mandrel equal to 80 percent fill of duct. If obstructions are indicated, remove obstructions and retest.
   3. Test handhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Division 26 Section "Grounding and Bonding for Electrical Systems."

B. Correct deficiencies and retest as specified above to demonstrate compliance.

3.7 CLEANING

A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of ducts. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.

B. Clean internal surfaces of manholes, including sump. Remove foreign material.

END OF SECTION

SECTION 26 05 53

IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:
1. Identification for raceway and metal-clad cable.
2. Identification for conductors and communication and control cable.
3. Underground-line warning tape.
4. Warning labels and signs.
5. Instruction signs.
6. Equipment identification labels.
7. Miscellaneous identification products.

1.3 SUBMITTALS

A. Product Data: For each electrical identification product indicated.

B. Identification Schedule: An index of nomenclature of electrical equipment and system components used in identification signs and labels.

C. Samples: For each type of label and sign to illustrate size, colors, lettering style, mounting provisions, and graphic features of identification products.

1.4 QUALITY ASSURANCE

A. Comply with ANSI A13.1 and ANSI C2.

B. Comply with NFPA 70.

C. Comply with 29 CFR 1910.145.

1.5 COORDINATION

A. Coordinate identification names, abbreviations, colors, and other features with requirements in the Contract Documents, 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 RACEWAY AND 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 raceway and cable size.

B. Color for Printed Legend:
   1. Power Circuits: Black letters on an orange field.
   2. Legend: Indicate system or service and voltage, if applicable.

C. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeves, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

D. Snap-Around, Color-Coding Bands: Slit, pretensioned, flexible, solid-colored acrylic sleeves, 2 inches (50 mm) long, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

E. Self-Adhesive Vinyl Tape: Colored, heavy duty, waterproof, fade resistant; 2 inches (50 mm) wide; compounded for outdoor use.

2.2 CONDUCTOR AND COMMUNICATION- AND CONTROL-CABLE IDENTIFICATION MATERIALS

A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils (0.08 mm) thick by 1 to 2 inches (25 to 50 mm) wide.

B. Marker Tapes: Vinyl or vinyl-cloth, self-adhesive wraparound type, with circuit identification legend machine printed by thermal transfer or equivalent process.

C. Write-On Tags: Polyester tag, 0.015 inch (0.38 mm) thick, with corrosion-resistant grommet and polyester or nylon tie for attachment to conductor or cable.
   1. Marker for Tags: Permanent, waterproof, black ink marker recommended by tag manufacturer.

2.3 UNDERGROUND-LINE WARNING TAPE

A. Description: Permanent, bright-colored, continuous-printed, polyethylene tape.
   1. Not less than 6 inches (150 mm) wide by 4 mils (0.102 mm) thick.
   2. Compounded for permanent direct-burial service.
   3. Embedded continuous metallic strip or core.
   4. Printed legend shall indicate type of underground line.

2.4 WARNING LABELS AND SIGNS

A. Comply with NFPA 70 and 29 CFR 1910.145.

B. Baked-Enamel Warning Signs: Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application. 1/4-inch (6.4-mm) grommets in corners for mounting. Nominal size, 7 by 10 inches (180 by 250 mm).

C. Metal-Backed, Butyrate Warning Signs: Weather-resistant, nonfading, preprinted, cellulose-acetate butyrate signs with 0.0396-inch (1-mm) galvanized-steel backing; and with colors, legend, and size required for application. 1/4-inch (6.4-mm) grommets in corners for mounting. Nominal size, 10 by 14 inches (250 by 360 mm).

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. Workspace Clearance Warning: "WARNING - OSHA REGULATION - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 36 INCHES (915 MM)."

2.5 INSTRUCTION SIGNS

A. Engraved, laminated acrylic or melamine plastic, minimum 1/16 inch (1.6 mm) thick for signs up to 20 sq. in. (129 sq. cm) and 1/8 inch (3.2 mm) 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.

2.6 EQUIPMENT IDENTIFICATION LABELS

A. 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 (10 mm). Name plate descriptions shall be as follows:
   1. Switchboard: Identify and switchboard main breaker as such and feeder breakers by panelboard, transformer and equipment FED
      a. Example: SWBD 4A, PANEL DP2G
         480/277 V, 3 PH, 4W
   2. Panelboards: Identify with panel designation and characteristics.
      a. Example: DP2G
         480/277 V, 3 PH, 4W
   3. Low Voltage Transformers: Identify with source of power.
      a. Example: FED from SWBD N-1
   4. Enclosed Breakers and Disconnect Switches: Identify with equipment served.
      a. Example: CWP-1
   5. Transfer Switches: Identify by designation and indicate generator location.
      a. Example: ATS-EM
         Generator located North side of Building.
   6. Signs:
      a. Provide a nameplate on the service entrance section that indicated location of on-site emergency power source.
         1) Example: Emergency Generator located southwest corner of building.
      b. Provide a nameplate at the generator grounding location if the emergency source is a separately deriver system and is connected to a

grounding electrode at a location that is remote from the emergency source.
1) Example: Generator grounding location connection.

c. Provide a nameplate next to the generator ground fault sensor that states instructions on the course of action to be taken in event of indicated ground fault.

2.7 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Cable Ties: Fungus-inert, self-extinguishing, 1-piece, self-locking, Type 6/6 nylon cable ties.
1. Minimum Width: 3/16 inch (5 mm).
2. Tensile Strength: 50 lb (22.6 kg), minimum.
3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).
4. Color: Black, except where used for color-coding.

B. Paint: Paint materials and application requirements are specified in Division 09 painting Sections.

1. Exterior Ferrous Metal:
a. Semigloss Alkyd-Enamel Finish: Two finish coat(s) over a primer.
1) Primer: Exterior ferrous-metal primer.
2) Finish Coats: Exterior semigloss alkyd enamel.
2. Exterior Zinc-Coated Metal (except Raceways):
a. Semigloss Alkyd-Enamel Finish: Two finish coat(s) over a primer.
1) Primer: Exterior zinc-coated metal primer.
2) Finish Coats: Exterior semigloss alkyd enamel.
3. Interior Ferrous Metal:
a. Semigloss Acrylic-Enamel Finish: One finish coat(s) over a primer.
1) Primer: Interior ferrous-metal primer.
2) Finish Coats: Interior semigloss acrylic enamel.
4. Interior Zinc-Coated Metal (except Raceways):
a. Semigloss Acrylic-Enamel Finish: One finish coat(s) over a primer.
1) Primer: Interior zinc-coated metal primer.
2) Finish Coats: Interior semigloss acrylic enamel.

C. 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 APPLICATION

A. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits More Than 30 A: Identify with orange snap-around label.

B. Accessible Raceways and Cables of Auxiliary Systems: Identify the following systems with color-coded, snap-around, color-coding bands:
1. Fire Alarm System: Red.
2. Fire-Suppression Supervisory and Control System: Red and yellow.
3. Security System: Blue and yellow.
4. Mechanical and Electrical Supervisory System: Green and blue.
5. Telecommunication System: Green and yellow.

6. Control Wiring: Green and red.

C. Power-Circuit Conductor Identification: For primary and secondary conductors No. 1/0 AWG and larger in vaults, pull and junction boxes, manholes, and handholes use write-on tags. Identify source and circuit number of each set of conductors. For single conductor cables, identify phase in addition to the above.

D. Branch-Circuit Conductor Identification: Where there are conductors for more than three branch circuits in same junction or pull box, use write-on tags. Identify each ungrounded conductor according to source and circuit number.

E. Conductors to Be Extended in the Future: Attach write-on tags to conductors and list source and circuit number.

F. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, signal, sound, intercommunications, voice, and data 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 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. 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: Comply with 29 CFR 1910.145 and apply baked-enamel warning signs. Identify system voltage with black letters on an orange background. Apply to exterior of door, cover, or other access.
   1. 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.
   2. Equipment Requiring Workspace Clearance According to NFPA 70: Unless otherwise indicated, apply to door or cover of equipment but not on flush panelboards and similar equipment in finished spaces.

I. Instruction Signs:
   1. Operating Instructions: 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.
   2. Emergency Operating Instructions: Install instruction signs with white legend on a red background with minimum 3/8-inch- (10-mm-) high letters for emergency instructions at equipment used for power transfer.

J. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and 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- (13-mm-) high letters on 1-1/2-inch- (38-mm-) high label; where 2 lines of text are required, use labels 2 inches (50 mm) 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.

2. Equipment to Be Labeled: All equipment requires a label 94D shall include but not limited to:
   a. Panelboards, electrical cabinets, and enclosures.
   b. Access doors and panels for concealed electrical items.
   c. Electrical switchboards.
   d. Transformers.
   e. Automatic transfer switches.
   f. Emergency system boxes and enclosures.
   g. Motor-control centers.
   h. Disconnect switches.
   i. Enclosed circuit breakers.
   j. Motor starters.
   k. Push-button stations.
   l. Power transfer equipment.
   m. Contactors.
   n. Remote-controlled switches, dimmer modules, and control devices.
   o. Battery inverter units.
   p. Battery racks.
   q. Power-generating units.
   r. Master clock and program equipment.
   s. Intercommunication and call system master and staff stations.
   t. Television/audio components, racks, and controls.
   u. Fire-alarm control panel and annunciators.
   v. Security and intrusion-detection control stations, control panels, terminal cabinets, and racks.
   w. Monitoring and control equipment.
   x. Uninterruptible power supply equipment.
   y. Terminals, racks, and patch panels for voice and data communication and for signal and control functions.

3.2 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 nonadhesive signs and plastic labels with screws and auxiliary hardware appropriate to the location and substrate.

F. System Identification Color Banding for Raceways and Cables: Each color 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 (15-m) maximum intervals in straight runs, and at 25-foot (7.6-m) maximum intervals in congested areas.

G. Color-Coding for Phase and neutral Identification, 600 V and Less: Use the colors listed below for ungrounded service, feeder, and branch-circuit conductors.
   1. Color shall be factory applied or, for sizes larger than No. 10 AWG if authorities having jurisdiction permit, field applied.
   2. Colors for 208/120-V Circuits:
      a. Phase A: Black.
      b. Phase B: Red.
      c. Phase C: Blue.
      d. Neutral: White
   3. Colors for 480/277-V Circuits:
      a. Phase A: Brown.
      b. Phase B: Orange.
      c. Phase C: Yellow.
      d. Neutral: Gray
   4. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches (150 mm) 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.

H. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches (150 to 200 mm) below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches (400 mm) overall.

I. Painted Identification: Prepare surface and apply paint according to Division 09 painting Sections.

END OF SECTION

This page is intentionally left blank.

SECTION 26 05 73

OVERCURRENT PROTECTIVE DEVICE COORDINATION STUDY

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Refer to riser diagrams included in drawing set.

1.2 SUMMARY

A. This Section includes computer-based, fault-current and overcurrent protective device coordination studies. Protective devices shall be set based on results of the protective device coordination study.
   1. Series-rated devices are not permitted. All devices shall be fully rated to meet the available fault and equipment at the point of installation.

B. The contractor shall provide an engineering analysis and coordination study for the entire electrical distribution system. The analysis shall include a short-circuit analysis with protective device evaluation, ground fault coordination evaluation and a protective device coordination study.

C. The analysis shall begin at the point of primary service for the facility and continue down through the system, to all downstream distribution and branch panelboards, and significant motor locations.

1.3 SUBMITTALS

A. Product Data: For computer software program to be used for studies.

B. Product Certificates: For coordination-study and fault-current-study computer software programs, certifying compliance with IEEE 399.

C. Qualification Data: For coordination-study specialist.

D. Other Action Submittals: The following submittals shall be made after the approval process for system protective devices has been completed. Submittals may be in digital form (with one printed copy)
   1. Coordination-study input data, including completed computer program input data sheets.
   2. Study and Equipment Evaluation Reports.
   3. Coordination-Study Report.

E. Shop drawings for equipment will not be reviewed until the coordination study has been submitted and approved. Submit a preliminary study with estimated feeder lengths with first distribution submittal that verifies submitted overcurrent protective devices provide “clean” coordination. Submit a final study with feeder lengths as installed, that verifies all data in preliminary report. Adjust all

overcurrent protective devices types and/or settings as required after final approval.

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 not acceptable.

B. Coordination-Study Specialist Qualifications: A firm experienced in the application of computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices. Firm must have a minimum of 5 years of experience of successful study completion.
   1. Professional engineer, licensed in the State of Massachusetts, shall be responsible for the study. All elements of the study shall be performed under the direct supervision and control of engineer. Study shall be signed and sealed by professional engineer. Engineer shall have a minimum of 8 years' experience in the analysis, evaluation and coordination of electrical distribution systems.

C. Comply with IEEE 242 for short-circuit currents and coordination time intervals.

D. Comply with IEEE 399 for general study procedures.

E. Level of system coordination shall reflect the intention of system planning per IEEE std-192.

F. Contractor shall submit electrical distribution equipment based on the system design and listed acceptable manufacturers. The contractor shall provide with the submittal, a coordination study based on the equipment submitted. The contractor shall be required to submit equipment equal in characteristics to the basis of design. This is to say the selectivity of the overcurrent devices shall be as clean in coordination as the basis of design devices.

G. Should the contractor submit a study, including related equipment submittal, that does not give clean coordination; the contractor shall be obligated to change components to allow clean coordination and selectivity, prior to getting approval for releasing equipment for manufacture at no additional cost to the project.

H. The study shall be prepared in accordance with the latest edition of NETA Std. ATS, NFPA 70, the "National Electrical Code", ANSI C2 "National Electrical Safety Code", and ANSI/IEEE Guidelines, as well as manufacturer's recommendations.

PART 2 - PRODUCTS

2.1 COMPUTER SOFTWARE DEVELOPERS

A. Available Computer Software Developers: Subject to compliance with requirements, companies offering computer software programs that may be used in the Work include, but are not limited to, the following:
   1. SKM Systems Analysis, Inc.

2.2 COMPUTER SOFTWARE PROGRAM REQUIREMENTS

A. Comply with IEEE 399.

B. Analytical features of fault-current-study computer software program shall include "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.

C. 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.

D. Study preparer shall update the MMC Master Coordination and Arc Flash Study with the equipment installed as part of this project. Existing study to be updated shall be obtained from MMC Engineering and Facilities.

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 and approved. Overcurrent protective devices that have not been submitted and approved prior to coordination study may not be used in study.

3.2 POWER SYSTEM DATA

A. Gather and tabulate the following input data to support coordination study:
   1. Product Data for overcurrent protective devices specified in other Division 26 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. Impedance of utility service entrance. Obtain the available fault current from the serving utility company.
   3. Electrical Distribution System Diagram: In hard-copy and electronic-copy formats, showing the following:
      a. Circuit-breaker and fuse-current ratings along with types.
      b. Relays and associated power and current transformer ratings and ratios.
      c. Transformer kilovolt amperes, primary and secondary voltages, connection type, impedance, and X/R ratios.
      d. Generator kilovolt amperes, size, voltage, and source impedance.
      e. Cables: Indicate conduit material, sizes of conductors, conductor material, insulation, and length.
      f. Busway ampacity and impedance.
      g. Motor horsepower and code letter designation according to NEMA MG 1.

4. Data sheets to supplement electrical distribution system diagram, cross-referenced with tag numbers on diagram, showing the following:
   a. Special load considerations, including starting inrush currents and frequent starting and stopping.
   b. Transformer characteristics, including primary protective device, magnetic inrush current, and overload capability.
   c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.
   d. Generator thermal-damage curve.
   e. Ratings, types, and settings of utility company's overcurrent protective devices.
   f. Special overcurrent protective device settings or types stipulated by utility company.
   g. Time-current-characteristic curves of devices indicated to be coordinated.
   h. 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.
   i. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.
   j. Panelboards, switchboards, motor-control center ampacity, and interrupting rating in amperes rms symmetrical.

3.3 FAULT-CURRENT STUDY

A. Calculate the maximum available short-circuit current in amperes rms symmetrical at circuit-breaker positions of the electrical power distribution system to determine the required settings/sizes of the protective devices to maximize selectivity. The calculation shall be for a current immediately after initiation and for a three-phase bolted short circuit at each of the following:
   1. Distribution panelboards.
   2. Branch circuit panelboards.

B. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for the Project. Include studies of system-switching configurations and alternate operations that could result in maximum fault conditions.

C. Calculate momentary and interrupting duties on the basis of maximum available fault current. Motor contribution shall be incorporated in determining fault levels. Assume 50 percent of motor loads being served by VFD's are in by- pass mode.

D. Calculations to verify interrupting ratings of overcurrent protective devices shall comply with IEEE 141, IEEE 241 and IEEE 242.
   1. Transformers:
      a. ANSI C57.12.10.
      b. ANSI C57.12.22.
      c. ANSI C57.12.40.
      d. IEEE C57.12.00.
      e. IEEE C57.96.
   2. Low-Voltage Circuit Breakers: IEEE 1015 and IEEE C37.20.1.
   3. Low-Voltage Fuses: IEEE C37.46.

E. Study Report:
   1. Show calculated X/R ratios and equipment interrupting rating (1/2-cycle) fault currents on electrical distribution system diagram.
   2. Show interrupting (5-cycle) and time-delayed currents (6 cycles and above) on medium- and high-voltage breakers as needed to set relays and assess the sensitivity of overcurrent relays.

F. Equipment Evaluation Report:
   1. For 600-V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.
   2. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in the standards to 1/2-cycle symmetrical fault current.
   3. Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure that short-circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.

3.4 COORDINATION STUDY

A. Perform coordination study using approved computer software program. Prepare a written report using results of fault-current study. Comply with IEEE 399.
   1. Calculate the maximum and minimum 1/2-cycle short-circuit currents.
   2. Calculate the maximum and minimum interrupting duty (5 cycles to 2 seconds) short-circuit currents.
   3. Calculate the maximum and minimum ground-fault currents.

B. Comply with IEEE 141 recommendations for fault currents and time intervals.

C. 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.

D. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and conductor melting curves 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.

E. Coordination-Study Report: Prepare a written report indicating the following results of coordination study:
   1. Tabular Format of Settings Selected for Overcurrent Protective Devices:
      a. Device tag.
      b. Relay-current transformer ratios; and tap, time-dial, and instantaneous-pickup values.

c. Circuit-breaker sensor rating; and long-time, short-time, and instantaneous settings.
d. Fuse-current rating and type.
e. Ground-fault relay-pickup and time-delay settings.

2. Coordination Curves: Prepared to determine settings of overcurrent protective devices to achieve maximum selective coordination. Level of selective coordination to be approved by engineer (AKF). Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's main device. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:
   a. Device tag.
   b. Voltage and current ratio for curves.
   c. Three-phase and single-phase damage points for each transformer.
   d. No damage, melting, and clearing curves for fuses.
   e. Cable damage curves.
   f. Transformer inrush points.
   g. Maximum fault-current cutoff point.
   h. Single-line for the portion of the system illustrated in the TCC.

F. Completed data sheets for setting of overcurrent protective devices.

G. A narrative analysis shall accompany each coordination curve sheet and describe the coordination and protection in explicit detail. All curve sheets shall be multi-color for improved clarity. Areas lacking complete coordination shall be highlighted and reasons provided for allowing condition to remain or provide solution to resolve situation.

3.5 GROUND FAULT COORDINATION EVLAUATION

A. The report shall include a ground fault coordination evaluation for operation of the service and feeder disconnecting means such that the feeder device, but not the service device, shall open on ground faults on the load side of the feeder device. A six-cycle minimum separation between the service and feeder tripping bands shall be provided. Operating time of the disconnecting devices shall be considered in selecting the time spread between these two bands to achieve 100 percent selectivity.

B. Provide a schedule of all settings for ground fault protection devices to include relay pick-up and time delay settings.

C. The ground fault protection system shall be performance tested when first installed on site. The test shall be conducted in accordance with the instructions that shall be provided with the equipment. A written record of this test shall be made and submitted to the Architect/Engineer. A copy shall be available to the Authority having Jurisdiction.

3.6 ARC-FLASH EVALUTION

A. The final report shall include an arc-flash study for all new equipment. Arc flash study shall be performed per NFPA 70E – “calculated method” requirements. Labels of calculated values shall be submitted to the electrical contractor.

B. Electrical contractor shall label all new equipment with calculated arc-flash labels from study.

3.7 FIELD SETTINGS

A. The contractor shall engage the manufacturer's service group or alternately a qualified independent testing firm to perform field adjustments of the protective devices as required for placing the equipment in final operating condition. The settings shall be in accordance with the approved short circuit study and protective device evaluation/coordination study.

B. Necessary field settings of devices and adjustments and minor modifications to equipment to accomplish conformance with the approved short-circuit and protective device coordination study, shall be carried out by manufacturer's service group.

END OF SECTION

This page intentionally left blank.

SECTION 26 09 23

LIGHTING CONTROL DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following lighting control devices:
   1. Time switches.
   2. Photoelectric switches.
   3. Indoor occupancy sensors.
   4. Outdoor motion sensors.
   5. Lighting contactors.
   6. Emergency shunt relays.

B. Related Sections include the following:

   1. Division 26 Section "Network Lighting Controls" for low-voltage, manual and programmable lighting control systems.
   2. Division 26 Section "Wiring Devices" for wall-box dimmers, wall-switch occupancy sensors, and manual light switches.

1.3 DEFINITIONS

A. LED: Light-emitting diode.

B. PIR: Passive infrared.

1.4 SUBMITTALS

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

B. Shop Drawings: Show installation details for occupancy and light-level sensors.
   1. Interconnection diagrams showing field-installed wiring.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.6 COORDINATION

A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression system, and partition assemblies.

PART 2 - PRODUCTS

2.1 INDOOR OCCUPANCY SENSORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Hubbell Lighting.
   2. Leviton Mfg. Company Inc.
   3. Lithonia Lighting; Acuity Lighting Group, Inc.
   4. Sensor Switch, Inc.
   5. Watt Stopper (The).

B. General Description: Wall- or ceiling-mounting, solid-state units with a separate relay unit.

   1. Operation: Unless otherwise indicated, turn lights on when covered area is occupied and off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 15 minutes.
   2. Sensor Output: Contacts rated to operate the connected relay, complying with UL 773A. Sensor shall be powered from the relay unit.
   3. Relay Unit: Dry contacts rated for 20-A ballast load at 120- and 277-V ac, for 13-A tungsten at 120-V ac, and for 1 hp at 120-V ac. Power supply to sensor shall be 24-V dc, 150-mA, Class 2 power source as defined by NFPA 70.
   4. Mounting:

      a. Sensor: Suitable for mounting in any position on a standard outlet box.
      b. Relay: Externally mounted through a 1/2-inch (13-mm) knockout in a standard electrical enclosure.
      c. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind hinged door.

   5. Indicator: LED, to show when motion is being detected during testing and normal operation of the sensor.
   6. Bypass Switch: Override the on function in case of sensor failure.
   7. Automatic Light-Level Sensor: Adjustable from 2 to 200 fc (21.5 to 2152 lx); keep lighting off when selected lighting level is present.

C. Dual-Technology Type: Ceiling mounting; detect occupancy by using a combination of PIR and ultrasonic detection methods in area of coverage. Particular technology or combination of technologies that controls on-off functions shall be selectable in the field by operating controls on unit.
   1. Sensitivity Adjustment: Separate for each sensing technology.
   2. Detector Sensitivity: Detect occurrences of 6-inch- (150-mm-) minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. (232 sq. cm), and detect a person of average size and weight

moving not less than 12 inches (305 mm) in either a horizontal or a vertical manner at an approximate speed of 12 inches/s (305 mm/s).

3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.

2.2 CONDUCTORS AND CABLES

A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 16 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

PART 3 - EXECUTION

3.1 SENSOR INSTALLATION

A. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

3.2 CONTACTOR INSTALLATION

A. Mount electrically held lighting contactors with elastomeric isolator pads, to eliminate structure-borne vibration, unless contactors are installed in an enclosure with factory-installed vibration isolators.

3.3 WIRING INSTALLATION

A. Wiring Method: Comply with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size shall be 1/2 inch (13 mm).

B. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.

C. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.

D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.4 IDENTIFICATION

A. Identify components and power and control wiring according to Division 26 Section "Identification for Electrical Systems."

1. Identify controlled circuits in lighting contactors.
2. Identify circuits or luminaries controlled by photoelectric and occupancy sensors at each sensor.

B. Label time switches and contactors with a unique designation.

3.5 FIELD QUALITY CONTROL

A. Perform the following field tests and inspections and prepare test reports:
1. After installing time switches and sensors, and after electrical circuitry has been energized, adjust and test for compliance with requirements.
2. Operational Test: Verify operation of each lighting control device, and adjust time delays.

B. Lighting control devices that fail tests and inspections are defective work.

3.6 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting sensors to suit occupied conditions. During business hours provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.7 DEMONSTRATION

A. Coordinate demonstration of products specified in this Section with demonstration requirements for low-voltage, programmable lighting control system specified in Division 26 Section "Network Lighting Controls."

B. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain lighting control devices. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION

SECTION 26 11 16

SINGLE ENDED SECONDARY UNIT SUBSTATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes indoor secondary single ended unit substations, each consisting of the following:
   1. Primary incoming section.
   2. Transformer.
   3. Secondary distribution section.

B. Related Sections include the following:
   1. Division 26 Section "Medium-Voltage Cables" for requirements of terminating cables in incoming section of substation.
   2. Division 26 Section "Overcurrent Protective Device Coordination Study" for short-circuit rating of devices and for setting of overcurrent protective devices.
   3. ~~Division 26 Section "Electrical Power Monitoring and Control" for communication features of power distribution system devices.~~
   4. ~~Division 26 Section "Medium-Voltage Switchgear" for metering and instrument transformers.~~

1.3 DEFINITIONS

A. NETA ATS: Acceptance Testing Specification.

1.4 SUBMITTALS

A. Product Data: Include rated capacities, furnished specialties, and accessories.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   1. Wiring Diagrams: Power, signal, and control wiring.
   2. Dimensioned plans and elevations showing major components and features.
   3. One-line diagram.
   4. List of materials.
   5. Nameplate legends.
   6. Size and number of bus bars and current rating for each bus, including mains and branches of phase, neutral, and ground buses.

7. Short-time and short-circuit current ratings of secondary unit substations and components.
8. Ratings of individual protective devices.

C. Time-Current Characteristic Curves: For overcurrent protective devices.

D. Primary Fuses: Submit recommendations and size calculations.

E. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
1. Dimensioned concrete base, outline of secondary unit substation, conduit entries, and ground rod locations.
2. Location of structural supports for structure-supported raceways, busways, and seismic bracing.
3. Location of lighting fixtures, sprinkler piping and heads, ducts, and diffusers.

F. Manufacturer Seismic Qualification Certification: Submit certification that transformer assembly and components will withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems." 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 and the unit will be fully operational after the seismic event."
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.

G. Product Certificates: For secondary unit substations, signed by product manufacturer.

H. Qualification Data: For testing agency.

I. Material Test Reports: For secondary unit substations.

J. Factory test reports.

K. Field quality-control test reports.

L. Operation and Maintenance Data: For secondary unit substations and accessories to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for

Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

B. Source Limitations: Obtain secondary unit substation through one source from a single manufacturer.

C. Product Options: Drawings indicate size, profiles, and dimensional requirements of secondary unit substations and are based on the specific system indicated.

D. 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.

E. Comply with IEEE C2.

F. Comply with IEEE C37.121.

G. Comply with NFPA 70.

1.6 MANUFACTURER'S WARRANTY

A. Unless specifically noted otherwise in the following paragraphs, provide an Equipment manufacturer's written warranty for all work free from defects in material and workmanship and guarantee performance of equipment as required and Drawings for one (1) year of normal use and service beginning on date of initial start-up and Owner's Acceptance or eighteen (18) months from date of shipment, whichever comes first.

B. During the warranty period, the Manufacturer shall repair or replace, at no additional cost to the Owner, any equipment, material, or workmanship in which defects may develop.

C. All equipment and components furnished shall be covered under the specified 1-year warranty. This shall also include all controls components and all specified auxiliary equipment, and shall include labor and material to replace any parts or controls that might fail in service as the result of a defect in material or manufacture.

D. All labor required to replace components during the warranty period will be performed by the Manufacturer.

E. Equipment Manufacturer shall furnish a written warranty covering the above requirements.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver in shipping splits in sizes that can be moved past obstructions in delivery path.

B. Coordinate delivery of secondary unit substations to allow movement into designated space.

C. Store secondary unit substation components protected from weather and so condensation will not form on or in units. Provide temporary heating according to manufacturer's written instructions.

D. Handle secondary unit substation components according to manufacturer's written instructions. Use factory-installed lifting provisions.

1.8 PROJECT CONDITIONS

A. Field Measurements: Indicate measurements on Shop Drawings.

B. Interruption of Existing electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
   1. Notify Owner no fewer than 2 weeks in advance of proposed interruption of electric service.
   2. Do not proceed with interruption of electric service without Owner's written permission.

C. Service Conditions: IEEE C37.121, usual service conditions, except for the following:
   1. Exposure to significant solar radiation.
   2. Altitudes above 5000 feet (1000 m).
   3. Exposure to fumes, vapors, or dust.
   4. Exposure to explosive environments.
   5. Exposure to hot and humid climate or to excessive moisture, including steam, salt spray, and dripping water.
   6. Exposure to seismic shock or to abnormal vibration, shock, or tilting.
   7. Exposure to excessively high or low temperatures.
   8. Unusual transportation or storage conditions.
   9. Unusual grounding resistance conditions.
   10. Unusual space limitations.

1.9 COORDINATION

A. Coordinate layout and installation of secondary unit substations with other construction that penetrates floors and ceilings, or is supported by them, including light fixtures, HVAC equipment, and fire-suppression-system components.

B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.10 EXTRA MATERIALS

A. Furnish extra materials described below, before installation begins, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Spare fuses: Six of each type and rating of fuse and fusible device used, except for medium-voltage fuses. Include spares for the following:
      a. Primary disconnect fuses.
      b. Potential transformer fuses.
      c. Control power fuses.
      d. Fuses and fusible devices for fused circuit breakers.
      e. Fuses for secondary fusible devices.
   2. Spare Indicating Lights: Six of each type installed.
   3. Touchup Paint: Three half-pint containers of paint matching enclosure's exterior finish.
   4. Primary Switch Contact Lubricant: One container(s).

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Cutler-Hammer, Eaton Corporation
   2. GE Electrical Distribution & Control.
   3. Square D; Schneider Electric.

2.2 MANUFACTURED UNITS

A. Indoor Unit Arrangement: Single assembly.

B. Enclosure Finish: Factory-applied finish in manufacturer's standard color, including under surfaces treated with corrosion-resistant undercoating.

C. Enclosure Finish: Factory-applied finish in manufacturer's standard gray over a rust-inhibiting primer on treated metal surface.

2.3 INCOMING SECTION

A. Primary Incoming Section: Terminal assembly with adequate space for incoming-cable terminations and surge arresters.

B. Primary Incoming Section: Enclosed, air-interrupter, primary switch.
   1. Three pole, single throw, dead front, metal enclosed, with manual stored energy operator, without fuses, complying with IEEE C37.20.3.
   2. Key interlocking system to prevent fuse access door from being opened unless switch is open. Additionally, interlock air-interrupter switch with transformer secondary main circuit breaker, preventing switch from being opened or closed unless secondary main circuit breaker is open.
   3. Phase Barriers: Located between blades and fuses of each phase, designed for easy removal, allows visual inspection of switch components when barrier is in place.
   4. Window: Permits viewing switch-blade positions when door is closed.
   5. Accessory Set: Tools and miscellaneous items required for interrupter switchgear test, inspection, maintenance, and operation. Include fuse-handling tool as recommended by switchgear manufacturer.
   6. Continuous-Current Rating: 600 A.
   7. Infrared scanning window
   8. System Voltage: 12,470V grounded.
   9. Short-Circuit Rating:
      a. Short-time momentary asymmetrical fault rating of 40 kA.
      b. 3-second symmetrical rating of 25 kA RMS.
      c. Fault close asymmetrical rating of 40 kA.
   10. Fuses: Sizes recommended by secondary unit substation manufacturer, considering fan cooling, temperature-rise specification, and cycle loading. Comply with the following:
      a. Current-limiting type, rated for not less than 50-kA RMS symmetrical current-interrupting capacity.
      b. Indicator integral with each fuse to show when it has blown.

c. Spares: Include three fuses in use and three spare fuses in storage clips in each switch.

C. Surge Arresters: Comply with IEEE C62.11, Distribution class; metal-oxide-varistor type, with ratings as indicated, connected in each phase of incoming circuit and ahead of any disconnecting device.

2.4 DRY-TYPE TRANSFORMER SECTION

A. Description: ANSI C57, IEEE C57.12.01, IEEE C57.12.50, NEMA ST 20, and dry-type, 2-winding, secondary unit substation transformer.

B. Enclosure: Indoor, ventilated, VPI, with insulation system rated at 220 deg C with an 115 deg C average winding temperature rise above a maximum ambient temperature of 40 deg C.

C. Cooling System: Class AA/FA, air cooled 33% overload, complying with IEEE C57.12.01.

D. Insulation Materials: IEEE C57.12.01, rated 220 deg C.

E. Insulation Temperature Rise: 115 deg C, maximum rise above 40 deg C.

F. Basic Impulse Level: 95 kV.

G. Full-Capacity Voltage Taps: 4 nominal 2.5 percent taps, 2 above and 2 below rated primary voltage.

H. Sound level standards shall meet the requirements of NEMA TR-1. Sound measurement procedure shall be as specified in ANSO C57.12.90.

I. Impedance: 5.75 percent.

J. High-Temperature Alarm: Sensor at transformer with local audible and visual alarm and contacts for remote alarm.

K. Fan cooling equipment shall include temperature monitor controls, fan exerciser and power supply.

L. Windings: Copper

M. Listings: Transformer shall be fully UL listed

N. 120V control voltage shall originate from a control power transformer residing in the transformer enclosure. No exterior conduit allowed.

2.5 SECONDARY DISTRIBUTION SECTION

A. Secondary Distribution: Low-voltage switchgear as specified in Division 26 Section "Low-Voltage Switchgear."

2.6 IDENTIFICATION DEVICES

A. Compartment Nameplates: Engraved, laminated-plastic or metal nameplate for each compartment, mounted with corrosion-resistant screws. Nameplates and label products are specified in Division 26 Section "Identification for Electrical Systems."

2.7 SOURCE QUALITY CONTROL

A. Factory Tests: Perform design and routine tests according to standards specified for components. Conduct transformer tests according to IEEE C57.12.90. Conduct switchgear and switchboard tests according to ANSI C37.51.

B. Factory Tests: Perform the following factory-certified tests on each secondary unit substation:
   1. Resistance measurements of all windings on the rated voltage connection and on tap extreme connections.
   2. Ratios on the rated voltage connection and on tap extreme connections.
   3. Polarity and phase relation on the rated voltage connection.
   4. No-load loss at rated voltage on the rated voltage connection.
   5. Exciting current at rated voltage on the rated voltage connection.
   6. Impedance and load loss at rated current on the rated voltage connection and on tap extreme connections.
   7. Applied potential.
   8. Induced potential.
   9. Temperature Test: Test at lowest kilovolt-ampere Class OA or Class AA rating
      a. Temperature test is not required if a record of a temperature test on an essentially duplicate unit is available.

C. On-Site Testing: Perform the following factory-certified tests on each secondary unit substation:
   1. Resistance measurements of all windings on the rated voltage connection and on tap extreme connections.
   2. Ratios on the rated voltage connection and on tap extreme connections.
   3. Polarity and phase relation on the rated voltage connection.
   4. No-load loss at rated voltage on the rated voltage connection.
   5. Exciting current at rated voltage on the rated voltage connection.
   6. Impedance and load loss at rated current on the rated voltage connection and on tap extreme connections.
   7. Applied potential.
   8. Induced potential.

D. Prepare equipment for shipment.
   1. Provide suitable crating, blocking, and supports so equipment will withstand expected domestic shipping and handling shocks and vibration.
   2. Gear shall be braced to be laid down in necessary. Complete sets of lay down brackets of each type shall be furnished to allow one set to be installed while another piece is being rigged into place.
   3. Weatherproof equipment for shipment. Close connection openings to prevent entrance of foreign material during shipment and storage.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and space conditions for compliance with requirements for secondary unit substations and other conditions affecting performance of work.

B. Examine roughing-in of conduits and grounding systems to verify the following:
   1. Wiring entries comply with layout requirements.

2. Entries are within conduit-entry tolerances specified by manufacturer and no feeders will have to cross section barriers to reach load or line lugs.

C. Examine walls, floors, roofs, and concrete bases for suitable conditions for secondary unit substation installation.

D. Verify that ground connections are in place and that requirements in Division 26 Section "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at secondary unit substation location.

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

3.2 INSTALLATION

A. Install secondary unit substations on concrete bases.
1. Anchor secondary unit substations to concrete bases according to manufacturer's written instructions, seismic codes at Project, and requirements in Division 26 Sections "Hangers and Supports for Electrical Systems" and "Vibration and Seismic Controls for Electrical Systems."
2. Construct concrete bases of dimensions indicated, but not less than 4 inches (100 mm) larger in both directions than supported unit and 4 inches (100 mm) high.
3. Provide concrete and reinforcement as specified in Division 03 Section.
4. Install dowel rods to connect concrete bases to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around full perimeter of base.
5. Install epoxy-coated anchor bolts for anchoring equipment to the concrete base.
6. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
7. Bolt transformers to channel-iron sills embedded in concrete bases. Install sills level and grout flush with floor or base.

B. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and NFPA 70.

3.3 IDENTIFICATION

A. Identify field-installed wiring and components and provide warning signs as specified in Division 26 Section "Identification for Electrical Systems."

B. Operating Instructions: Frame printed operating instructions for secondary unit substations, including key interlocking, control sequences, elementary single-line diagram, and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of secondary unit substation.

3.4 CONNECTIONS

A. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.5 CLEANING

A. After completing equipment installation and before energizing, inspect unit components. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish. Vacuum interiors of secondary unit substation sections.

3.6 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

B. Testing: Engage a qualified testing and inspecting agency to perform the following field tests and inspections and prepare test reports:

C. Perform the following field tests and inspections and prepare test reports:
   1. Perform each visual and mechanical inspection and electrical test according to NETA ATS. Certify compliance with test parameters.
   2. After installing secondary unit substation but before primary is energized, verify that grounding system at the substation tested at the specified value or less.
   3. After installing secondary unit substation and after electrical circuitry has been energized, test for compliance with requirements.
   4. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
      a. Remove and replace malfunctioning units and retest as specified above.

3.7 FOLLOW-UP SERVICE

A. Voltage Monitoring and Adjusting: After Substantial Completion, if requested by Owner, but not more than six months after Final Acceptance, perform the following voltage monitoring:
   1. During a period of normal load cycles as evaluated by Owner, perform seven days of three-phase voltage recording at the outgoing section of each secondary unit substation. Use voltmeters with calibration traceable to the National Institute of Science and Technology standards and with a chart speed of not less than 1 inch (25 mm) per hour. Voltage unbalance greater than 1 percent between phases, or deviation of any phase voltage from the nominal value by more than plus or minus 5 percent during the test period, is unacceptable.
   2. Corrective Action: If test results are unacceptable, perform the following corrective action, as appropriate:
      a. Adjust transformer taps.
      b. Rebalance loads.
      c. Prepare written request for voltage adjustment by electric utility.
   3. Retests: Repeat monitoring, after corrective action has been performed, until satisfactory results are obtained.
   4. Report: Prepare a written report covering monitoring performed and corrective action taken.

B. Infrared Scanning: Perform as specified in Division 26 Section "Medium-Voltage Switchgear."

3.8 DEMONSTRATION

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

END OF SECTION

SECTION 26 11 17

DOUBLE ENDED SECONDARY UNIT SUBSTATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes indoor secondary double ended unit substations, each consisting of the following:

1. Primary incoming section.
2. Transformer.
3. Secondary distribution section.

B. Related Sections include the following:

1. Division 26 Section "Medium-Voltage Cables" for requirements of terminating cables in incoming section of substation.
2. Division 26 Section "Overcurrent Protective Device Coordination Study" for short-circuit rating of devices and for setting of overcurrent protective devices.
3. ~~Division 26 Section "Electrical Power Monitoring and Control" for communication features of power distribution system devices.~~
4. ~~Division 26 Section "Medium-Voltage Switchgear" for metering and instrument transformers.~~

1.3 DEFINITIONS

A. NETA ATS: Acceptance Testing Specification.

1.4 SUBMITTALS

A. Product Data: Include rated capacities, furnished specialties, and accessories.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Wiring Diagrams: Power, signal, and control wiring.
2. Dimensioned plans and elevations showing major components and features.
3. One-line diagram.
4. List of materials.
5. Nameplate legends.
6. Size and number of bus bars and current rating for each bus, including mains and branches of phase, neutral, and ground buses.
7. Short-time and short-circuit current ratings of secondary unit substations and components.
8. Ratings of individual protective devices.

C. Time-Current Characteristic Curves: For overcurrent protective devices.

D. Primary Fuses: Submit recommendations and size calculations.

E. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

1. Dimensioned concrete base, outline of secondary unit substation, conduit entries, and ground rod locations.
2. Location of structural supports for structure-supported raceways, busways, and seismic bracing.
3. Location of lighting fixtures, sprinkler piping and heads, ducts, and diffusers.

F. Manufacturer Seismic Qualification Certification: Submit certification that transformer assembly and components will withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems." 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 and the unit will be fully operational after the seismic event."

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.

G. Product Certificates: For secondary unit substations, signed by product manufacturer.

H. Qualification Data: For testing agency.

I. Material Test Reports: For secondary unit substations.

J. Factory test reports.

K. Field quality-control test reports.

L. Operation and Maintenance Data: For secondary unit substations and accessories to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

B. Source Limitations: Obtain secondary unit substation through one source from a single manufacturer.

C. Product Options: Drawings indicate size, profiles, and dimensional requirements of secondary unit substations and are based on the specific system indicated.

D. 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.

E. Comply with IEEE C2.

F. Comply with IEEE C37.121.

G. Comply with NFPA 70.

1.6 MANUFACTURER'S WARRANTY

A. Unless specifically noted otherwise in the following paragraphs, provide an Equipment manufacturer's written warranty for all work free from defects in material and workmanship and guarantee performance of equipment as required for one (1) year of normal use and service beginning on date of initial start-up and Owner's Acceptance or eighteen (18) months from date of shipment, whichever comes first.

B. During the warranty period, the Manufacturer shall repair or replace, at no additional cost to the Owner, any equipment, material, or workmanship in which defects may develop.

C. All equipment and components furnished shall be covered under the specified 1-year warranty. This shall also include all controls components and all specified auxiliary equipment, and shall include labor and material to replace any parts or controls that might fail in service as the result of a defect in material or manufacture.

D. All labor required to replace components during the warranty period will be performed by the Manufacturer.

E. Equipment Manufacturer shall furnish a written warranty covering the above requirements.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver in shipping splits in sizes that can be moved past obstructions in delivery path.

B. Coordinate delivery of secondary unit substations to allow movement into designated space.

C. Store secondary unit substation components protected from weather and so condensation will not form on or in units. Provide temporary heating according to manufacturer's written instructions.

D. Handle secondary unit substation components according to manufacturer's written instructions. Use factory-installed lifting provisions.

1.8 PROJECT CONDITIONS

A. Field Measurements: Indicate measurements on Shop Drawings.

B. Interruption of Existing electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:

1. Notify Owner no fewer than 2 weeks in advance of proposed interruption of electric service.
2. Do not proceed with interruption of electric service without Owner's written permission.

C. Service Conditions: IEEE C37.121, usual service conditions, except for the following:

1. Exposure to significant solar radiation.
2. Altitudes above 5000 feet (1000 m).
3. Exposure to fumes, vapors, or dust.
4. Exposure to explosive environments.

5. Exposure to hot and humid climate or to excessive moisture, including steam, salt spray, and dripping water.
6. Exposure to seismic shock or to abnormal vibration, shock, or tilting.
7. Exposure to excessively high or low temperatures.
8. Unusual transportation or storage conditions.
9. Unusual grounding resistance conditions.
10. Unusual space limitations.

1.9 COORDINATION

A. Coordinate layout and installation of secondary unit substations with other construction that penetrates floors and ceilings, or is supported by them, including light fixtures, HVAC equipment, and fire-suppression-system components.

B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.10 EXTRA MATERIALS

A. Furnish extra materials described below, before installation begins, that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.

1. Spare fuses: Six of each type and rating of fuse and fusible device used, except for medium-voltage fuses. Include spares for the following:

   a. Primary disconnect fuses.
   b. Potential transformer fuses.
   c. Control power fuses.
   d. Fuses and fusible devices for fused circuit breakers.
   e. Fuses for secondary fusible devices.

2. Spare Indicating Lights: Six of each type installed.
3. Touchup Paint: Three half-pint containers of paint matching enclosure's exterior finish.
4. Primary Switch Contact Lubricant: One container(s).

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Cutler-Hammer, Eaton Corporation
2. GE Electrical Distribution & Control.

3. Square D; Schneider Electric.

2.2 MANUFACTURED UNITS

A. Indoor Unit Arrangement: Single assembly.

B. Enclosure Finish: Factory-applied finish in manufacturer's standard color, including under surfaces treated with corrosion-resistant undercoating.

C. Enclosure Finish: Factory-applied finish in manufacturer's standard gray over a rust-inhibiting primer on treated metal surface.

2.3 INCOMING SECTION

A. Primary Incoming Section: Terminal assembly with adequate space for incoming-cable terminations and surge arresters.

B. Primary Incoming Section: Enclosed, air-interrupter, primary switch.

1. Three pole, single throw, dead front, metal enclosed, with manual stored energy operator, without fuses, complying with IEEE C37.20.3.
2. Key interlocking system to prevent fuse access door from being opened unless switch is open. Additionally, interlock air-interrupter switch with transformer secondary main circuit breaker, preventing switch from being opened or closed unless secondary main circuit breaker is open.
3. Phase Barriers: Located between blades and fuses of each phase, designed for easy removal, allows visual inspection of switch components when barrier is in place.
4. Window: Permits viewing switch-blade positions when door is closed.
5. Accessory Set: Tools and miscellaneous items required for interrupter switchgear test, inspection, maintenance, and operation. Include fuse-handling tool as recommended by switchgear manufacturer.
6. Continuous-Current Rating: 600 A.
7. Infrared scanning window
8. System Voltage: 12,470 V, three phase.
9. System Grounding: Solidly grounded.
10. Short-Circuit Rating:

    a. Short-time momentary asymmetrical fault rating of 40 kA.
    b. 3-second symmetrical rating of 25 kA RMS.
    c. Fault close asymmetrical rating of 40 kA.

11. Fuses: Sizes recommended by secondary unit substation manufacturer, considering fan cooling, temperature-rise specification, and cycle loading. Comply with the following:

    a. Current-limiting type, rated for not less than 50-kA RMS symmetrical current-interrupting capacity.

b. Indicator integral with each fuse to show when it has blown.
c. Spares: Include three fuses in use and three spare fuses in storage clips in each switch.

C. Surge Arresters: Comply with IEEE C62.11, Distribution class; metal-oxide-varistor type, with ratings as indicated, connected in each phase of incoming circuit and ahead of any disconnecting device.

2.4 DRY-TYPE TRANSFORMER SECTION

A. Description: ANSI C57, IEEE C57.12.01, IEEE C57.12.50, NEMA ST 20, and dry-type, 2-winding, secondary unit substation transformer.

B. Enclosure: Indoor, VPI , with insulation system rated at 220 deg C with a 115 deg C average winding temperature rise above a maximum ambient temperature of 40 deg C.

C. Cooling System: Class AA/FA, air cooled 33% overload complying with IEEE C57.12.01.

D. Insulation Materials: IEEE C57.12.01, rated 220 deg C.

E. Insulation Temperature Rise: 115 deg C, maximum rise above 40 deg C.

F. Basic Impulse Level: 95 kV.

G. Full-Capacity Voltage Taps: 4 nominal 2.5 percent taps, 2 above and 2 below rated primary voltage.

H. Sound level standards shall meet the requirements of NEMA TR-1. Sound measurement procedure shall be as specified in ANSO C57.12.90.

I. Impedance: 5.75 percent.

J. High-Temperature Alarm: Sensor at transformer with local audible and visual alarm and contacts for remote alarm.

K. Fan cooling equipment shall include temperature monitor controls, fan exerciser and power supply.

L. Windings: Copper

M. Listings: Transformer shall be fully UL listed

N. 120V control voltage shall originate from a control power transformer residing in the low voltage switchgear or residing in transformer enclosure. No exterior conduit allowed.

2.5 SECONDARY DISTRIBUTION SECTION

A. Secondary Distribution: Low-voltage switchgear as specified in Division 26 Section "Low-Voltage Switchgear."

2.6 IDENTIFICATION DEVICES

A. Compartment Nameplates: Engraved, laminated-plastic or metal nameplate for each compartment, mounted with corrosion-resistant screws. Nameplates and label products are specified in Division 26 Section "Identification for Electrical Systems."

2.7 SOURCE QUALITY CONTROL

A. Factory Tests: Perform design and routine tests according to standards specified for components. Conduct transformer tests according to IEEE C57.12.90. Conduct switchgear and switchboard tests according to ANSI C37.51.

B. Factory Tests: Perform the following factory-certified tests on each secondary unit substation:

1. Resistance measurements of all windings on the rated voltage connection and on tap extreme connections.
2. Ratios on the rated voltage connection and on tap extreme connections.
3. Polarity and phase relation on the rated voltage connection.
4. No-load loss at rated voltage on the rated voltage connection.
5. Exciting current at rated voltage on the rated voltage connection.
6. Impedance and load loss at rated current on the rated voltage connection and on tap extreme connections.
7. Applied potential.
8. Induced potential.
9. Temperature Test: Test at lowest kilovolt-ampere Class OA or Class AA rating

    a. Temperature test is not required if a record of a temperature test on an essentially duplicate unit is available.

C. On-Site Testing: Perform the following factory-certified tests on each secondary unit substation:

1. Resistance measurements of all windings on the rated voltage connection and on tap extreme connections.
2. Ratios on the rated voltage connection and on tap extreme connections.
3. Polarity and phase relation on the rated voltage connection.
4. No-load loss at rated voltage on the rated voltage connection.
5. Exciting current at rated voltage on the rated voltage connection.
6. Impedance and load loss at rated current on the rated voltage connection and on tap extreme connections.

7. Applied potential.
8. Induced potential.

D. Prepare equipment for shipment.

1. Provide suitable crating, blocking, and supports so equipment will withstand expected domestic shipping and handling shocks and vibration.
2. Gear shall be braced to be laid down in necessary. Complete sets of lay down brackets of each type shall be furnished to allow one set to be installed while another piece is being rigged into place.
3. Weatherproof equipment for shipment. Close connection openings to prevent entrance of foreign material during shipment and storage.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas and space conditions for compliance with requirements for secondary unit substations and other conditions affecting performance of work.

B. Examine roughing-in of conduits and grounding systems to verify the following:

1. Wiring entries comply with layout requirements.
2. Entries are within conduit-entry tolerances specified by manufacturer and no feeders will have to cross section barriers to reach load or line lugs.

C. Examine walls, floors, roofs, and concrete bases for suitable conditions for secondary unit substation installation.

D. Verify that ground connections are in place and that requirements in Division 26 Section "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at secondary unit substation location.

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

3.2 INSTALLATION

A. Install secondary unit substations on concrete bases.

1. Anchor secondary unit substations to concrete bases according to manufacturer's written instructions, seismic codes at Project, and requirements in Division 26 Sections "Hangers and Supports for Electrical Systems" and "Vibration and Seismic Controls for Electrical Systems."
2. Construct concrete bases of dimensions indicated, but not less than 4 inches (100 mm) larger in both directions than supported unit and 4 inches (100 mm) high.

3. Provide concrete and reinforcement as specified in Division 03 Section.
4. Install dowel rods to connect concrete bases to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around full perimeter of base.
5. Install epoxy-coated anchor bolts for anchoring equipment to the concrete base.
6. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
7. Bolt transformers to channel-iron sills embedded in concrete bases. Install sills level and grout flush with floor or base.

B. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions and NFPA 70.

3.3 IDENTIFICATION

A. Identify field-installed wiring and components and provide warning signs as specified in Division 26 Section "Identification for Electrical Systems."

B. Operating Instructions: Frame printed operating instructions for secondary unit substations, including key interlocking, control sequences, elementary single-line diagram, and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of secondary unit substation.

3.4 CONNECTIONS

A. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.5 CLEANING

A. After completing equipment installation and before energizing, inspect unit components. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish. Vacuum interiors of secondary unit substation sections.

3.6 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

B. Testing: Engage a qualified testing and inspecting agency to perform the following field tests and inspections and prepare test reports:

C. Perform the following field tests and inspections and prepare test reports:

1. Perform each visual and mechanical inspection and electrical test according to NETA ATS. Certify compliance with test parameters.
2. After installing secondary unit substation but before primary is energized, verify that grounding system at the substation tested at the specified value or less.
3. After installing secondary unit substation and after electrical circuitry has been energized, test for compliance with requirements.
4. Set field-adjustable switches and circuit-breaker trip ranges as indicated.

    a. Remove and replace malfunctioning units and retest as specified above.

3.7 FOLLOW-UP SERVICE

A. Voltage Monitoring and Adjusting: After Substantial Completion, if requested by Owner, but not more than six months after Final Acceptance, perform the following voltage monitoring:

1. During a period of normal load cycles as evaluated by Owner, perform seven days of three-phase voltage recording at the outgoing section of each secondary unit substation. Use voltmeters with calibration traceable to the National Institute of Science and Technology standards and with a chart speed of not less than 1 inch (25 mm) per hour. Voltage unbalance greater than 1 percent between phases, or deviation of any phase voltage from the nominal value by more than plus or minus 5 percent during the test period, is unacceptable.
2. Corrective Action: If test results are unacceptable, perform the following corrective action, as appropriate:

    a. Adjust transformer taps.
    b. Rebalance loads.
    c. Prepare written request for voltage adjustment by electric utility.

3. Retests: Repeat monitoring, after corrective action has been performed, until satisfactory results are obtained.
4. Report: Prepare a written report covering monitoring performed and corrective action taken.

B. Infrared Scanning: Perform as specified in Division 26 Section "Medium-Voltage Switchgear."

3.8 DEMONSTRATION

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

END OF SECTION

SECTION 26 22 00

LOW-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following types of dry-type transformers rated 600 V and less, with capacities up to 1000 kVA:
   1. Distribution transformers.

1.3 SUBMITTALS

A. Product Data: Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer indicated.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
   1. Wiring Diagrams: Power, signal, and control wiring.

C. Manufacturer Seismic Qualification Certification: Submit certification that transformers, accessories, and components will withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems." 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 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.

D. Qualification Data: For testing agency.

E. Source quality-control test reports.

F. Field quality-control test reports.

G. Operation and Maintenance Data: For transformers to include in emergency, operation, and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

B. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7.

C. Source Limitations: Obtain each transformer type through one source from a single manufacturer.

D. 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.

E. Comply with IEEE C57.12.91, "Test Code for Dry-Type Distribution and Power Transformers."

1.5 DELIVERY, STORAGE, AND HANDLING

A. Temporary Heating: Apply temporary heat according to manufacturer's written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.

1.6 COORDINATION

A. Coordinate size and location of concrete bases with actual transformer provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

B. Coordinate installation of wall-mounting and structure-hanging supports with actual transformer provided.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
   1. Eaton Electrical Inc.; Cutler-Hammer Products.
   2. General Electric Company.
   3. Siemens Energy & Automation, Inc.
   4. Square D; Schneider Electric.

2.2 GENERAL TRANSFORMER REQUIREMENTS

A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.

B. Cores: Grain-oriented, non-aging silicon steel.

C. Coils: Continuous windings without splices except for taps.
   1. Internal Coil Connections: Brazed or pressure type.

2.3 DISTRIBUTION TRANSFORMERS

A. All bus and windings shall be copper.

B. Comply with NEMA ST 20, and list and label as complying with UL 1561.

C. Provide transformers that are constructed to withstand seismic forces specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

D. Cores: One leg per phase.

E. Enclosure: Ventilated, NEMA 250, Type 2.
   1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air for 15 kVA units and smaller. Ventilated design for units over 15 kVA.

F. Transformer Enclosure Finish: Comply with NEMA 250.
   1. Finish Color: ANSI 61 gray.

G. Taps for Transformers Smaller Than 3 kVA: None.

H. Taps for Transformers 7.5 to 24 kVA: One 5 percent tap above and one 5 percent tap below normal full capacity.

I. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and two 2.5 percent taps below normal full capacity.

J. Insulation Class: 220 deg C, UL-component-recognized insulation system with a maximum of 150 deg C rise above 40 deg C ambient temperature.

K. Energy Efficiency for Transformers Rated 15 kVA and Larger:
   1. Complying with DOE 2016 Efficiency Standards.

L. K-Factor Rating: Transformers indicated to be K-factor rated shall comply with UL 1561 requirements for nonsinusoidal load current-handling capability to the degree defined by designated K-factor. All bus and windings shall be copper.
   1. Unit shall not overheat when carrying full-load current with harmonic distortion corresponding to designated K-factor.

2. Indicate value of K-factor on transformer nameplate.

M. Electrostatic Shielding: Where indicated each winding shall have an independent, single, full-width copper electrostatic shield arranged to minimize interwinding capacitance.
1. Arrange coil leads and terminal strips to minimize capacitive coupling between input and output terminals.
2. Include special terminal for grounding the shield.
3. Shield Effectiveness:
a. Capacitance between Primary and Secondary Windings: Not to exceed 33 picofarads over a frequency range of 20 Hz to 1 MHz.
b. Common-Mode Noise Attenuation: Minimum of minus 120 dBA at 0.5 to 1.5 kHz; minimum of minus 65 dBA at 1.5 to 100 kHz.
c. Normal-Mode Noise Attenuation: Minimum of minus 52 dBA at 1.5 to 10 kHz.

N. Wall Brackets: Manufacturer's standard brackets.

O. Fungus Proofing: Permanent fungicidal treatment for coil and core.

P. Low-Sound-Level Requirements: Minimum of 3 dBA less than NEMA ST 20 standard sound levels when factory tested according to IEEE C57.12.91.

Q. Low-Sound-Level Requirements: Maximum sound levels, when factory tested according to IEEE C57.12.91, as follows:
1. 9 kVA and Less: 40dBA
2. 30 to 50 kVA: 45dBA
3. 51 to 150 kVA: 50dBA
4. 151 to 300 kVA: 55dBA
5. 301 to 500 kVA: 60dBA
6. 501 to 750 kVA: 62dBA
7. 751 to 1000 kVA: 64dBA

2.4 IDENTIFICATION DEVICES

A. Nameplates: Engraved, laminated-plastic or metal nameplate for each distribution transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Division 26 Section "Identification for Electrical Systems."

2.5 SOURCE QUALITY CONTROL

A. Test and inspect transformers according to IEEE C57.12.91.

B. Factory Sound-Level Tests: Conduct sound-level tests on equipment for this Project.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.

B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer's written instructions.

C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.

D. Verify that ground connections are in place and requirements in Division 26 Section "Grounding and Bonding for Electrical Systems" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.

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

3.2 INSTALLATION

A. Install wall-mounting transformers level and plumb with wall brackets fabricated by transformer manufacturer.
   1. Brace wall-mounting transformers as specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems.

B. Construct concrete bases and anchor floor-mounting transformers according to manufacturer's written instructions, seismic codes applicable to Project, and requirements in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

3.3 CONNECTIONS

A. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.
   1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

B. Remove and replace units that do not pass tests or inspections and retest as specified above.

C. Test Labeling: On completion of satisfactory testing of each unit, attach a dated and signed "Satisfactory Test" label to tested component.

3.5 ADJUSTING

A. Record transformer secondary voltage at each unit for at least 48 hours of typical occupancy period. Adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 10 percent and not being lower than nameplate voltage minus 3 percent at maximum load conditions. Submit recording and tap settings as test results.

B. Connect buck-boost transformers to provide nameplate voltage of equipment being served, plus or minus 5 percent, at secondary terminals.

C. Output Settings Report: Prepare a written report recording output voltages and tap settings.

3.6 CLEANING

A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

END OF SECTION

SECTION 26 23 00

LOW-VOLTAGE SWITCHGEAR

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes metal-enclosed, low-voltage power circuit-breaker switchgear rated 1000 V and less for use in ac systems.

~~B. Related Sections include the following:~~

~~1. Division 26 Section "Electrical Power Monitoring and Control" for interfacing communication and metering requirements.~~

1.3 DEFINITIONS

A. ATS: Acceptance Testing Service.

B. GFCI: Ground-fault circuit interrupter.

1.4 SUBMITTALS

A. Product Data: For each type of switchgear, circuit breaker, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each type of switchgear and related equipment.
   1. Dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Include the following:
      a. Tabulation of installed devices with features and ratings.
      b. Enclosure types and details.
      c. Outline and general arrangement drawing showing dimensions, shipping sections, and weights of each assembled section.
      d. Bus configuration with size and number of conductors in each bus run, including phase, neutral, and ground conductors of main and branch buses.
      e. Current rating of buses.

f. Short-time and short-circuit current rating of switchgear assembly.
g. Nameplate legends.
h. Mimic-bus diagram.
i. Features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

2. Wiring Diagrams: Power, signal, and control wiring.

C. Coordination Drawings: Floor plans showing dimensioned layout, required working clearances, and required area above and around switchgear where pipe and ducts are prohibited. Show switchgear layout and relationships between components and adjacent structural and mechanical elements. Show support locations, type of support, and weight on each support. Indicate field measurements.

D. Samples: Representative portion of mimic bus with specified finish. Manufacturer's color charts showing colors available for mimic bus.

E. Manufacturer Seismic Qualification Certification: Submit certification that switchgear, overcurrent protective devices, accessories, and components will withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems." Include the following:

1. Basis of 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 and the unit will be fully operational after the seismic event."
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.

F. Qualification Data: For testing agency.

G. Field quality-control test reports.

H. Updated mimic-bus diagram reflecting field changes after final switchgear load connections have been made, for record.

I. Operation and Maintenance Data: For switchgear and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," 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.

1.5 MANUFACTURER'S WARRANTY

A. Unless specifically noted otherwise in the following paragraphs, provide an Equipment manufacturer's written warranty for all work free from defects in

material and workmanship and guarantee performance of equipment as required these 'Pre-Purchase' Specifications and Drawings for one (1) year of normal use and service beginning on date of initial start-up and Owner's Acceptance or eighteen (18) months from date of shipment, whichever comes first.

B. During the warranty period, the Manufacturer shall repair or replace, at no additional cost to the Owner, any equipment, material, or workmanship in which defects may develop.

C. All equipment and components furnished shall be covered under the specified 1-year warranty. This shall also include all controls components and all specified auxiliary equipment, and shall include labor and material to replace any parts or controls that might fail in service as the result of a defect in material or manufacture.

D. All labor required to replace components during the warranty period will be performed by the Manufacturer.

E. Equipment Manufacturer shall furnish a written warranty covering the above requirements.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.
   1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.
   2. The engineering service divisions lead engineer shall be a degreed engineer and a full time employee of the company with current factory training.

B. Source Limitations: Obtain switchgear through one source from a single manufacturer.

C. Product Options: Drawings indicate size, profiles, and dimensional requirements of switchgear and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."

D. 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.

E. Comply with NFPA 70.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver switchgear in sections of lengths that can be moved past obstructions in delivery path.

B. Store switchgear indoors in clean dry space with uniform temperature to prevent condensation. Protect switchgear from exposure to dirt, fumes, water, corrosive substances, and physical damage.

C. If stored in areas subjected to weather, cover switchgear to provide protection from weather, dirt, dust, corrosive substances, and physical damage. Remove loose packing and flammable materials from inside switchgear; install electric heating (250 W per section) to prevent condensation.

1.8 PROJECT CONDITIONS

A. Installation Pathway: Remove and replace building components and structures to provide pathway for moving switchgear into place.

B. Interruption of Existing Electric Service: Do not interrupt electric service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electric service according to requirements indicated:
   1. Notify Owner no fewer than 2 weeks in advance of proposed interruption of electric service.
   2. Do not proceed with interruption of electric service without Owner's written permission.

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchgear, including clearances between switchgear, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

D. Environmental Limitations: Rate equipment for continuous operation under the following conditions, unless otherwise indicated:
   1. Ambient Temperature: Not exceeding 40 deg C.
   2. Altitude: Not exceeding 6600 feet (2010 m).

1.9 COORDINATION

A. Coordinate layout and installation of switchgear and components with other construction that penetrates ceilings or is supported by them, including conduit, piping, equipment, and adjacent surfaces. Maintain required clearances for workspace and equipment access doors and panels.

B. Coordinate size and location of concrete bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.10 EXTRA MATERIALS

A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Fuses: Six of each type and rating used. Include spares for potential transformer fuses, control power fuses, and fuses and fusible devices for fused circuit breakers.
   2. Indicating Lights: Six of each type installed.
   3. Touchup Paint: 3 containers of paint matching enclosure finish, each 0.5 pint (250 mL).

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Cutler-Hammer, Inc.; Eaton Corporation.
   2. General Electric Company.
   3. Square D; Schneider Electric.

2.2 RATINGS

A. Nominal System Voltage: 480/277 V, 4 wire, 60 Hz.

B. Main-Bus Continuous: As indicated on plans and schedules.

C. Short-Time and Short-Circuit Current: Match rating of highest-rated circuit breaker in switchgear assembly (fully rated, series rating not permitted). Refer to drawings and schedules, 100K AIC minimum.

2.3 FABRICATION

A. Factory assembled and tested and complying with IEEE C37.20.1.

B. Indoor Enclosure Material: Steel.

C. Finish: IEEE C37.20.1, manufacturer's standard gray finish over a rust-inhibiting primer on phosphatizing-treated metal surfaces.

D. Section barriers between main and tie circuit-breaker compartments shall be extended to rear of section.

E. Bus isolation barriers shall be arranged to isolate line bus from load bus at each main and tie circuit breaker.

F. Circuit-breaker compartments shall be equipped to house drawout-type circuit breakers and shall be fitted with hinged outer doors.

G. Fabricate enclosure with padlock-able removable, rear cover hinged doors to allow access to rear interior of switchgear. Include infrared scanning windows for each main and feeder breaker structure aligned with terminations and bus connections most likely to exhibit heating.

H. Auxiliary Compartments: Match and align with basic switchgear assembly. Include the following:
   1. Customer metering
   2. Bus transition sections.
   3. Incoming-line pull sections.
   4. Hinged front panels for access to metering, accessory, and blank compartments.
   5. Pull box on top of switchgear for extra room for pulling cable, with removable top, front, and side covers and ventilation provisions adequate to maintain air temperature in pull box within same limits as switchgear.
      a. Set pull box back from front to clear circuit-breaker lifting mechanism.
      b. Bottom: Insulating, fire-resistant material with separate holes for cable drops into switchgear.
      c. Cable Supports: Arranged to ease cabling and adequate to support cables indicated, including those for future installation.

I. Bus bars connect between vertical sections and between compartments. Cable connections are not permitted.
   1. Main Phase Bus: Uniform capacity the entire length of assembly.
   2. Neutral Bus: 100 percent of phase-bus ampacity. Equip bus with pressure-connector terminations for outgoing circuit neutral conductors. Include braces for neutral-bus extensions for busway feeders.
   3. Vertical Section Bus Size: Comply with IEEE C37.20.1, including allowance for spare circuit breakers and spaces for future circuit breakers.
   4. Phase- and Neutral-Bus Material: Hard-drawn copper of 98 percent minimum conductivity, with copper feeder circuit-breaker line connections.
   5. Use copper for connecting circuit-breaker line to copper bus.
   6. Contact Surfaces of Buses: Silver plated.
   7. Feeder Circuit-Breaker Load Terminals: Silver-plated copper bus extensions equipped with pressure connectors for outgoing circuit conductors.
   8. Ground Bus: Hard-drawn copper of 98 percent minimum conductivity, with pressure connector for feeder and branch-circuit ground conductors, minimum size 1/4 by 4 inches (6 by 100 mm).
   9. Supports and Bracing for Buses: Adequate strength for indicated short-circuit currents.
   10. Neutral bus equipped with pressure-connector terminations for outgoing circuit neutral conductors. Neutral-bus extensions for busway feeders are braced.
   11. Neutral Disconnect Link: Bolted, uninsulated, 1/4-by-2-inch (6-by-50-mm) copper bus, arranged to connect neutral bus to ground bus.
   12. Provide for future extensions from either end of main phase, neutral, and ground bus by means of predrilled bolt-holes and connecting links.

13. Bus-Bar Insulation: Individual bus bars wrapped with factory-applied, flame-retardant tape or spray-applied, flame-retardant insulation.
    a. Sprayed Insulation Thickness: 3 mils (0.08 mm), minimum.
    b. Bolted Bus Joints: Insulate with secure joint covers that can easily be removed and reinstalled.

2.4 COMPONENTS

A. Instrument Transformers: Comply with IEEE C57.13.
   1. Potential Transformers: Secondary-voltage rating of 120 V and NEMA accuracy class of 0.3 with burdens of W, X, and Y.
   2. Current Transformers: Ratios as indicated; burden and accuracy class suitable for connected relays, meters, and instruments.

B. Multifunction Digital-Metering (based on Square D PM5563) : provide UL-listed or -recognized, microprocessor-based unit suitable for three- or four-wire systems and with the following features, meters shall communicate via TCP/IP:
   1. Inputs from sensors or 5-A current-transformer secondaries, and potential terminals rated to 600 V.
   2. Electrical power metering shall be installed on all new unit substations as identified on drawings and at a minimum, metering shall be provided as indicated in the attached “Table 1- Electric Power Metering Application”.
   3. The installation of new equipment shall provide the complete installation of new power metering devices. Complete installation shall include(but not necessarily be limited to) furnishing and installing all; metering hardware components, power wiring, data wiring, software, graphical updates and programming required for fully functional metering integrated in to the Owner’s power metering systems.
   4. Unless specifically directed otherwise, all electrical power metering components installed shall be fully compatible with the Hospital’s existing Eaton power monitoring system.
   5. Installed metering devices shall conform to the following:
      a. Main meters in switchgear/ switchboards- Square D PM5000 Series web-enabled or approved equal.
      b. Sub-meters – Square D PM5000 Series web-enabled or approved equal
      c. Automatic Transfer Switches – Eaton PX2000 Series web-enabled with I/O card or approved equal
      d. All meters shall be provided with scalable pulse output contacts for BMS integration.
   6. Installed metering system wiring methods shall conform to the following:
      a. All current transformers shall be provided with readily accessible shorting terminal cable to safely be accessed with the equipment energized.
      b. All potential taps shall be fused and provided with readily accessible disconnecting means capable of safely being accessed with the equipment energized.
      c. RD-485 daisy chain data wiring, where provided, shall be limited to no more than ten (8) metering devices and shall not have a circuit length of greater than 500 feet.

d. RS-422 daisy chain data wiring, where provided, shall be limited to no more than ten (8) metering devices and shall not have a circuit length of greater than 500 feet.
e. IMP CABLE, where provided shall be Belden type 3072F and shall be limited to no more than sixty-four (64) devices.
f. All ModBus devices connected on a single fieldbus loop or daisy chain shall be similar devices by a single manufacturer. Under no circumstances shall fieldbus loops serve multiple type devices and or devices by multiple manufacturers.

7. All metering components shall be enclosed in either a stand-alone equipment cabinet or in the terminal electrical equipment itself (switchgear, etc.). The metering equipment shall be located in a readily accessible location as defined by NFPA 70.

Table 1- Electric Power Meter Application:

Equipment	Volts	Amperes	Watts	VARS	VA	p.f.	Hz	V thd	Ithd	WH	Waveform Capture	Peak Demand
Substation mains,	X	X	X	X	X	X	X	X	X	X	X	X
Substaion Branch devices	X	X	X	X	X	X				X		X

8. Switch-selectable digital display of the following:
   a. Phase Currents, Each Phase: Plus or minus 1 percent.
   b. Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.
   c. Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.
   d. Three-Phase Real Power: Plus or minus 2 percent.
   e. Three-Phase Reactive Power: Plus or minus 2 percent.
   f. Power Factor: Plus or minus 2 percent.
   g. Frequency: Plus or minus 0.5 percent.
   h. Integrated Demand, with Demand Interval Selectable from 5 to 60 Minutes: Plus or minus 2 percent.
   i. Accumulated energy, in megawatt hours (joules), plus or minus 2 percent; stored values unaffected by power outages for up to 72 hours.

C. Relays: Comply with IEEE C37.90, types and settings as indicated; with test blocks and plugs.

D. Surge Arresters: Distribution class, metal-oxide-varistor type. Comply with IEEE C62.11 and NEMA LA 1.
   1. Install in cable termination compartments and connect in each phase of circuit.
   2. Coordinate rating with circuit voltage.

E. Provision for Future Devices: Equip compartments with rails, mounting brackets, supports, necessary appurtenances, and bus connections.

F. Fungus Proofing: Permanent fungicidal treatment for switchgear interior, including instruments and instrument transformers.

G. Control Power Supply: Control power transformer supplying 120-V control circuits through secondary disconnect devices. Provide a control power transformer in the 480 Volt section to supply the substation fans and control, as well as for usage in the low voltage switchgear. Include the following features:
   1. Dry-type transformers, in separate compartments for units larger than 3 kVA, including primary and secondary fuses.
   2. Two control power transformers in separate compartments with necessary interlocking relays; each transformer connected to line side of associated main circuit breaker.
      a. Secondary windings connected through a relay or relays to control bus to effect an automatic transfer scheme.
   3. Control Power Fuses: Primary and secondary fuses with current-limiting and overload protection.
   4. Fuses are specified in Division 26 Section "Fuses."

H. Control Wiring: Factory installed, complete with bundling, lacing, and protection; and complying with the following:
   1. Flexible conductors for No. 8 AWG and smaller, for conductors across hinges and for conductors for interconnections between shipping units.
   2. Conductors sized according to NFPA 70 for duty required.
   3. Low voltage switchgear and substation transformers shall be designed such that terminal blocks and wiring jumpers are to be included for ease of field connection between the two pieces of equipment. No exterior wire and conduits shall be required.

2.5 CIRCUIT BREAKERS

A. Description: Comply with IEEE C37.13.

B. Ratings: As indicated for continuous, interrupting, and short-time current ratings for each circuit breaker; voltage and frequency ratings same as switchgear.

C. Operating Mechanism: Mechanically and electrically trip-free, stored-energy operating mechanism with the following features:
   1. Normal Closing Speed: Independent of both control and operator.
   2. Slow Closing Speed: Optional with operator for inspection and adjustment.
   3. Stored-Energy Mechanism: Electrically charged, with optional manual charging.
   4. Operation counter.

D. Trip Devices: Solid-state, overcurrent trip-device system consisting of one or two current transformers or sensors per phase, a release mechanism, and the following features:
   1. Functions: Long-time-delay, short-time-delay, and instantaneous-trip functions, independent of each other in both action and adjustment.
   2. Temperature Compensation: Ensures accuracy and calibration stability from minus 5 to plus 40 deg C.

3. Field-adjustable, time-current characteristics.
4. Current Adjustability: Dial settings and rating plugs on trip units or sensors on circuit breakers, or a combination of these methods.
5. Three bands, minimum, for long-time- and short-time-delay functions; marked "minimum," "intermediate," and "maximum."
6. Pickup Points: Five minimum, for long-time- and short-time-trip functions. Equip short-time-trip function for switchable I^2t operation.
7. Ground-fault protection shall be provided on all main, tie and feeder breakers with at least three short-time-delay settings and three trip-time-delay bands; adjustable current pickup. Arrange to provide protection for the following:
   a. Four-wire, double-ended substation.
8. Trip Indication: Labeled, battery-powered lights or mechanical targets on trip device to indicate type of fault. Include a power/relay module to supply control power to the read out display.
9. Provide a power trip unit on all feeder breakers and main and tie circuit breakers. Include a 24 character LED display.
10. Arc Flash Reduction Maintenance: Each breaker 1200A and larger shall be provided with an arc flash reduction maintenance feature. Include an Arc flash reduction blue light and a 22 mm blue push to test LED confirmation light shall be included with each breaker.
11. Feeder trip units shall be capable of monitoring the following data:
    a. Phase neutral and ground current
    b. Line to line voltage
    c. Minimum and Maximum current values
    d. Watts, vars, VA, watt-hours, varhours, and VA hours.
    e. The trip unit shall be capable of displaying peak demand, present demand, and energy consumption. It shall also be able to display power factor.

E. Auxiliary Contacts: For interlocking or remote indication of circuit-breaker position, with spare auxiliary switches and other auxiliary switches required for normal circuit-breaker operation, quantity as indicated. Each consists of two Type "a" and two Type "b" stages (contacts) wired through secondary disconnect devices to a terminal block in stationary housing.

F. Drawout Features: Circuit-breaker mounting assembly equipped with a racking mechanism to position circuit breaker and hold it rigidly in connected, test, and disconnected positions. Include the following features:
1. Interlocks: Prevent movement of circuit breaker to or from connected position when it is closed, and prevent closure of circuit breaker unless it is in connected, test, or disconnected position.
2. Circuit-Breaker Positioning: An open circuit breaker may be racked to or from connected, test, and disconnected positions only with the associated compartment door closed unless live parts are covered by a full dead-front shield. An open circuit breaker may be manually withdrawn to a position for removal from the structure with the door open. Status for connection devices for different positions includes the following:
   a. Test Position: Primary disconnect devices disengaged, and secondary disconnect devices and ground contact engaged.
   b. Disconnected Position: Primary and secondary devices and ground contact disengaged.

G. Arc Chutes: Readily removable from associated circuit breaker when it is in disconnected position, and arranged to permit inspection of contacts without removing circuit breaker from switchgear.

H. Padlocking Provisions: For installing at least three padlocks on each circuit breaker to secure its enclosure and prevent movement of drawout mechanism.

I. Operating Handle: One for each circuit breaker capable of manual operation.

J. Electric Close Button: One for each electrically operated circuit breaker.

K. Mechanical Interlocking of Circuit Breakers: Uses a mechanical tripping lever or equivalent design and electrical interlocks.

L. Key Interlocks: Arranged so keys are attached at devices indicated. Mountings and hardware are included where future installation of key-interlock devices is indicated.

M. Undervoltage Trip Devices: Adjustable time-delay and pickup voltage.

N. Shunt-Trip Devices: Where indicated.

O. Indicating Lights: To indicate circuit breaker is open or closed, for main and bus tie circuit breakers interlocked either with each other or with external devices.

2.6 ACCESSORIES

A. Accessory Set: Furnish tools and miscellaneous items required for circuit-breaker and switchgear test, inspection, maintenance, and operation.
   1. Racking handle to manually move circuit breaker between connected and disconnected positions.
   2. Portable test set for testing all functions of circuit-breaker, solid-state trip devices without removal from switchgear.
   3. Relay and meter test plugs suitable for testing switchgear meters and switchgear class relays.
   4. Provide remote racking system (Square D Masterpact remote device or approved equal)

B. Circuit-Breaker Removal Apparatus: Overhead-circuit-breaker lifting device, track mounted at top front of switchgear and complete with hoist and lifting yokes matching each size of drawout circuit breaker installed.

C. Spare-Fuse Cabinet: Identified and compartmented steel box or cabinet with lockable door.

D. Storage for Manual: Include a rack or holder, near the operating instructions, for a copy of maintenance manual.

2.7 IDENTIFICATION

A. Mimic Bus: Continuous mimic bus, arranged in single-line diagram format, using symbols and lettered designations consistent with approved mimic-bus diagram.
   1. Mimic-bus segments coordinated with devices in switchgear sections to which applied, to produce a concise visual presentation of principal switchgear components and connections.
   2. Medium: Screw on Plastic graphics, as selected by Architect.
   3. Color: Contrasting with factory-finish background; as selected by Architect from manufacturer's full range.

B. System Power Riser Diagrams: Depict power sources, feeders, distribution components, and major loads. Include as-built data for low-voltage power switchgear and connections as follows:
   1. Frame size of each circuit breaker.
   2. Trip rating for each circuit breaker.
   3. Conduit and wire size for each feeder.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine elements and surfaces where switchgear will be installed for compliance with installation tolerances, required clearances, and other conditions affecting performance.
   1. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

A. Comply with applicable portions of NECA 400.

B. Anchor switchgear assembly to 4-inch (100-mm), channel-iron floor sill embedded in concrete base and attach by bolting.
   1. Sills: Select to suit switchgear; level and grout flush into concrete base.
   2. Design each fastener and support to carry load indicated by seismic requirements and according to seismic-restraint details. See Division 26 Section "Vibration and Seismic Controls for Electrical Systems" for seismic-restraint requirements.
   3. Concrete Bases: 4 inches (100 mm) high, reinforced, with chamfered edges. Extend base no more than 6 inches (150 mm) in all directions beyond the maximum dimensions of switchgear unless otherwise indicated or unless required for seismic anchor support. Construct concrete bases according to Division 26 Section "Hangers and Supports for Electrical Systems."

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, brackets, and temporary blocking of moving parts from switchgear units and components.

3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs as specified in Division 26 Section "Identification for Electrical Systems."

B. Diagram and Instructions:
   1. Frame and mount under clear acrylic plastic on the front of switchgear.
      a. Operating Instructions: Printed basic instructions for switchgear, including control and key-interlock sequences and emergency procedures.
      b. System Power Riser Diagrams: Depict power sources, feeders, distribution components, and major loads.
   2. Storage for Maintenance: Include a rack or holder, near the operating instructions, for a copy of maintenance manual.

3.4 CONNECTIONS

A. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.5 FIELD QUALITY CONTROL

A. Prepare for acceptance tests as follows:
   1. Test insulation resistance for each switchgear bus, component, connecting supply, feeder, and control circuit.
   2. Test continuity of each circuit.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to perform the following:
   1. Inspect switchgear installation, including wiring, components, connections, and equipment. Test and adjust components and equipment.
   2. Verify that electrical control wiring installation complies with manufacturer's submittal by means of point-to-point continuity testing. Verify that wiring installation complies with requirements in Division 26 Sections.
   3. Complete installation and startup checks according to manufacturer's written instructions.
   4. Assist in field testing of equipment including pretesting and adjusting of equipment and components.
   5. Report results in writing.

C. Testing Agency: Engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.

D. Perform the following field tests and inspections and prepare test reports:

1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters. Perform NETA tests and inspections for each of the following NETA categories:
   a. Switchgear.
   b. Circuit breakers.
   c. Protective relays.
   d. Instrument transformers.
   e. Metering and instrumentation.
   f. Ground-fault systems.
   g. Battery systems.
   h. Surge arresters.
   i. Capacitors.
2. Remove and replace malfunctioning units and retest as specified above.

E. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switchgear. Remove front and rear panels so joints and connections are accessible to portable scanner.
   1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switchgear 11 months after date of Substantial Completion.
   2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
   3. Record of Infrared Scanning: Prepare a certified report that identifies switchgear checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.6 ADJUSTING

A. Set field-adjustable, protective-relay trip characteristics according to approved "Overcurrent Protective Device Coordination Study" submittal.

3.7 CLEANING

A. On completion of installation, inspect interior and exterior of switchgear. Remove paint splatters and other spots. Vacuum dirt and debris; do not use compressed air to assist in cleaning. Repair exposed surfaces to match original finish.

3.8 PROTECTION

A. Temporary Heating: Apply temporary heat to switchgear, according to manufacturer's written instructions, throughout periods when switchgear environment is not controlled for temperature and humidity within manufacturer's stipulated service conditions.

3.9 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain switchgear. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION

Conformed Set, 02 Oct 2020

SECTION 26 24 16

PANELBOARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Section 01 81 13 “Sustainable Design Requirements – LEED v4 for Building Design & Construction – New Construction” for sustainable design requirements and detailed sustainable design submittal requirements.

C. Section 01 74 19 “Construction and Demolition Waste Management and Disposal” for disposal of construction, demolition and packaging waste disposal requirements.

1.2 SUMMARY

A. Section Includes:
1. Distribution panelboards.
2. Lighting and appliance branch-circuit panelboards.

B. Sustainable Building Requirements:
1. The Owner requires the Contractor to implement practices and procedures to meet the project’s environmental performance goals, which include achieving LEED version 4 Certified level Certification. Specific project goals that may impact this area of work include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; construction waste recycling; and the implementation of a construction indoor air quality management plan. The Contractor shall ensure that the requirements related to these goals, as defined in the Articles below, are implemented to the fullest extent. Substitutions, or other changes to the work proposed by the Contractor or their Subcontractors, shall not be allowed if such changes compromise the aforementioned environmental goals and LEED certification.

1.3 DEFINITIONS

A. TVSS: Transient voltage surge suppressor.

B. SPD: Surge Protective Device

1.4 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Panelboards shall withstand the effects of earthquake motions determined according to SEI/ASCE 7 and as listed in seismic section of this specification.
   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."

1.5 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. Submittal shall include “Overcurrent Protective Coordination Study” as specified elsewhere in Division 26 Section which confirms all overcurrent protective devices submitted are in compliance with those requirements.

C. 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.

D. Qualification Data: For qualified testing agency.

E. Seismic Qualification Certificates: Submit certification that panelboards, overcurrent protective devices, accessories, and components will withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems." 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.

F. 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.

G. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.

H. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," 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 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or equivalent testing agency by manufacturer of distribution equipment being provided.
   1. Testing Agency's Field Supervisor: Currently certified by NETA or equivalent testing agency by manufacturer of distribution equipment being provided to supervise on-site testing

B. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. Comply with NEMA PB 1.

F. Comply with NFPA 70.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.

B. Handle and prepare panelboards for installation according to NEMA PB 1.

1.8 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 (minus 5 deg C) to plus 104 deg F (plus 40 deg C).
      b. Altitude: Not exceeding 6600 feet (2000 m).

B. Service Conditions: NEMA PB 1, usual service conditions, as follows:
   1. Ambient temperatures within limits specified.
   2. Altitude not exceeding 6600 feet (2000 m).

1.9 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.

B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.10 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: two years from date of Substantial Completion.

1.11 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Keys: Two spares for each type of panelboard cabinet lock.
   2. Circuit Breakers Including GFCI and Ground Fault Equipment Protection (GFEP) Types: Three spares of each size, type and poles.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PANELBOARDS

A. Fabricate and test panelboards according to IEEE 344 to withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

B. Enclosures: Flush- and surface-mounted cabinets. Coordinate with architectural drawings.
   1. Rated for environmental conditions at installed location.
      a. Indoor Dry and Clean Locations: NEMA 250, Type 1.
      b. Outdoor Locations: NEMA 250, Type 3R.
      c. Kitchen and Wash-Down Areas: NEMA 250, Type 4X, stainless steel.
      d. Other Wet or Damp Indoor Locations: NEMA 250, Type 4.
      e. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.
   2. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover or provide door-in-door type construction so that the trim may be opened to access wireways without removing the trim from the panel. All trims shall have concealed mounting hardware when the door is closed.
   3. 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.

4. Directory Card: Inside panelboard door, mounted in transparent card holder.
5. Electronic Panel schedules: Provide to owner/Architect with closeout documents.

C. Incoming Mains Location: Top and bottom. Coordinate with drawings, and site conditions.

D. 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.
3. Isolated Ground Bus: Adequate for branch-circuit isolated ground conductors; insulated from box.
4. Extra-Capacity Neutral Bus: Neutral bus rated 200 percent of phase bus and UL listed as suitable for nonlinear loads.

E. Conductor Connectors: Suitable for use with conductor material and sizes.
1. Material: Hard-drawn copper, 98 percent conductivity.
2. Main and Neutral Lugs: Mechanical type, compression for aluminum feeders.
3. Ground Lugs and Bus-Configured Terminators: Mechanical type, compression for aluminum feeders
4. Feed-Through Lugs: Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.
5. Subfeed (Double) Lugs: Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
6. Gutter-Tap Lugs: Mechanical type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.
7. Extra-Capacity Neutral Lugs: Rated 200 percent of phase lugs mounted on extra-capacity neutral bus.

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 of 65,000 or rating indicated on schedules.

2.2 DISTRIBUTION PANELBOARDS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following in paragraph B:
1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric.

B. Panelboards: NEMA PB 1, power and feeder distribution type.

C. Doors: Furnish semi-flush cylinder lock-and-catch assembly to secure hinged door over circuit breaker handles.

D. Mains: Circuit breaker and Lugs only.

E. Branch Overcurrent Protective Devices for circuit-breaker frame sizes 125 A and smaller: bolt-on circuit breakers.

F. Branch Overcurrent Protective Devices for circuit breakers frame sizes larger than 125A: bolt-on circuit breakers.

2.3 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following in paragraph B:
   1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
   2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
   3. Square D; a brand of Schneider Electric.

B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.

C. Mains: Circuit breaker or lugs only.

D. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

E. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

F. Column-Type Panelboards: Not Permitted.

2.4 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following in paragraph B:
   1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
   2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
   3. Siemens Energy & Automation, Inc.
   4. Square D; a brand of Schneider Electric.

B. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents of 65,000 or rating indicated on schedules.
   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 250 A and smaller.
   2. 250 AMP and larger electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable 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.
   3. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
      a. Standard frame sizes, trip ratings, and number of poles.
      b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials. Compression for Aluminum feeders.
      c. Application Listing: Appropriate for application.
      d. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in off position.

2.5 PANELBOARD BONDING FOR PATIENT VICINITY

A. The equipment grounding terminal busses of the normal and essential branch-circuit panelboards serving the same individual patient vicinity shall be bonded together with an insulated continuous copper conductor not smaller than No. 10. Where more than two (2) panels serve the same individual patient vicinity, this conductor shall be continuous from panel to panel, but shall be permitted to be broken in order to terminate on the ground bus in each panel.

2.6 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.

2.7 INTEGRAL SURGE PROTECTION DEVICES

A. Transient Surge Protection Device (SPD) equipment shall meet all ratings and features specified herein, where designated on the drawings.

B. Electrical requirements:

1. Unit Operating Voltage – Refer to drawings for operating voltage and unit configuration.
2. Maximum Continuous Operating Voltage (MCOV) – The MCOV shall be greater than 115% of the nominal system operating voltage.
3. Protection Modes – For a wye configured system, the device must have directly connected suppression elements between line-neutral (L-N), line-ground (L-G), and neutral-ground (N-G). For a delta configured system, the device must have suppression elements between line to line (L-L) and line to ground (L-G).
4. UL 1449 3rd Edition Suppressed Voltage Rating (SVR) – The maximum UL 1449 SVR for the device must not exceed the following:

Models	208Y/120	480Y/277	600Y/347
L-N; L-G; N-G	400 V	800 V	1200 V
L-L	800 V	1500 V	2000 V

5. ANSI/IEEE Cat C3 Let Through Voltage – The let through voltage based on IEEE C62.41 and C62.45 recommended procedures for Category C3 surges (20 kV, 10 kA) shall be less than:

Models	208Y/120	480Y/277	600Y/347
L-N	470 V	900 V	1300 V

6. ANSI/IEEE Cat. B# Let Through Voltage – Let through voltage based on IEEE C62.41 and C62.45 recommended procedures for the ANSI/IEEE Cat. B3 ringwave (6 kV, 5000amps) shall be less than:

Models	208Y/120	480Y/277	600Y/347
L-N	150 V	200 V	300 V

C. TVSS Design

1. Balanced Suppression Platform – The surge current shall be equally distributed to all MOV components to ensure equal stressing and maximum performance. The surge suppression platform must provide equal impedance paths to each matched MOV. Designs incorporating TVSS modules which do not provide a balanced impedance path to each MOV shall not be acceptable.
2. Electrical Noise Filter – Each unit shall include a high-performance EMI/RFI noise rejection filter. Noise attenuation for electric line noise shall be 55 dB at 100 kHz using the MIL-STD-220A insertion loss test method. The unit shall be complimentary listed to UL 1283. Products not able to demonstrate noise attenuation of 55 dB @ 100 kHz shall be rejected.
3. Internal Connections – No plug-in component modules or printed circuit boards shall be used as surge current conductors. All internal components shall be hardwired with connections utilizing low impedance conductors and compression fittings.
4. Safety and Diagnostic Monitoring – Each unit shall be equipped with 200 kAIC internal fuses. Each unit shall provide the following three levels of monitoring:

    a. Continuous monitoring of fusing system
    b. Internal infrared sensor system for monitoring individual MOVs (including neutral to ground). The system must be capable of identifying open circuit failures not monitored by conventional fusing systems.
    c. Thermal detection circuit shall monitor for overheating in all modes due to thermal runaway.
    d. A green/red solid state indicator light shall be provided on each phase. The absence of a green light and the presence of a red light, shall indicate which phase(s) have been damaged. Fault detection will activate a flashing trouble light. Units which can not detect open-circuit damage, thermal conditions and over current will not be accepted.
5. Warranty – The manufacturer shall provide a full five (5) year warranty from the date of shipment against any TVSS part failure when installed in compliance with manufacturer's written instructions and any applicable national or local electric code.
6. TVSS devices shall be mounted such that they are seismically qualified per the International Building Code.
7. The unit must be equipped with transient event counter and audible alarm.
8. Remote Status Monitor – The TVSS device must include form C dry contacts (one NO and one NC) for remote annunciation of unit status. The remote alarm shall change state if any of the three monitoring systems described detect a fault condition.
9. Push-To-Test Feature – Each suppression unit shall incorporate an integral test feature which verifies the operational integrity of the unit's monitoring system.

D. Surge Current Capacity – The minimum total surge current 8 x 20 microsecond waveform that the device is capable of withstanding shall be as shown in the following table:

Application	Min. Surge Current Per Phase	Min. Surge Current Per Mode*
Distribution Panelboards	160 kA	80 kA
High Exposure Roof Top Locations	160 kA	80 kA
Branch Locations (Panelboards)	120 kA	60kA

*L-G, L-N and N-G (WYE system); L-L, L-G (Delta system)

E. Panelboard Requirements
1. The TVSS units shall be tested to demonstrate suitability for ANSI/IEEE C62.41 Category C1 environments.
2. Withstand – Each unit must be capable of surviving more than 2500 category C1 transients without failure or degradation of UL 1449, Second Edition, Suppression Voltage Rating.
3. Branch panels shall be UL labeled as “suitable for non-linear loads”.
4. Distribution and panel suppressors shall be installed inside the panelboards or bus plugs at the manufacturer’s factory.
5. A direct bus bar connection shall be used to mount the TVSS component to the panelboard bus bar or the bus plug disconnect to reduce the impedance of the shunt path.
6. The TVSS panelboard shall be constructed using a direct bus bar connection (cable connection between bus bar and TVSS device is not acceptable). TVSS units that use a wire connection do not meet the intent of this specification.
7. Suppression shall be included and mounted within the panelboard and bus plug by the manufacturer of the panelboard or bus way.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Receive, inspect, handle, and store panelboards according to NECA 407.

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.

B. Equipment Mounting: Install panelboards on concrete bases, 4-inch (100-mm) nominal thickness. Comply with requirements for concrete base specified in Division 03 Section " Miscellaneous Cast-in-Place Concrete."

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around full perimeter of base.
2. For panelboards, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to panelboards.
5. Attach panelboard to the vertical finished or structural surface behind the panelboard.

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.

D. Comply with mounting and anchoring requirements specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

E. Mount top of trim 90 inches (2286 mm) above finished floor unless otherwise indicated.

F. 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.

G. Install overcurrent protective devices and controllers not already factory installed.
1. Set field-adjustable, circuit-breaker trip ranges.

H. Install filler plates in unused spaces.

I. Stub four 1-inch empty conduits from recessed panelboards into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch empty conduits into raised floor space or below slab not on grade.

J. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.

K. Comply with NECA 1.

3.3 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Division 26 Section "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 software/spreadsheet to create directory; handwritten directories are not acceptable. Provide electronic files of directories to owner/architect with closeout documents.

C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Division 26 Section "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 Division 26 Section "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. Acceptance Testing Preparation:
   1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
   2. Test continuity of each circuit.

C. 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.
      b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panelboard 11 months after date of Substantial Completion.
      c. Instruments and Equipment:
         1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

D. Panelboards will be considered defective if they do not pass tests and inspections.

E. 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 Division 26 Section "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.

3.6 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions.

END OF SECTION

SECTION 26 24 17

ISOLATED POWER SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 DESCRIPTION OF WORK

A. Section Includes:
1. Isolated power panels.
2. Dual Voltage isolated power panels
3. Line isolation monitors.
4. Associated power and grounding outlets.

1.3 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Panelboards 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 and the unit will be fully operational after the seismic event."

1.4 REFERENCES

A. The surgical facility panels, isolated power panels, portable laser and X-Ray panels and all components shall be designed, manufactured and tested in accordance with the latest applicable edition of the following standards:
1. NFPA 99 – Health Care Facilities
2. NFPA 70 – National Electrical Code (NEC)
3. UL Standard 1047 – Isolated Power System Distribution Equipment
4. UL Standard 1022 – Line Isolation Monitors

1.5 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.
1. Isolated power panels.
2. Dual voltage isolated power panels
3. Line isolation monitors.
4. Associated power and grounding outlets.

B. Submittal shall include "Overcurrent Protective Coordination Study" as specified elsewhere in Division 26 Section which confirms all overcurrent protective devices submitted are in compliance with those requirements.

C. Shop Drawings: For each isolated power panels, three phase laser isolated power panels, laser, line isolated monitors, associated power and ground outlets 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. Impedance for transformers.

D. Qualification Data: For qualified testing agency.

E. Seismic Qualification Certificates: Submit certification that panelboards, overcurrent protective devices, accessories, and components will withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems." 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.

F. 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.

G. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.

H. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," 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 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA.
   1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

B. Source Limitations: Obtain isolated power panels, three phase laser isolated power panels, line isolation monitors, associated power and grounding outlets from single source from single manufacturer.
   1. Isolated power panels.
   2. Dual Voltage isolated power panels
   3. Line isolation monitors.
   4. Associated power and grounding outlets.

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. For the equipment specified herein, the manufacturer shall be ISO 9000, 9001 or 9002 certified.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.

B. Handle and prepare panelboards for installation according to NECA 407 and NEMA PB 1.

1.8 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 minus 22 deg F (minus 30 deg C) to plus 104 deg F (plus 40 deg C).
      b. Altitude: Not exceeding 6600 feet (2000 m).

B. Service Conditions: NEMA PB 1, usual service conditions, as follows:
   1. Ambient temperatures within limits specified.
   2. Altitude not exceeding 6600 feet (2000 m).

1.9 COORDINATION

A. Coordinate layout and installation of isolated power panels, three phase laser isolated power panels, line isolation monitors, associated power and grounding

outlets 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.

B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.10 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.
   1. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR ISOLATED POWER SYSTEMS

A. The back box housing the isolation transformer and related components shall be a minimum of 14 gauge steel which shall be degreased, phosphatized, primed and finish painted with a coat of baked enamel paint. 14 gauge galvanized steel is acceptable for flush mounted panels. The maximum depth of the panel shall be the minimum as manufactured by specified vendor.

B. The front trim shall be 12 gauge type 304 stainless steel polished to a #4 satin/brushed finish and shall have a 1.5 inch return flange on all sides. Front trim shall have a hinged door with keyed lock to give access to the circuit breakers and LIM and allow for testing. The entire section behind the hinged door shall be a dead front design. All hinges shall be concealed.

C. The front trim shall not contain any type of grille or louver for the purpose of ventilation. The panel and transformer shall be so designed that the heat generated by the transformer under full load conditions shall not affect the normal operation of the circuit breakers, LIM or ground detector. The maximum front panel temperature shall not exceed 30 degrees C under full load continuous operation. Certification of the temperature test shall be provided to the Engineer upon request.

D. Back boxes for accessories shall be fabricated of mild steel. When accessories are surface mounted the back box shall have a finished appearance, all seams shall be welded and ground smooth with the outer surface of the box. The front trim shall be 14 gauge type 304 stainless steel with a #4 satin/brushed finish..

2.2 ISOLATION POWER SYSTEMS

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

B. Basis-of-Design Product: Subject to compliance with requirements, provide a comparable product by one of the following:

1. Square D; a brand of Schneider Electric
2. PG LifeLink
3. Post Glover

C. Isolated Power Panels
1. Isolation transformers shall be single phase, 60 hertz, 10 kVA with 277 volt primary and 120 volt secondary.

D. Dual voltage Isolated Power Panels
1. Isolation transformers shall be three phase, 60 hertz, 7.5/25 kVA with 480 volt, primary and 208/120 volt, secondary.

E. Single Phase Transformers
1. The transformer shall be wound with an electrostatic shield between the primary and secondary windings which shall be grounded to the enclosure. The electrostatic shield shall be designed such that it will prevent direct shorting of the primary winding to the secondary winding and reduce the coupling of harmonic distortions between the primary circuits and secondary circuits.
2. Regulation shall not exceed 2.6% at 0.8 power factor at 20 degrees C above the full load continuous operating temperature in accordance with NEMA-ANSI Standards.
3. The transformer shall have a Class H insulation system with a temperature rise of 55 degrees C above ambient under full load conditions when tested in accordance with NEMA-ANSI Standards. Transformer shall have a 220 degrees C UL recognized insulation system.
4. The transformer shall be of the stacked core design and shall be securely clamped and bolted. The core and coils shall be internally isolated from the enclosure by means of a suitable vibration dampening system. The core and coils shall be varnish impregnated and shall have a final wrap of insulating material to prevent exposure of bare conductors.
5. Transformers shall meet or exceed Class 1 efficiency levels per NEMA TP-1-2002, or the latest adopted edition.

F. The total leakage current to ground from the transformer shall not exceed the values shown in UL 1047, Standard for Hospital Isolating Panels, Table 29.2

Noise levels shall not exceed the values in the following table: Transformer Rating (kVA)	Noise Level (db)
3	27
5	27
7.5	35
10	35
15	35
25	35

G. Transformers shall meet or exceed Class 1 efficiency levels per NEMA TP-1, the latest adopted edition.

2.3 CIRCUIT BREAKERS

A. Provide a primary and secondary main circuit breaker for each isolated power panel transformer. Refer to the drawings and schedule for voltage and ampere ratings and number of poles.

B. Single Phase Isolated Power Panels
   1. All circuit breakers for single phase isolated power panels shall be 2 pole with a minimum interrupting rating of 10,000 amperes. Panel shall have a minimum capacity of 16 secondary circuit breakers.

C. Three Phase Isolated Power Panels
   1. All circuit breakers for three phase isolated power panels shall be three pole with a minimum interrupting rating of 10,000 amperes. Panels shall have a minimum capacity of 8 secondary circuit breakers

D. All circuit breakers shall be of the thermal-magnetic type.

E. Refer to drawings for sizes and quantities of circuit breakers.

2.4 LINE ISOLATION MONITOR

A. Each isolated power panel, duplex isolated power panel, three phase laser isolated power panel shall be equipped with a line isolation monitor (LIM).

B. The LIM shall be microprocessor based, digital and shall use circuitry to continuously monitor the impedance from all secondary conductors of the isolated power system to ground. The LIM shall be capable of detecting all combinations of resistive and capacitive faults whether they are balanced, unbalanced or hybrid. LIM's that internally switch between either line to ground will not be acceptable. The LIM shall not contribute more than 25 microamperes to the total hazard current of the system.

C. The LIM shall have the following specifications:

1.	Operating voltage:	85 to 265 VAC
2.	Accuracy:	5% or better
3.	Alarm level:	2 or 5 mA (selectable)
4.	Alarm bandwidth:	Zero (0)
5.	Alarm hysteresis (on/off):	50 micro amperes
6.	Mode:	Single- or three-phase
7.	Monitor hazard current:	50 micro amperes
8.	Operating frequency:	50 or 60 Hz

D. The LIM shall alarm when the total hazard current reaches a value of 5 milliamperes. When the total hazard current is less than 5 milliamperes, a green light shall be illuminated indicating normal conditions. Should the total hazard current reach 5 milliamperes, a red light shall illuminate and a buzzer shall sound indicating alarm. A silence switch shall be provided to quite the buzzer, which, when operated shall cause an amber warning light to illuminate, indicating that the audible signal has been silenced. The LIM shall automatically reset to normal status when the fault condition is corrected. The LIM shall also detect and signal

an alarm if the ground connection to the LIM is broken. All lamps shall be long life LED type.

E. A momentary test switch shall be provided for periodic testing of the LIM circuitry. When presses, the test switch shall check and recalibrate the unit. The test switch shall also perform a complete test of all indicating lamps and meters on the face of the LIM and at any remote indicating stations. Test switches that require manual reset will not be acceptable.

F. In addition to the test switch recalibration, the LIM shall be capable of automatically checking its calibration and recalibrating itself to original performance specifications every 90 minutes. If internal components are more than 30% out of original specifications because of aging or failure, the LIM shall notify the user by displaying an error message.

G. The LIM shall contain both analog and digital indication of the isolated power system's hazard current. Digital indication shall be provided by a digital meter and the analog indication shall be graph type calibrated from 0 – 160% of the alarm setting of the LIM.

H. Provide an external set of normally open and normally closed dry contacts, rated 3 amperes at 120 volt for use with external alarm systems. The LIM shall also provide an output signal of sufficient capacity to power remote indicator alarm units. This output signal shall not increase the hazard current of the system being monitored.

I. The LIM shall incorporate a loss-of-ground feature which will activate the audible and visual alarms when connection is lost with the reference ground of the isolated power system being monitored. The unit shall also display an error code in the digital display.

J. The LIM shall be flush mounted on the front of the panel and flush mounted in a remote location as indicated on the drawings so that the LIM signals are clearly visible at all times. The LIM signals must not be obscured when the circuit breaker door is open.

2.5 MASTER REMOTE ANNUNCIATOR PANEL

A. The LIM in each isolated power panel, and three phase laser isolated power panel shall report to a Master Remote Annunciator panel.

B. Provide a master remote annunciator panel to provide centralized monitoring of all isolated power systems. The master remote annunciator panel shall be located at the nurses station.

C. The annunciator panel shall have one set of red, green and amber lights and a silence switch for each isolated power system. A buzzer shall provide audible annunciation of an alarm. The master remote annunciator shall be flush mounted. The lights shall mimic the lights on the associated line isolation monitor. The lights in the remote annunciator shall also mimic the lights on the LIM when the test switch on the LIM is depressed.

2.6 POWER AND GROUND OUTLETS

A. Provide a Power Module with 8300-R, duplex straight blade and 23000HG, twist lock power receptacles and ground jacks. Devices shall be flush mounted and located as indicated on the drawings. All receptacles shall be firmly attached with concealed fasteners that do not appear on the surface of the trim.

B. Provide Master Ground Module, located as indicated on the drawings. A copper ground bus with 24 terminals for wire sizes #14 AWG to #6 AWG and a #14 AWG to #1/0 AWG main lug shall be included.

2.7 LASER OUTLETS

A. Provide Laser Outlets to match the laser plug in locations as shown on the drawings mounted in an angular recessed compartment. The laser outlet shall include a plug control interface switch. A door over the recessed compartment shall conceal the receptacle when not in use. The laser outlet shall be flush mounted. The remote line isolation monitor signals, consisting of red and green indication lights, warning buzzer and silence switch, shall be incorporated into the front trim.

B. Provide a Plug in Control system for selective activation of each branch circuit so only those circuits with a laser machine plugged in will be energized. All other circuits will remain OFF. The system shall interface with the outlet module. A series of branch circuit contactors and relays shall be provided to control both the power and the line isolation monitor signals for each circuit.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Receive, inspect, handle, and store panelboards according to NECA 407.

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 WIRING

A. All components within the isolation panel shall be prewired using low leakage type XLP wire. A barriered compartment shall be provided for the incoming primary feeder and separation shall be maintained between grounded and ungrounded conductors. Terminal blocks shall be provided for connection of branch circuits and remote signal conductors.

B. All branch circuit conductors of the isolated power system shall be stranded copper having cross linked polyethylene insulation or equivalent with a dielectric constant of 3.5 or less. Type XLP is suitable for this purpose. Each branch circuit conductor shall be color coded in accordance with the National Electrical Code. Wire pulling compound produces an adverse effect upon the dielectric constant of conductor

insulation and shall not be used when pulling the wire of the isolated power system.

C. All wiring within isolation panels, remote accessories and field wiring installed by the Electrical Subcontractor shall be color-coded in compliance with the NEC and NFPA No. 99.

3.3 INSTALLATION

A. Install panelboards and accessories according to NECA 407.

B. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.

C. Comply with mounting and anchoring requirements specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

D. Mount top of trim 90 inches (2286 mm) above finished floor unless otherwise indicated.

E. 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.

F. Install overcurrent protective devices and controllers not already factory installed.
   1. Set field-adjustable, circuit-breaker trip ranges.

G. Install filler plates in unused spaces.

H. Stub four 1-inch empty conduits from recessed panelboards into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch empty conduits into raised floor space or below slab not on grade.

I. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.

J. Comply with NECA 1.

K. The Electrical Subcontractor shall ensure that no piping, ductwork or other equipment foreign to the electrical trade passes through the area extending from the floor to the structural ceiling with the width and depth equal to that of the electrical distribution equipment plus 6" on either side of panel.

L. All electrical equipment shall be installed such that the handle of the highest circuit breaker does not exceed 6’-6” above finished floor.

M. Electrical distribution equipment that is part of the emergency distribution system shall be located in spaces fully protected by an approved automatic fire suppression system or in spaces with a one (1) hour fire resistance rating.

N. The life safety branch, critical branch and equipment branch of the emergency electrical system shall be kept entirely independent of all other wiring, devices and equipment, and shall not enter the same raceways, boxes or cabinets with each other or other wiring, except where allowed by code.

3.4 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Division 26 Section "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 Division 26 Section "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 Division 26 Section "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Acceptance Testing Preparation:
   1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
   2. Test continuity of each circuit.

C. 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.
      b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each panelboard 11 months after date of Substantial Completion.
      c. Instruments and Equipment:
         1) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

D. Panelboards will be considered defective if they do not pass tests and inspections.

E. 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.

F. The factory technician shall check and record system leakage currents and shall simulate faults, on each system panel, of a magnitude high enough to bring the total system leakage, which the line isolation monitor detects, above the calibrated point, thus verifying correct operation of the LIM. The faults simulated shall be combinations of resistive and capacitive faults.

G. The factory technician shall check the resistance between the ground point of each receptacle and the reference point and ensure it is less than 0.1 ohms. The voltage potential difference between any exposed conductive surfaces in the patient vicinity shall be checked and shall be no more than 40 millivolts. Tests shall be per requirements in NFPA 99.

H. The technician shall also test the system impedance of the entire isolated power system to ensure compliance with the applicable sections of NFPA 99, chapter 4. The measured system impedance shall become part of the permanent logged records of each panel.

END OF SECTION

This page is intentionally left blank.

SECTION 26 27 26

WIRING DEVICES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:
1. Receptacles, receptacles with integral GFCI, and associated device plates.
2. Twist-locking receptacles.
3. Wall-box motion sensors.
4. Isolated-ground receptacles.
5. Hospital-grade receptacles.
6. Snap switches and wall-box dimmers.
7. Wall-switch and exterior occupancy sensors.
8. Floor service outlets, poke-through assemblies, service poles, and multioutlet assemblies.

1.3 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.

1.4 SUBMITTALS

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

B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.

C. Samples: One for each type of device and wall plate specified, in each color specified.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing label warnings and instruction manuals that include labeling conditions.

1.5 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of wiring device and associated wall plate through one source from a single manufacturer. Insofar as they are available, obtain all wiring devices and associated wall plates from a single manufacturer and one source.

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 NFPA 70.

1.6 COORDINATION

A. Receptacles for Owner-Furnished Equipment: Match plug configurations.
   1. Cord and Plug Sets: Match equipment requirements.

1.7 EXTRA MATERIALS

A. Furnish extra materials described in subparagraphs below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Poke-Through, Fire-Rated Closure Plugs: One for every five floor service outlets installed, but no fewer than two.
   2. Receptacles and switches: One for every 10 of each type installed, but no fewer ten two of each type.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers' Names: Shortened versions (shown in parentheses) of the following manufacturers' names are used in other Part 2 articles:
   1. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
   2. Leviton Mfg. Company Inc. (Leviton).
   3. Pass & Seymour/Legrand; Wiring Devices & Accessories (Pass & Seymour).

2.2 STRAIGHT BLADE RECEPTACLES

A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Hubbell; HBL5351 (single), CR5352 (duplex).
      b. Leviton; 5891 (single), 5352 (duplex).
      c. Pass & Seymour; 5381 (single), 5352 (duplex).

B. Hospital-Grade, Duplex Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498 Supplement SD. Critical branch circuit devices shall include Illumination.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Hubbell; HBL8310 (single), HBL8300H (duplex) IL (Illuminated) for OR Devices and Critical devices.
   b. Leviton; 8310 (single), 8300 (duplex).
   c. Pass & Seymour; 9301-HG (single), 9300-HG (duplex).

C. Tamper-Resistant Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Hubbell; HBL8300SG.
      b. Leviton; 8300-SGG.
      c. Pass & Seymour; 63H.
   2. Description: Labeled to comply with NFPA 70, "Health Care Facilities" Article, "Pediatric Locations" Section.

2.3 GFCI RECEPTACLES

A. General Description: Straight blade, non-feed-through type. Comply with NEMA WD 1, NEMA WD 6, UL 498, and UL 943, Class A, and include indicator light that is lighted when device is tripped.

B. Hospital-Grade, Duplex GFCI Convenience Receptacles, 125 V, 20 A: Comply with UL 498 Supplement SD.
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Hubbell; HGF8300.
      b. Leviton; 6898-HG.
      c. Pass & Seymour; 2091-SHG.

2.4 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. Available Products: Subject to compliance with requirements, products that may be incorporated into the Work include, but are not limited to, the following:
   2. Products: Subject to compliance with requirements, provide one of the following:
      a. Hubbell; HBL2310.
      b. Leviton; 2310.
      c. Pass & Seymour; L520-R.

2.5 TOGGLE SWITCHES

A. Comply with NEMA WD 1 and UL 20.

B. Switches, 120/277 V, 20 A:
   1. Products: Subject to compliance with requirements, provide one of the following:
      a. Hubbell; CS1221 (single pole), CS1222 (two pole), CS1223 (three way), CS1224 (four way).

b. Leviton; 1221-2 (single pole), 1222-2 (two pole), 1223-2 (three way), 1224-2 (four way).
c. Pass & Seymour; 20AC1 (single pole), 20AC2 (two pole), 20AC3 (three way), 20AC4 (four way).

C. Pilot Light Switches, 20 A:
1. Products: Subject to compliance with requirements, provide one of the following:
a. Hubbell; HPL1221PL for 120 V and 277 V.
b. Leviton; 1221-PLR for 120 V, 1221-7PLR for 277 V.
c. Pass & Seymour; PS20AC1-PLR for 120 V.
2. Description: Single pole, with neon-lighted handle, illuminated when switch is "ON."

D. Key-Operated Switches, 120/277 V, 20 A:
1. Products: Subject to compliance with requirements, provide one of the following:
a. Hubbell; HBL1221L.
b. Leviton; 1221-2L.
c. Pass & Seymour; PS20AC1-L.
2. Description: Single pole, with factory-supplied key in lieu of switch handle.

E. Single-Pole, Double-Throw, Momentary Contact, Center-Off Switches, 120/277 V, 20 A; for use with mechanically held lighting contactors.
1. Products: Subject to compliance with requirements, provide one of the following:
a. Hubbell; HBL1557.
b. Leviton; 1257.
c. Pass & Seymour; 1251.

2.6 WALL-BOX DIMMERS

A. Dimmer Switches: Modular, full-wave, solid-state units with integral, quiet on-off switches, with audible frequency and EMI/RFI suppression filters.

B. Control: Continuously adjustable slider; with single-pole or three-way switching. Comply with UL 1472.

C. Incandescent Lamp Dimmers: 120 V; control shall follow square-law dimming curve. On-off switch positions shall bypass dimmer module.
1. 600 W; dimmers shall require no derating when ganged with other devices. Illuminated when "OFF."

D. Fluorescent Lamp Dimmer Switches: Modular; compatible with dimmer ballasts; trim potentiometer to adjust low-end dimming; dimmer-ballast combination capable of consistent dimming with low end not greater than 20 percent of full brightness.

2.7 OCCUPANCY SENSORS

A. Wall-Switch Sensors:
1. Products: Subject to compliance with requirements, provide one of the manufacturers' as indicated on the legend.

2. Description: Dual technology, with both passive-infrared- and ultrasonic-type sensing, 120/277 V, adjustable time delay up to 30 minutes, 110-degree field of view, and a minimum coverage area of 1200 sq. ft. (111 sq. m).

2.8 WALL PLATES

A. Single and combination types to match corresponding wiring devices.
   1. Plate-Securing Screws: Metal with head color to match plate finish.
   2. Material for Finished Spaces: 0.035-inch- (1-mm-) thick, satin-finished stainless steel.
   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 locations."

B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with type 3R weather-resistant with rain tight while in use covers.

C. Coordinate colors and material with Architect.

2.9 FLOOR SERVICE FITTINGS

A. Type: Modular, flush-type, dual-service units suitable for wiring method used.

B. Compartments: Barrier separates power from voice and data communication cabling.

C. Service Plate: Rectangular and round, die-cast aluminum with satin finish.

D. Power Receptacle: NEMA WD 6 configuration 5-20R, gray finish, unless otherwise indicated.

E. Voice and Data Communication Outlet: Two modular, keyed, color-coded, RJ-45 Category 6e jacks for UTP cable. Coordinate with Telcom drawings and specifications.

F. Coordinate all finishes, materials and colors with architect.

2.10 POKE-THROUGH ASSEMBLIES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Hubbell Incorporated; Wiring Device-Kellems.
   2. Pass & Seymour/Legrand; Wiring Devices & Accessories.
   3. Wiremold Company (The).

B. Description: Factory-fabricated and -wired assembly of below-floor junction box with multichanneled, through-floor raceway/firestop unit and detachable matching floor service outlet assembly.
   1. Service Outlet Assembly: Flush type with four simplex receptacles and space for four RJ-45 jacks.
   2. Size: Selected to fit nominal 4-inch (100-mm) cored holes in floor and matched to floor thickness.
   3. Fire Rating: Unit is listed and labeled for fire rating of floor-ceiling assembly.
   4. Closure Plug: Arranged to close unused 4-inch (100-mm) cored openings and reestablish fire rating of floor.

5. Wiring Raceways and Compartments: For a minimum of four No. 12 AWG conductors and a minimum of four, 4-pair, Category 6e voice and data communication cables.

2.11 MULTIOUTLET ASSEMBLIES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Hubbell Incorporated; Wiring Device-Kellems.
   2. Wiremold Company (The).

B. Components of Assemblies: Products from a single manufacturer designed for use as a complete, matching assembly of raceways and receptacles.

C. Raceway Material: Aluminum.

D. Wire: No. 12 AWG.

2.12 FINISHES

A. Color: Wiring device catalog numbers in Section Text do not designate device color.
   1. Wiring Devices Connected to Normal Power System: As selected by Architect (White), unless otherwise indicated or required by NFPA 70 or device listing.
   2. Wiring Devices Connected to Emergency Power System: Red.
   3. TVSS Devices: Blue.
   4. Isolated-Ground Receptacles: Orange.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1, including the mounting heights listed in that standard, unless otherwise noted.

B. Coordination with Other Trades:
   1. Take steps to insure that devices and their boxes are protected. 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 the 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 just 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. Pigtailing existing conductors is permitted provided the outlet box is large enough.

D. Device Installation:

1. Replace all devices that have been in temporary use during construction or that show signs that they 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 (152 mm) in length.
5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, 2/3 to 3/4 of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by the 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. Receptacle Orientation:
1. Install ground pin of vertically mounted receptacles up, and on horizontally mounted receptacles to the right.
2. Install hospital-grade receptacles in patient-care areas with the ground pin or neutral blade at the top.

F. 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.

G. Dimmers:
1. Install dimmers within terms of their listing.
2. Verify that dimmers used for fan speed control are listed for that application.
3. Install unshared neutral conductors on line and load side of dimmers according to manufacturers' device listing conditions in the written instructions.

H. 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.

I. Adjust locations of floor service outlets and service poles to suit arrangement of partitions and furnishings.

3.2 IDENTIFICATION

A. Comply with Division 26 Section "Identification for Electrical Systems."
   1. Receptacles: Identify panelboard and circuit number from which served. Use hot, stamped or engraved machine printing with black-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.
   1. In healthcare facilities, prepare reports that comply with recommendations in NFPA 99.
   2. Test Instruments: Use instruments that comply with UL 1436.
   3. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated LED indicators of measurement.

B. 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 not acceptable.
   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. The 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.

C. Test straight blade hospital-grade convenience outlets for the retention force of the grounding blade according to NFPA 99. Retention force shall be not less than 4 oz. (115 g).

END OF SECTION

SECTION 26 28 16

ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
1. Fusible switches.
2. Molded-case circuit breakers (MCCBs).
3. Enclosures.

1.3 DEFINITIONS

A. NC: Normally closed.

B. NO: Normally open.

C. SPDT: Single pole, double throw.

1.4 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Enclosed switches and circuit breakers shall withstand the effects of earthquake motions determined according to so that 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."

1.5 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. Include evidence of NRTL listing for series rating of installed devices.
5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.
6. 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. Submit on translucent log-log graph paper.

B. Shop Drawings: For enclosed switches and circuit breakers. Include plans, elevations, sections, details, and attachments to other work.
   1. Wiring Diagrams: For power, signal, and control wiring.

C. Qualification Data: For qualified testing agency.

D. Seismic Qualification Certificates: For enclosed switches and circuit breakers, 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.

E. 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.

F. Manufacturer's field service report.

G. Operation and Maintenance Data: For enclosed switches and circuit breakers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
   1. Manufacturer's written instructions for testing and adjusting enclosed switches and circuit breakers.
   2. 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. Submit on translucent log-log graph paper.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.
   1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

B. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single source from single manufacturer.

C. Product Selection for Restricted Space: Drawings indicate maximum dimensions for enclosed switches and circuit breakers, including clearances between enclosures, and adjacent surfaces and other items. Comply with indicated maximum dimensions.

D. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

E. 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 (minus 30 deg C) and not exceeding 104 deg F (40 deg C).
   2. Altitude: Not exceeding 6600 feet (2010 m).

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.

1.9 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.
   2. Fuse Pullers: two for each size and type.

PART 2 - PRODUCTS

2.1 FUSIBLE SWITCHES

A. Basis-of-Design Product: Subject to compliance with requirements, provide or comparable product by one of the following:
   1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
   2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
   3. Siemens Energy & Automation, Inc.
   4. Square D; a brand of Schneider Electric.

B. Type HD, Heavy Duty, Single Throw, 600-V ac, 800 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate specified fuses, 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. Isolated Ground Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
   4. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
   5. Auxiliary Contact Kit: Two NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open.
   6. Hookstick Handle: Allows use of a hookstick to operate the handle.
   7. Lugs: Mechanical type, suitable for number, size, and conductor material.
   8. Service-Rated Switches: Labeled for use as service equipment.
   9. Accessory Control Power Voltage: Remote mounted and powered.

2.2 MOLDED-CASE CIRCUIT BREAKERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide or comparable product by one of the following:
   1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
   2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
   3. Siemens Energy & Automation, Inc.
   4. Square D; a brand of Schneider Electric.

B. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.

C. 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 250 A and larger.

D. Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.

E. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:
   1. Instantaneous trip.
   2. Long- and short-time pickup levels.
   3. Long- and short-time time adjustments.
   4. Ground-fault pickup level, time delay, and I^2t response.

F. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller, and let-through ratings less than NEMA FU 1, RK-5.

G. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker and trip activation on fuse opening or on opening of fuse compartment door.

H. Ground-Fault, Circuit-Interrupter (GFCI) Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).

I. Ground-Fault, Equipment-Protection (GFEP) Circuit Breakers: With Class B ground-fault protection (30-mA trip).

J. Features and Accessories:
   1. Standard frame sizes, trip ratings, and number of poles.
   2. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.
   3. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.
   4. Ground-Fault Protection: Comply with UL 1053; integrally mounted, self-powered type with mechanical ground-fault indicator; relay with adjustable pickup and time-delay settings, push-to-test feature, internal memory, and shunt trip unit; and three-phase, zero-sequence current transformer/sensor.
   5. Communication Capability: Integral communication module with functions and features compatible with power monitoring and control system, specified in Division 26 Section "Electrical Power Monitoring and Control."
   6. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.
   7. Undervoltage Trip: Set to operate at 35 to 75 percent of rated voltage without intentional time delay.

8. Auxiliary Contacts: Two SPDT switches with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.
9. Alarm Switch: One NC contact that operates only when circuit breaker has tripped.
10. Key Interlock Kit: Externally mounted to prohibit circuit-breaker operation; key shall be removable only when circuit breaker is in off position.
11. Electrical Operator: Provide remote control for on, off, and reset operations.
12. Accessory Control Power Voltage: 1 integrally mounted, self powered 120-V ac

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. Kitchen Wash-Down Areas: NEMA 250, Type 4X.
   4. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4.
   5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.
   6. Hazardous Areas: NEMA 250, Type 9.

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. Comply with mounting and anchoring requirements specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from enclosures and components.

D. Install fuses in fusible devices.

E. Comply with NECA 1.

3.3 IDENTIFICATION

A. Comply with requirements in Division 26 Section "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. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

B. Acceptance Testing Preparation:
   1. Test insulation resistance for each enclosed switch and circuit breaker, component, connecting supply, feeder, and control circuit.
   2. Test continuity of each circuit.
   3. Perform over current trip test for circuit breakers over 200 amps based on NEMA standards. The use of secondary injection for solid state trip devices shall be for trip settings of 200 amps up to 400A. Provide primary injection testing for trip settings over 400 amps.

C. 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 enclosed switch and circuit breaker. Remove front panels so joints and connections are accessible to portable scanner.
      b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each enclosed switch and circuit breaker 11 months after date of Substantial Completion.
      c. Instruments and Equipment: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
   4. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

D. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies enclosed switches and circuit breakers 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 components to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as specified in Division 26 Section "Overcurrent Protective Device Coordination Study".

END OF SECTION

SECTION 26 29 33

FIRE PUMP SERVICE ENTRANCE SWITCHBOARD

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Service and distribution switchboards rated 600 V and less.
2. Disconnecting and overcurrent protective devices.
3. Utility Metering.
4. Identification.
5. Mimic bus.

1.3 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Switchboards 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.

1.4 SUBMITTALS

A. Product Data: For each switchboard, overcurrent protective device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

B. Shop Drawings: For each switchboard and related equipment.

1. Include dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings.
2. Detail enclosure types for types other than NEMA 250, Type 1.
3. Detail bus configuration, current, and voltage ratings.
4. Detail short-circuit current rating of switchboards and overcurrent protective devices.

5. Include descriptive documentation of optional barriers specified for electrical insulation and isolation.
6. Include evidence of NRTL listing for series rating of installed devices.
7. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.
8. Include time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.
9. Include diagram and details of proposed mimic bus.
10. Include schematic and wiring diagrams for power, signal, and control wiring.

C. Samples: Representative portion of mimic bus with specified material and finish, for color selection.

D. Qualification Data: For qualified Installer.

E. Seismic Qualification Certificates: Submit certification that switchboards, overcurrent protective devices, accessories, and components will withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems." 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.

F. 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.

G. Operation and Maintenance Data: For switchboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Routine maintenance requirements for switchboards and all installed components.
2. Manufacturer's written instructions for testing and adjusting overcurrent protective devices.
3. Time-current coordination curves for each type and rating of overcurrent protective device included in switchboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: An employer of workers qualified as defined in NEMA PB 2.1 and trained in electrical safety as required by NFPA 70E.

B. Testing Agency Qualifications: Member company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Currently certified by NETA to supervise on-site testing.

C. Source Limitations: Obtain switchboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

D. Product Selection for Restricted Space: Drawings indicate maximum dimensions for switchboards including clearances between switchboards and adjacent surfaces and other items. Comply with indicated maximum dimensions.

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.

F. Comply with NEMA PB 2.

G. Comply with NFPA 70.

H. Comply with UL 891.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver switchboard in sections or lengths that can be moved past obstructions in delivery path.

B. Remove loose packing and flammable materials from inside switchboards and install temporary electric heating (250 W per section) to prevent condensation.

C. Handle and prepare switchboards for installation according to NEMA PB 2.1.

1.7 PROJECT CONDITIONS

A. Installation Pathway: Remove and replace access fencing, doors, lift-out panels, and structures to provide pathway for moving switchboards into place.

B. Environmental Limitations:

1. Do not deliver or install switchboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above switchboards 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 104 deg F.
   b. Altitude: Not exceeding 6600 feet.

C. Service Conditions: NEMA PB 2, usual service conditions, as follows:

1. Ambient temperatures within limits specified.
2. Altitude not exceeding 6600 feet.

1.8 COORDINATION

A. Coordinate layout and installation of switchboard 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.

B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.9 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace devices that fail in materials or workmanship within specified warranty period.

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

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

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 Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric.

B. Basis-of-Design Product: Subject to compliance with requirements, provide product indicated on Drawings or comparable product by one of the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric.

C. Fire pump service entrance switchboard shall be UL listed for use as service entrance equipment. The unit shall be floor mounted, free standing, front accessible totally enclosed, externally operable. Switchboard bus bracing shall be rated to exceed the available fault current or as a minimum 100kA symmetrical RMS at 240V and 65kA symmetrical at 600V.

D. Nominal System Voltage: 480Y/277 V

E. Main-Bus Continuous: As indicated.

F. Seismic Requirements: Fabricate and test switchboards according to IEEE 344 to withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

G. Indoor Enclosures: Steel, NEMA Type 1

H. Enclosure Finish for Indoor Units: Factory-applied finish in manufacturer's standard gray finish over a rust-inhibiting primer on treated metal surface.

I. Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.

J. Removable, Hinged Rear Doors and Compartment Covers: Secured by standard bolts, for access to rear interior of switchboard.

K. Hinged Front Panels: Allow access to circuit breaker, metering, accessory, and blank compartments.

L. Buses and Connections: Three phase, four wire unless otherwise indicated.

1. Phase- and Neutral-Bus Material: Hard-drawn copper of 98 percent conductivity, with tin-plated aluminum or copper feeder circuit-breaker line connections.
2. Phase- and Neutral-Bus Material: Tin-plated, high-strength, electrical-grade aluminum alloy with tin-plated aluminum circuit-breaker line connections.
3. Phase- and Neutral-Bus Material: Hard-drawn copper of 98 percent conductivity or tin-plated, high-strength, electrical-grade aluminum alloy.
4. Load Terminals: Insulated, rigidly braced, runback bus extensions, of same material as through buses, equipped with mechanical connectors for outgoing circuit conductors. Provide load terminals for future circuit-breaker positions at full-ampere rating of circuit-breaker position.
5. Ground Bus: Minimum-size required by UL 891, hard-drawn copper of 98 percent conductivity, equipped with mechanical connectors for feeder and branch-circuit ground conductors. For busway feeders, extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.

6. Main Phase Buses and Equipment Ground Buses: Uniform capacity for entire length of switchboard's main and distribution sections. Provide for future extensions from both ends.
7. Neutral Buses: 100 percent of the ampacity of phase buses unless otherwise indicated, equipped with mechanical connectors for outgoing circuit neutral cables. Brace bus extensions for busway feeder neutral bus.
8. Isolation Barrier Access Provisions: Permit checking of bus-bolt tightness.

M. Bus-Bar Insulation: Factory-applied, flame-retardant, tape wrapping of individual bus bars or flame-retardant, spray-applied insulation. Minimum insulation temperature rating of 105 deg C.

N. Provide line and load side lugs/adapters of appropriate size to accommodate the service entrance conductors and load side feeder conductors shown on the drawings.

2.2 MAIN OVERCURRENT PROTECTIVE DEVICE

A. The switchboard shall contain one instantaneous magnetic trip only molded case circuit breaker with available interrupting current rating that meets the switchboard assembly UL listed integrated short circuit rating. The circuit breaker shall have and instantaneous trip rating to carry indefinitely the sum of the locked rotor current of the fire pump motor, pressure maintenance pump motor and full load current of any additional electric fire pump related accessory connected to this service.

B. Auxiliary Contacts: For interlocking or remote indication of circuit-breaker position, with spare auxiliary switches and other auxiliary switches required for normal circuit-breaker operation, quantity as indicated. Each consists of two Type "a" and two Type "b" stages (contacts) wired through secondary disconnect devices to a terminal block in stationary housing.

2.3 IDENTIFICATION

A. Mimic Bus: Entire single-line switchboard bus work, as depicted on factory record drawing, on a photoengraved nameplate.

1. Nameplate: At least 0.032-inch-thick anodized aluminum, located at eye level on front cover of the switchboard incoming service section.

B. Mimic Bus: Entire single-line switchboard bus work, as depicted on factory record drawing, on an engraved laminated-plastic (Gravoply) nameplate.

1. Nameplate: At least 0.0625-inch-thick laminated plastic (Gravoply), located at eye level on front cover of the switchboard incoming service section.

C. Mimic Bus: Continuously integrated mimic bus factory applied to front of switchboard. Arrange in single-line diagram format, using symbols and letter designations consistent with final mimic-bus diagram.

D. Coordinate mimic-bus segments with devices in switchboard sections to which they are applied. Produce a concise visual presentation of principal switchboard components and connections.

E. Presentation Media: Painted graphics in color contrasting with background color to represent bus and components, complete with lettered designations.

F. Service Equipment Label: NRTL labeled for use as service equipment for switchboards with one or more service disconnecting and overcurrent protective devices.

G. The enclosure shall include a laminated 3/32 inch thick plastic nameplate 4 inches high by 8 inched long with white engraved lettering on a red background indicating the text, “FIRE PUMP DISCONNECTING MEANS”, in minimum 1 inch high lettering. The nameplate shall be fastened by four self-tapping stainless steel screws

PART 3 - EXECUTION

3.1 EXAMINATION

A. Receive, inspect, handle, and store switchboards according to NEMA PB 2.1.

B. Examine switchboard before installation. Reject switchboards that are moisture damaged or physically damaged.

C. Examine elements and surfaces to receive switchboards 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 switchboards and accessories according to NEMA PB 2.1.

B. Equipment Mounting: Install switchboards on concrete base, 4-inch nominal thickness.

1. 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.
2. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
4. Install anchor bolts to elevations required for proper attachment to switchboards.

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from switchboard units and components.

D. Comply with mounting and anchoring requirements specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

E. Operating Instructions: Frame and mount the printed basic operating instructions for switchboards, including control and key interlocking sequences and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of switchboards.

F. Electric fire pump service entrance conductors shall be routed outside the building to a point nearest the fire pump room or main service electrical room. Once inside the building and outside the main service electrical room or fire pump room, fire pump service entrance conductors and feeder conductors shall be in rigid steel conduit enclosed within a 2 hour fire resistive rated assembly or MI cable if approved for use within the building as 2 hour fire rated protection by the local authority having jurisdiction. Electric fire pump and pressure maintenance pump feeder conductors and control conductors within the fire pump room shall be in threaded rigid steel conduit

G. Install spare-fuse cabinet.

H. Comply with NECA 1.

3.3 CONNECTIONS

A. Comply with requirements for terminating feeder bus specified in Division 26 Section "Enclosed Bus Assemblies." Drawings indicate general arrangement of bus, fittings, and specialties.

B. Comply with requirements for terminating cable trays specified in Division 26 Section "Cable Trays for Electrical Systems." Drawings indicate general arrangement of cable trays, fittings, and specialties.

3.4 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

B. Switchboard Nameplates: Label each switchboard compartment with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

C. Device Nameplates: Label each disconnecting and overcurrent protective device and each meter and control device mounted in compartment doors with a

nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.5 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections.

C. 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.

D. Acceptance Testing Preparation:

1. Test insulation resistance for each switchboard bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

E. 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 switchboard. Remove front and rear panels so joints and connections are accessible to portable scanner.
b. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switchboard 11 months after date of Substantial Completion.
c. Instruments and Equipment:

1.) Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

4. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

F. Switchboard will be considered defective if it does not pass tests and inspections.

G. Prepare test and inspection reports, including a certified report that identifies switchboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.6 ADJUSTING

A. Adjust moving parts and operable components to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as specified in Division 26 Section "Overcurrent Protective Device Coordination Study."]

3.7 PROTECTION

A. Temporary Heating: Apply temporary heat, to maintain temperature according to manufacturer's written instructions, until switchboard is ready to be energized and placed into service.

3.8 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain switchboards, overcurrent protective devices, instrumentation, and accessories.

END OF SECTION

SECTION 26 33 53

CENTRAL UPS SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. This specification describes a 500 kVA, 550 kW, 480 volt input, 480 volt output, 3-phase, 3-wire on-line three-phase continuous duty, an on-line, solid-state, uninterruptible power system, hereinafter referred to as the UPS. The UPS System design for the medical equipment is based on CPN Power, Inc., a provider of UPS Systems for Diagnostic Imaging applications. CPN Power can be contacted at (800) 491-1210. The UPS shall operate utilizing the power distribution system to provide high quality power designed to meet the critical requirements of medical equipment loads. Medical equipment loads have large momentary inrush requirements along with large non-linear load profiles. The UPS shall operate utilizing the existing power distribution system to provide a high quality, reserve source of power to electronic equipment loads. The system shall consist of a converter, system battery, solid-state inverter, automatic static bypass transfer circuit, (optional) external isolation transformer, and external maintenance bypass.

B. All ~~acceptable~~ equal approved bidders must provide a UPS system designed to meet the demanding power requirements for medical equipment: maintain ±1% voltage regulation during all peak current conditions within the 100% rating of the UPS module and ±2% voltage regulation within the 150% overload capability; and provide 96.3% full load UPS module efficiency; 95.1% efficiency @ 25% load while in the on-line double conversion operating mode.

C. The UPS System must be able to support medical imaging equipment. Medical equipment loads have tremendous non-linear load profiles and large, momentary inrush peaks, produced by the firing or switching of one or several X-Ray generators, gradient amplifiers, Klystrons, Magnetrons, or other components. Large, momentary inrush peaks along with the continuous operation base load across multiple suites is referred to as Multi-Modality Peak Current (MMPC). The UPS System must be able to support MMPC or any peak current state under the following conditions:

1. The UPS system must be capable of maintaining ±1% voltage regulation during events where a base load exists along with MMPC demands being in coincidence. This ±1% voltage regulation exceeds the following medical equipment vendor requirements:

   a. Voltage tolerance requirement of ±2-3% for Cath, EP, Angio, IR, Vascular, and Special Procedure Labs at generator peak current output
   b. Voltage tolerance requirement of ±4-5% for other Diagnostic Imaging and Linear Accelerator applications
   c. Phase balance requirement of ±2% for all medical equipment applications

2. The UPS module must operate without drawing current from the DC plant during MMPC or normal peak conditions. This situation causes over-cycling of

the DC plant due to normal peak momentary conditions for medical equipment applications. Improper UPS system design can lead to dramatically reduced battery life due to over-cycling. This type of UPS topology is not acceptable for medical equipment applications.

3. The UPS must operate without transferring to static bypass during MMPC or normal peak momentary conditions. Transferring to static bypass as a result of MMPC or normal peak conditions allows power anomalies to be passed onto the medical equipment loads. Being on static bypass also places these systems at risk of a power failure. The UPS system does not protect against power outages or deep sag conditions while operating on static bypass.

D. The UPS module shall be true, on-line double conversion type to reduce accumulative component damage and shall consist of a CSTBT rectifier, CSTBT charging circuit, CSTBT inverter, automatic static bypass transfer circuit sized to provide fault clearing, LCD touchscreen interface, and a Modbus TCP/IP interface for monitoring the UPS system via the building management system. The complete system shall also include one (1) 500 kVA 480D-277Y/480 dry-type isolation transformer, two (2) Battery Cabinets, one (1) Battery Monitoring System, one (1) Maintenance Bypass Cabinet, and one (1) Remote Status Alarm Panel . The UPS module shall achieve these operational requirements through the use of:

1. CSTBT Rectifier and Charger circuit design operating at 7.2 kHz
2. CSTBT Inverter design operating at 7.2 kHz
3. Unique Major Voltage and Minor Current Feed Forward Control Loops, enabling instantaneous control of UPS Module output
4. Field Programmable Gate Array (FPGA) for Current Minor Loop Control
5. Digital Signal Processor (DSP) based control for Feed Forward Control and Voltage Major Loop Control
6. DSP and Application Specified IC (ASIC) shall provide advanced controllability and simplify the control circuit. Direct Digital Control (DDC) utilizing DSP and ASIC ensures high reliability, as well as superior functionality and performance
7. DSP Sine wave sampling rate of 1000 times per cycle or greater allowing for the level of control required to achieve the ±1% voltage regulation
8. Active mitigation of reflected input harmonics
9. Active control of output voltage distortion

1.2 STANDARD

A. The UPS has been designed in accordance with and complies with the following standards:

1. UL 1778 (Underwriter Laboratories) Standard for UPS Equipment.
2. CSA 22.2 (Canadian Standards Association – cUL Equipment).
3. IEC (International Electro-technical Commission) Semiconductor Converter Standards.
4. EMI compatibility: FCC Title 47, Part 15, Subpart B
5. IEEE 587, ANSI C62.41 1991 Standard for Surge Withstand Ability.
6. ISO 9001 Quality Assurance program.

1.3 SYSTEM DESCRIPTION

A. Components

1. The UPS system shall consist of the following major equipment:

   a. UPS Module.

      1) Insulated Gate Bipolar Transistor (IGBT) Converter.
      2) Insulated Gate Bipolar Transistor (IGBT) Inverter.
      3) Digital Signal Processor (DSP) using Pulse Width Modulation (PWM) for Direct Digital Control (DDC) of all UPS control and monitoring functions.
      4) Static bypass switch sized to provide fault clearing.

   b. Battery systems with internal breaker
   c. Battery Monitoring System
   d. External Maintenance bypass
   e. Monitoring via Modbus TCP interface
   f. (Optional) External isolation transformer

B. Mode of Operation

1. The UPS shall be designed to operate continuously at rated capacity as an on-line, automatic reverse transfer system in the following modes:

   a. Normal - The inverter continuously supplies AC power to the critical load. The converter converts a utility AC power source to regulated DC power which then serves as the inverter input and, simultaneously, as a float charge input to the storage battery.
   b. Emergency - In the event of a utility AC power failure, the inverter shall derive its input from the system battery, therefore providing uninterrupted power to the critical load. This transition shall be accomplished without any switching or coupling, and with no interruption of power to the critical load from either a failure or restoration of the utility AC power.
   c. Recharge - Subsequent to restoration of utility AC power, the converter shall automatically reactivate and provide DC power to the inverter, simultaneously recharging the system battery. This occurs automatically and without interruption to the critical load.
   d. Bypass - In the event that the UPS must be taken off line due to an overload condition or UPS failure, the critical load shall be transferred to the bypass source via the static switch without interruption of AC power to the critical load. A paralleling, wrap-around contactor shall be used to maintain the bypass source. The static switch shall only be utilized for automatic emergency transfers. A re-transfer from bypass to inverter shall be performed automatically in overload conditions. A re-transfer shall be inhibited if satisfactory synchronization of the inverter and bypass is not accomplished. The use of the static switch shall not be required during the manual or automatic re-transfer process, therefore increasing reliability.

1.4 SUBMITTALS

A. Proposal Submittals

1. Submittals with the proposal shall include:

   a. System configuration with single-line drawings.
   b. Functional relationship of equipment including weights, dimensions, and heat dissipation.
   c. Descriptions of equipment to be furnished, including deviations from these specifications.
   d. Size and weight of shipping units to be handled by installing contractors.
   e. Detailed layout of customer power and control connections.
   f. Detailed installation drawings including all terminal locations.

B. Delivery Submittals

1. Submittals upon UPS delivery shall include:

   a. Shop Drawings.

      1) Submit system configurations with single-line diagrams, detailed layout of power and control connections, dimensional data and detailed installation drawings including all terminal locations.

   b. Product Data.

      1) Provide product data for UPS and battery including catalog sheets and technical data sheets to indicate electrical performance, UPS type, battery type, detailed equipment outlines, weight, dimensions, control and external wiring requirements, heat rejection and air flow requirements.

   c. Owner's and Technical Manual (1).
   d. Test Report.

      1) Submit a copy of factory and field test reports.

1.5 ENVIRONMENTAL CONDITIONS

A. The UPS shall be capable of withstanding any combination of the following external environment conditions without mechanical damage, electrical failure or degradation of operating characteristics.

1. Operating ambient temperature: 0°C to +25°C (32°F to 77°F) no de-rating required
2. Battery Operating ambient temperature: -20°C to +40°C (-4°F to 104°F)
3. Recommended operating temperature range: +15°C to +25°C (59°F to 77° F).
4. Operating relative humidity: 5% to 95%, non-condensing.
5. Recommended operating relative humidity: 30 % to 90%.
6. Operating altitude: Sea level to 2250 meter (7400ft).
7. There should be no inflammable / explosive gas.

8. Dust in the room where the UPS is installed must not exceed normal atmospheric dust levels. In particular, that dust should not include iron particles, oils or fats, or organic materials such as silicone.

B. Audible acoustical noise: Noise generated by the UPS, when operating under full rated load, at a distance of one meter from any UPS operator surface, shall not exceed 73dB as measured on the A scale of a standard sound level meter at slow response.

C. Input surge withstand capability: The UPS shall be in compliance with IEEE C62.41, Category B.

D. The 500 kVA UPS heat rejection at full load shall be 67,500 BTU/Hr Sensible and 31,800 BTU/Hr Sensible at 50% load. When applying the UPS for Diagnostic Imaging applications, the AC unit(s) could be sized to meet the 50% load requirement of the UPS, plus any other heat loads in the space, and any other heat gains through the walls or ceiling. The output transformer heat rejection will be described later in this specification.

1.6 WARRANTY

A. The UPS manufacture shall warrant to the original end user that the Uninterruptible Power Supply System (the "Product") shall be free from defects in material and workmanship under normal use and service for a period of thirty-six (36) months from the date of installation or forty-two (42) months from the date of shipment of the Product, whichever comes first, at the premises of the original end user.

1.7 QUALITY ASSURANCE

A. Reliability

1. The UPS equipment reliability shall be represented in terms of theoretical Mean-Time-Between-Failures (MTBF). The UPS manufacturer shall, as a minimum, provide the following capability:

a. Total single module UPS system output (includes reliability of bypass circuit):

1) 2,600,000 MTBF hours.

b. Single module UPS operation (represents UPS module operation only):

1) 100,000 MTBF hours.

B. Maintainability

1. MTTR of the UPS shall not exceed four (4) hours including time to replace components.

C. Factory Test

1. The manufacturer shall fully and completely test the system to assure compliance with the specifications, before shipment.
2. All UPS units shall come equipped with one (1) factory test report included in the UPS enclosure. The factory test report shall include the following:

   a. Series / kVA
   b. Serial number
   c. Date of test
   d. Approved by / Inspected by / Tested by
   e. Inspection of construction
   f. Checking of wiring (Black/Red marking on each connection point)
   g. Grounding continuity
   h. Insulation strength test
   i. Control circuit operation
   j. Measurement of steady state characteristics (Voltage/ current/ efficiencies)
   k. Transient characteristics (0-100% step load, AC input failure)
   l. Overload testing
   m. Transfer switch operation

PART 2 - PRODUCT

2.1 ELECTRIC CHARACTERISTICS

A. The UPS shall have the following electrical characteristics:

B. UPS Output Capacity and Dimensions

kVA	kW	UPS Module Dimensions
500	500	106.9”W x 32.7”D x 80.6”H

1. UPS Module output capacities are in accordance with 1.0 pf lagging.

C. Battery Capacity

1. Discharge time to end voltage: 8 minutes at 337.5 kW / 375 kVA, 0.9 load output pf, 25°C (77°F) with the two (2) Battery Cabinets noted in this specification.

D. AC Input

1. Nominal input voltage: 480V.
2. Number of phase: 3 phase, 3 wire, plus parity sized ground.
3. Voltage range: +15%, -20%. (-30% under 50% loading conditions)
4. Frequency and range: 60Hz ±10%.
5. Power walk-in time: Default set at 10 seconds (0% to 100% load).
6. Power factor:

   a. 0.99 typical at 100% load.

b. 0.99 typical at 50% load.

7. Reflected input current total harmonic distortion (THD):

a. 3% typical at 100% load.
b. 5% typical at 50% load.

E. Bypass Input

1. Nominal input voltage: 480V.
2. Number of phase: 3-phase, 3-wire.
3. Synchronization voltage range: ±10% of nominal.
4. Frequency tracking range: 60Hz ±5% Maximum.

a. (Bypass synchronous range shall be selectable from 1% to 5% in 0.1% increments)

F. AC Output

1. Nominal output voltage: 480V.
2. Number of phase: 3-phase, 3-wire, plus ground.
3. Nominal dynamic Voltage regulation:

a. ±1% for balanced load.
b. ±1% for unbalanced load.

4. Voltage balance: 1%
5. Manually adjustable output voltage: ±5% range.
6. Voltage transient response:

a. 100% step load: ±1%.
b. 150% step load: +2%
c. Loss or return of AC input: ±1%.
d. Retransfer from bypass to inverter: ±3%

1) (Voltage transient response shall not exceed the above and shall recover to within nominal voltage regulation tolerance within 20 msec.)

7. Frequency (inverter synchronous): 60 Hz (tracks frequency of static bypass source).
8. Free running output frequency (asynchronous): 60 Hz ±0.01%.
9. Frequency slew rate (inverter synchronized to static bypass): 1 to 5Hz/second (selectable).
10. Output voltage harmonic distortion:

a. 2% maximum at 100% linear load.
b. 5% maximum at 100% non-linear load.

1) (Load power factor range of 0.9 lagging to 1.0 within kW rating of UPS. Crest factor 2.3)

11. Voltage phase angle displacement:

    a. ±1 degree for 100% balanced load.
    b. ±3 degree for 100% unbalanced load.

12. Overload capability:

    a. 105% to 125% for 10 minutes (±2% Voltage regulation maintained).
    b. 126% to 150% for 1 minute (±2% Voltage regulation maintained).
    c. Fault clearing: Typically 1000% for 1 cycle (utilizing bypass source).

G. DC Input and Battery

1. Voltage: 480V DC nominal, 400V DC minimum.
2. Voltage ripple (normal operation): less than 10% of the battery AH at DC/DC chopper circuit switching frequency.

    a. The battery system shall be sized to provide the specified back-up time to the inverter when the UPS is supplying 100% rated load.
    b. The battery system shall be capable of operating in an average ambient temperature of 25°C, with short-term excursions of 16°C to 32°C and shall be sized as follows:

        1) Float Voltage: 545V DC (2.25 to 2.27 V/cell)
        2) Final Voltage: 400V DC (1.67 V/cell)

H. Efficiency while operating in on-line double conversion mode

UPS Module Capacity (kVA)	AC to AC			
	100%	75%	50%	25%
500	96.3	96.3	96.0	95.1

1. The UPS supplier shall provide UL certification of efficiency. If UL certification is not available, the UPS vendor shall demonstrate the efficiency with an on-site load bank test. Resistive load banks shall be of the size and type capable of demonstrating the efficiency at 100%, 75%, and 50% of the full load kW rating of the unit. If the UPS fails to meet the specified efficiency, the vendor shall modify the UPS to meet the efficiency or refund to the Owner a dollar value equal to the present value of 10 years of additional operating costs as determined by the Engineer.

2.2 COMPONENTS

A. UPS module shall be comprised of the following:

B. Converter Section:

1. AC input, converter input contactor, input harmonic filter, and converter utilizing:

2. IGBT Converter

a. General

1) The Converter shall convert the incoming AC power into regulated DC power to supply the inverter input and system battery. The Converter shall utilize the following technologies:

a) Solid state Pulse Width Modulation (PWM) controlled Insulated Gate Bipolar Transistors (IGBT).
b) Input Power: Rated kVA at 1:1 ratio.
c) DSP based control logic.

b. Reflected Harmonic Content

1) The IGBT converter shall typically not introduce more than 3% reflected input current total harmonic distortion (THD) into the utility AC input source at nominal voltage and rated load. The reflected input current shall typically not exceed 5% THD at 50% load.

c. Automatic Input Power Walk-in

1) The converter logic and control circuit power walk in function enables delayed and timed ramping of input current. Subsequent to energizing the converter input, initiation of the power walk in function and current ramping shall be delayed by a maximum of 3600 seconds. Upon initiation of the power walk-in function, the ramping of current shall be timed to gradually increase the load within 10 seconds. This function is included as standard in the converter control circuitry.

d. Input Overcurrent Protection

1) Converter input contactor, and the input current limit control shall provide converter protection against excessive input overload conditions.

e. Step Load Change Operation (0-100%)

1) In the occurrence of a 100% step load change, the UPS Module inverter shall draw power only from the converter to provide the required load demand. The system battery will not be cycled at any time during a step load change.

f. Input Current Limit

1) The Converter logic shall provide input current limiting by limiting the AC input current. Three (3) line-side current transformers shall be employed as a means of sensing the current amplitude. The DC output current limit values are as follows:

a) Input current limit setting: 110% of nominal rated current.
b) The AC input current limit shall be set up so that the converter can provide sufficient capacity to the inverter at rated load and have the capability to recharge a discharged battery.
c) The input current limit protects converter components from damage due to excessive input current.

g. Input Power Demand

1) The Converter logic and control shall also be capable of providing auxiliary current limiting when initiated by an external dry contact closure (e.g. in the event power demand is required when the UPS is fed from a generator).
2) Power Demand: Adjustable, maximum 110% of nominal rated current.

3. Charger/Booster

a. General

1) The charger/booster utilizes solid state Pulse Width Modulation (PWM) controlled Insulated Gate Bipolar Transistors (IGBT).

b. Charge Current Limit

1) The converter logic and control circuit DC charge current limiting function enables controlled DC charging. The DC charge current limit will control the recharge current by reducing the converter output when the set limit is reached. The following DC charge current limit shall be provided as a minimum:

a) DC charge current limit: 10% of battery Ah rate.
b) Maximum charge current: 20% ampere of UPS rated kVA.

c. Equalize Charge Timer

1) UPS Module logic and control shall provide an electronic equalize charge timer function (0 to 100hour selectable - default twenty-four (24) hour). Once activated the timer circuit shall provide a high rate equalizing charge voltage to the system battery for the selected time. The function can be manually activated and de-activated via the UPS Module LCD. The level of equalizing voltage shall be equal to that stated by the battery. Upon completion of the timer count, the converter output voltage shall return to the specified float voltage (typically 2.25 to 2.27 VDC/cell). An Auto Equalize charge operation is also provided following AC input restoration and subsequent to the power walk-in function. This equalizing charge will occur until the target voltage is reached (condition is met to end equalizing charge), in which float voltage will be applied.

d. Temperature Control Battery Charging

1) The UPS shall have as standard a temperature compensation function allowing the converter voltage to fold-back to a safe value in the event the battery system temperature reaches a pre-determined (dangerous) level. Initiation will be by dry contact input from thermocouple sensor (User supplied)

e. DC Input Protection

1) The DC input circuit shall be protected by a DC circuit breaker. The DC circuit breaker allows complete interruption of DC current and isolation of the UPS Module DC input and the battery system.
2) The DC Circuit breaker shall incorporate an UVR and auxiliary contact connections to the UPS Module control for prevention of incorrect start-up and shutdown sequencing.
3) The DC Circuit Breaker shall be provided as standard equipment.

f. Ripple Voltage

1) The DC bus RMS ripple current shall be less than 10% of the battery AH at DC/DC chopper circuit switching frequency at 133% load.

g. Battery Self-Test

1) For a short duration, a small power discharge from the battery is automatically performed. The UPS module, from this small power discharge, evaluates the degradation of the system battery. The following advantages are achieved:

a) The Battery Self-Test function can be performed even when load is on inverter.
b) Due to the short duration small power discharge, there is no effect to battery life expectancy.
c) The small power discharge has negligible effect on the overall battery backup time. The small power that is discharged will quickly be replenished.

2) The Battery Self-Test will occur automatically every 720-hour interval. An event alarm will occur and be displayed if battery abnormalities are detected.

C. Inverter

1. General

a. The inverter shall generate AC power derived from DC power supplied from the converter or system battery. The inverter shall be capable of providing rated output as specified while operating from any DC voltage within the battery operating range. The inverter shall utilize the following technology:

1) Solid state PWM controlled IGBT power transistors.
2) UPS Module Full Direct Digital Control (DDC) Adoption:

a) Field Programmable Gate Array (FPGA) Control.
b) DSP based Control

2. Voltage Regulation

a. The inverter output voltage shall not deviate by more than ±1% RMS with the following steady state conditions:

1) 0 to 100% loading.
2) Inverter DC input varies from maximum to minimum.
3) Environmental condition variations within the specifications defined herein.

3. Voltage Adjustments

a. The inverter shall have the ability to manually control and adjust the output voltage to within ±3% of the nominal value.

4. Voltage Transient Response

a. The dynamic regulation and transient response shall not exceed ±1% for 100% step load (applied or removed), ±1% for loss or return of AC input and ±3% for inverter to bypass and vice versa transfer.

5. Transient Recovery

a. Voltage transient response shall not exceed the above specification and shall recover to within nominal voltage regulation tolerance within 20 ms

6. Frequency Control

a. The Inverter output frequency shall be controlled by an oscillator internal to the UPS module logic. It shall be capable of synchronizing to an external reference (e.g. the bypass source) or operating asynchronously. A message located on the touch screen shall identify the loss of synchronization. Synchronization shall be maintained at 60 Hz ± 0.01% continuously for the duration of loss of the external reference. The Inverter output frequency shall not vary during steady state or transient operation due to the following conditions:

1) 0 to 100% loading.
2) Inverter DC input varies from maximum to minimum.
3) Environmental condition variations within the specifications defined herein.

7. Output Voltage Harmonic Distortion

a. The inverter output shall limit the amount of harmonic content to 2% maximum at 100% linear load, and 5% maximum at 100% non-linear load. The need for additional filtering to limit the harmonic content shall not be required. Therefore high efficiency, reliability and original equipment footprint are maintained.

8. Output Overload Capability

    a. The inverter output shall be capable of providing an overload current while maintaining rated output voltage (and voltage regulation) to:
    b. 105% to 125% for 10 minutes duration
    c. 126% to 150% for 1 minute duration
    d. The UPS Module Operation/Display panel LED indication will illuminate to identify an overload condition. If the time limit associated with the overload condition expires or the overload is in excess of the set current, the load power shall be transferred to the bypass source without interruption.

9. Inverter Current Limit

    a. The inverter output current shall be limited to 230% of rated load current. Two current transformers in separate locations on the output (and operating separately offering redundancy) shall be employed as means of current sensing.
    b. The inverter current limit protects inverter components from damage due to excessive over-current (Excessive load, faults and reverse current)

10. Inverter Output Isolate

    a. The inverter output contactor isolates the inverter from the load and bypass source.

D. UPS Module Control and Monitoring

1. UPS Module Control and Monitoring operates and controls the converter, inverter and independent automatic bypass static switch circuit
2. The UPS Module control circuitry utilizes Digital Signal Processor (DSP) and Application Specified IC (ASIC) which create advanced controllability and simplify the control circuit. Direct Digital Control (DDC) utilizing DSP and ASIC ensures high reliability, as well as superior functionality and performance.
3. All UPS Module Control and Monitoring printed circuit boards shall be effectively sealed to protect against corrosive vapors.
4. The UPS Module Control power supply employs a redundant design configuration, utilizing the UPS AC input (utility), Bypass input and the UPS Module inverter output therefore enhancing reliability.

E. Bypass and Static Switch

1. UPS module contains an automatic bypass static switch circuit and associated bypass static switch transfer control circuitry.
2. General

    a. A bypass circuit shall be provided as an alternate source of power other than the inverter. A high speed Thyristor switch and wrap-around contactor shall be used to assume the critical load during automatic transfers to the bypass circuit. The wrap-around contactor shall be electrically connected in parallel to the static switch and shall, at the same time as the static switch, be energized and upon closure maintain the

critical load feed from the bypass source. The static switch shall only be utilized for the time needed to energize the wrap-around contactor therefore increasing reliability. The bypass circuit shall be capable of supplying the UPS rated load current and also provide fault clearing current capabilities. The UPS system logic shall employ sensing which shall cause the static switch to energize within 150 microseconds therefore providing an uninterrupted transfer to the bypass source when any of the following limitations are exceeded:

1) Inverter output undervoltage or overvoltage.
2) Overloads beyond the capability of the inverter.
3) DC circuit undervoltage or overvoltage.
4) Final voltage of battery system is reached (bypass source present and available).
5) System failure (e.g.: logic fail, fuse blown, etc.).

3. Automatic Re-transfers

a. In the event that the critical load must be transferred to the bypass source due to an overload, the UPS system logic shall monitor the overload condition and, upon the overload being cleared, perform an automatic re-transfer back to the inverter output. The UPS system logic shall only allow a re-transfer to occur three times within a five minute period. Re-transfers shall be inhibited on the fourth transfer due to the likelihood of a recurring problem at the UPS load distribution. All retransfers will be inhibited if the inverter and static bypass line are not synchronized.

4. Manual Transfers

a. The UPS shall be capable of transferring the critical load to/from the bypass source via the front control panel. If performing manual retransfers to inverter or automatic retransfers, the UPS system logic shall force the inverter output voltage to match the bypass input voltage and then parallel the inverter and bypass sources providing a make-before-break transition allowing a controlled walk-in of load current to the inverter. Manual transfers will be inhibited if the inverter and static bypass line are not synchronized.

5. Static Switch

a. The static switch shall be a high speed transfer device comprised of naturally commutated Thyristors. During manual transfers the static switch is not required. The static switch shall not use fuses for protection.

F. Operation/Display Panel

1. The control panel shall employ the use of a 5.7” touch screen interface which allows lock-out of all UPS control function for security (The Emergency Power Off function shall not be locked out). The operator interface shall provide the following:

a. UPS start-up procedure

b. UPS shutdown procedure
c. Emergency Power Off (EPO)
d. Audible alarm silence
e. System status levels

2. The UPS module shall be provided with a control/indicator panel. The panel shall be on the front of the UPS module. Controls, meters, alarms and indicators for operation of the UPS module shall be on this panel.
3. Graphic Operator Terminal 5.7" Liquid Crystal Display (LCD):

a. The LCD touch screen interfaces with the UPS Module Control and main processor board to provide menu-driven operator instructions and UPS Module operation details. The LCD indicates system operation, operational guidance, measurement data, set up data and alarm messages and logs. All metering shall be digitally displayed on the LCD having an accuracy of 1% or better.
b. The touch screen area is composed of four MENU sheets: MAIN, MEASUREMENT, OPERATION, and STATUS. Each MENU sheet has a name tab at the top and the four name tabs form an overlap index at the top of the screen area. Touching the name tab of any of the MENU sheets at this index will make that specific MENU be displayed. Each MENU sheet displays specific information and includes touch icons that perform MENU related functions.

1) MAIN MENU Sheet: The MAIN MENU indicates power flow and measured values. The LCD panel allows the user to verify the status and operation of the UPS Module components by the mimic display. The following information is available on the MAIN MENU Sheet:

a) Converter operation
b) Battery operation
c) Load on inverter
d) Load on bypass
e) Typical measurement values of Input, Bypass, Battery and Output
f) Alarm/Fault messages

2) MEASUREMENT MENU Sheet: The MEASUREMENT MENU indicates measured values. The following information is available on the MEASUREMENT MENU Sheet:

a) Display information:
b) Input Voltage and Frequency
c) Bypass Voltage and Frequency
d) Battery Voltage and Charging/Discharging Current
e) Output Voltage, Frequency and Current
f) Output active power
g) Output power factor

3) OPERATION MENU Sheet: The OPERATION MENU Sheet prompts the user to select specific performance and UPS setting data.

(remote or local start & stop operation, date & time adjustment, battery test etc.)

4) STATUS MENU Sheet: The STATUS MENU Sheet indicates event and alarm/fault information and battery discharge records. A maximum of 50 events can be displayed. The following alarm/status information shall be available as a minimum:

a) Load on Inverter
b) Battery Low Voltage
c) Battery Operation
d) Output Overload
e) Converter Operation
f) Static Bypass Input Out of Range
g) Minor Fault Data
h) Major Fault Data

4. LED indication

a. The Operation/Display Panel contains the following LED indication:

1) Load on Inverter (Green)
2) Battery Operation (Orange)
3) Load on Bypass (Orange)
4) Overload (Orange)
5) LCD Fault (Red)
6) UPS Fault (Red)

5. Emergency Power Off (EPO) button

a. The UPS shall be provided with a set of terminals which may connect to a remote EPO contact signal. Remote contact shall be non-powered normally open. UPS shall also have a unit mounted EPO button. When the UPS Module EPO button is activated, the EPO function shuts down the UPS module. The EPO function can be performed both locally and remotely. When EPO is performed, all system UPS Modules will be shutdown and the critical load dropped.

G. Microprocessor Interface/Diagnostics

1. The UPS microprocessor logic shall, as standard equipment, provide menu-driven operator instructions detailing the operation of the UPS system. The instruction menu shall be accessible via a LCD touch screen display located at the control panel. The microprocessor shall monitor each step, thus prompting itself to the next step of the instructions. The following instructions shall be available as a minimum:

a. Inverter stop
b. Inverter start
c. Transfer of critical load to static bypass source
d. Equalize charge to system battery

2. Microprocessor Controlled Diagnostics

a. The UPS shall provide microprocessor controlled diagnostics capable of retaining fault alarms along with metering parameters in the event of a UPS failure. The microprocessor memory data shall be viewed via an LCD display or LED located at the control panel. The following alarm/status information shall be provided as a minimum:

1) Load on Inverter
2) Inverter Operation
3) Battery Operation
4) Battery Low Voltage
5) Output Overload
6) Remote Operation
7) Battery Depleted
8) Battery Temperature Abnormal
9) Converter Operation
10) DC breaker Open
11) Converter Input Out of Range
12) Equalize Charge Activated
13) Inverter Running Asynchronously
14) Load on Bypass
15) Static Bypass Input out of Range
16) Minor Fault
17) Major Fault

H. UPS Status and Function Interfacing

1. Output Contact

a. The internal UPS logic shall provide, as standard equipment, a selectable set of eight (8) normally open, A-type dry contact outputs to allow user interfacing of the UPS operating status. The available parameters are identical to the alarm and status information schedule, itemized as the following:

1) Total Alarm
2) Minor Fault
3) Alarm
4) AC Input Abnormal
5) Bypass Abnormal
6) Battery Abnormal
7) Battery Low Voltage
8) Battery Depletion
9) Overload
10) Overload Pre-alarm
11) Fault Group 1
12) Fault Group 2
13) Synchronous
14) Asynchronous
15) Remote Operation Enable
16) Load on Inverter
17) Load on Bypass

18) Load On AC
19) Battery Operation
20) Converter Operation
21) Inverter Operation
22) CB1 Close
23) CB2 Close
24) 52S Close
25) Power Demand
26) Equalizing Charge
27) Another Bus Synch OK

b. ModbusTCP/IP Communication

1) The UPS shall have, as standard equipment, an Ethernet port allowing the user to interface the UPS status information via ModbusTCP/IP to a Building Management System. Field installed, and field tested Modbus adapter peripherals/additions shall not be accepted.

c. RS 232 Communication

1) The UPS shall have, as standard equipment, an RS 232 smart port allowing the user to interface the UPS status information to a host computer. Field installed, and field tested RS 232 additions shall not be accepted.

d. Input Ports

1) The UPS shall have, as standard equipment, EPO (Emergency Power Off) and selectable four (4) input ports. The selectable input ports are the following parameters:

a) Remote Start
b) Remote Stop
c) Power Demand 1
d) Power Demand 2
e) Battery Liquid Low
f) Battery Temperature Abnormal
g) Generator Operation
h) Asynchronous Operation
i) Another Bus Synch
j) Remote Inverter Supply (MMS)
k) Remote Bypass Supply (MMS)
l) Ext Byp dV Str
m) Battery Charger Limit 2
n) Charger Stop
o) External Alarm
p) CB2 Ex

2.3 MECHANICAL DESIGN

A. Cabinet Structure (Enclosure)

1. The enclosure shall be primed and painted with the Munsell 5Y7/1 (beige) color. The enclosure shall be free standing floor mount design. The enclosure panels and doors shall consist of minimum 16 gage steel for maximum strength and durability.
2. The UPS shall be installed in cabinets of heavy-duty structure meeting with NEMA standard for floor mounting. The UPS shall be equipped with standard forklift provisions to allow ease of installation using conventional lifting/moving equipment. The UPS module cabinet shall have hinged and lockable doors on the front only. Operating controls shall be located outside the locked doors. Input, output, and battery cables shall be installed through the bottom or right side of the cabinet.

B. Serviceability

1. The UPS shall have front access for all servicing adjustments and connections only for maintenance or service. Side access or rear access shall not be accepted. The UPS shall be designed such that its rear can be pressed against a back wall and its sides can be pressed against side walls.

C. Ventilation

1. Forced air cooling shall be provided to allow all components to operate within their rated temperature window. Thermal relay, using a latched contact which is capable of being reset, shall be used as overload protection to cooling fan. All air inlets use air filters that shall be removable from the front of the UPS without exposure to any electrical hazard. Air filters shall be door mounted to prevent floor dust from being sucked into the unit. Bottom mount air filters shall not be accepted.

2.4 BATTERY SYSTEM DESCRIPTION PREMIUM BATTERIES????

A. Two (2) Matching Battery Cabinets to provide a reliable, pre-packaged system for standby requirements. The battery system shall be complete with the following features and accessories:

1. 46” W x 31.5” D x 82”H each, 6,000 lbs
2. Design based on East Penn/Deka model HR5500ETSeries front terminal premium batteries
3. UBC64 Battery Cabinet
4. UL listed design
5. Certified for Zone 4 Seismic Applications
6. Valve Regulated Lead Acid Sealed Battery design
7. Insulated rail design
8. Batteries to be pre-wired within cabinet
9. Battery restraint system to meet seismic and transportation requirements
10. Cable access knockouts on the top, side, and bottom of the cabinet
11. 8 minutes at 337.5 kW / 375 kVA
12. 13 minutes at 270 kW / 300 kVA
13. 21 minutes at 202.5 kW / 225 kVA
14. 37 minutes at 135 kW / 150 kVA
15. Battery discharge times based on 0.9 output power factor

16. 40 Sealed, flame retardant, front terminal battery jars per cabinet
17. Batteries installed and pre-wired
18. Internal cabinet mounted 600 amp circuit breaker
19. The breaker to include UVR and breaker position contacts
20. Four year full parts warranty against manufacturing defects
21. One year labor warranty on batteries and battery cabinets
22. The electrolyte volume for (2) Cabinets is 184.8 gallons

2.5 BATTERY CABINET ENCLOSURE

A. The matching battery cabinet(s) shall be equipped with standard forklift provisions to allow ease of installation using conventional lifting/moving equipment. All battery cabinet enclosures shall require a special tool or screwdriver to allow internal access through the front-hinged door. The cabinet shall meet NEMA 1 standards. The cabinet shall be powder coated for extra durability in a matching color to the UPS system. The cabinet shall allow for natural ventilation using front inlet louver design.

2.6 BATTERY MONITORING SYSTEM

A. Battery Monitoring System Description

1. Battery Monitoring System shall provide string level monitoring and IFC 608 thermal runaway compliance for up to 8 strings of batteries, without limitation to any particular battery chemistry.
2. Battery Monitoring System shall consist of a control unit for each string, each assignable as master or slave. One control unit per string shall be assigned master with all others assigned slave.
3. The master unit shall poll and collect data from slave control units, and be the point of access for viewing the status information from all control units in a string.
4. The master unit shall include an ambient temperature probe.
5. The Battery Monitoring System shall provide an Event Log that displays time and date stamped events.
6. The Battery Monitoring System shall provide a Battery Log that displays battery date codes, in-service date, and notes fields.
7. The Battery Monitoring System shall provide a System Log, downloadable in CSV format, that maintains the operational data of the following parameters:

    a. String voltage
    b. String state
    c. Ambient temperature
    d. String temperature
    e. String current

8. The Battery Monitoring System shall have the ability to sense the onset of thermal runaway and have provisions to individually trip the circuit breaker associated with the affected battery string before full thermal runaway occurs.
9. The Battery Monitoring System shall be UL, CSA, and IFC listed/compliant.
10. Room signage and hydrogen and smoke detection are not within the scope of the Battery Monitoring System.

B. Battery Monitoring System Operation

1. System Parameters

a. String Capacity: Maximum of 8 per system
b. String Voltage: 12 to 600 Volts ±.2% of reading ± 2V
c. Discharge Current: 2400A per string ± 2%
d. Float Current: 0 to 25A per string ± 100mA
e. Charge Current: 1 to 600A ± 2%
f. Temperature: -10 to 120ºC ± 1ºC (ambient and string)
g. Input Power: 6W maximum per Control Unit
h. Operating Temperature: 0 to 50ºC
i. Humidity: 0 to 90% RH (non-condensing)
j. Altitude: 0 to 12,000 ft. above sea level

2. Operational Requirements

a. Continuous string voltage monitoring and logging (alarm generated within 10% above or below user-programmed voltage threshold)
b. Continuous string current monitoring and logging with master unit current summation (alarm generated for string current imbalance or total current above user-programmed total current thresholds)
c. Battery strings' floating, discharging, or charging status display (alarm "On Battery" generated with discharging status)
d. Continuous ambient and string temperature monitoring and logging (alarm generated above user-programmed ambient threshold or ambient-string differential threshold)
e. Continuous master-salve communication (alarm generated after user-programmable failed attempts)
f. Continuous System Log status monitoring (alarm generated approaching maximum data limit)
g. Battery cycle counter logging total cycles and time, date, and duration of last discharge event, Cycle counter shall also display number of cycles of the following durations:

1) <1 minute
2) 1 - 5 minutes
3) 5 -10 minutes
4) >15 minutes

h. Dry contact input for smoke or hydrogen detector (alarm generated on closure)
i. Thermal runaway notification (warning generated upon indication of runaway; alarm generated upon condition of runaway confirmation and pending disconnect)
j. Alarm relay for activating external alarm device

C. Battery Monitoring System Interface

1. The Battery Monitoring System primary interface shall be an HTTP web browser. Browser access shall be password protected. The Battery Monitoring System

shall also have a string status panel visual indicator for each control unit, surface-mounted to the battery cabinet door. This panel shall indicate Normal status, Warning Status, and Voltage, Current and Temperature alarm statuses. The Battery Monitoring System shall also have the following interface capabilities:

a. Modbus TCP/IP
b. SNMP with community string support
c. SMTP e-mail

D. Warranty

1. Battery Monitoring System shall be warranted against defects in design, materials, and overall performance for one (1) year from the date of initial shipment, independent of any other product or service warranties.

2.7 MAINTENANCE BYPASS CABINET

A. Maintenance Bypass Cabinet Description

1. The system shall include a three (3) breaker Maintenance Bypass Cabinet (MBC) for floor mounting. The cabinet shall be properly sized to match the UPS load requirements. The maintenance bypass breakers shall be noted as a UPS input isolation breaker (SW1), maintenance bypass breaker (SW2) and UPS output isolation breaker (SW3). The MBC shall have the following features and accessories:

a. UL 891 listed design
b. 24.0”W x 32.7”D x 78.75”H, not to exceed 900 lbs
c. 480 volt design
d. One (1) 800AF/800AT 3P UPS Input circuit breaker
e. One (1) 800AF/800AT 3P Maintenance Bypass circuit breaker
f. One (1) 800AF/800AT 3P UPS Output circuit breaker
g. The breakers, bus, and cabinet shall be designed for 65 kAIC fault current rating
h. (2) Kirk-keys and Solenoid Key Release Unit (SKRU) incorporated for proper transfer to bypass
i. 12 gauge painted steel enclosure design
j. 12 gauge powder coated front access door with three point catch handle
k. Continuously welded seams and corners
l. Copper bus throughout
m. Ground termination points
n. Internal wire bending gutter meets or exceeds NEC tables 373-6(a – b)
o. Output bus 500VA 120VAC output termination points for auxiliary peripheral power

2.8 REMOTE MONITORING SYSTEM

1. The UPS manufacturer shall offer a Remote Status Alarm Panel which shall not allow any control over the UPS. The RSAP shall have, as standard equipment, a battery backup feature allowing it to continue monitoring UPS status conditions during power outage situations. RSAP Back-up shall be for a

minimum of 8 hours. The RSAP shall act only as an annunciation panel providing the following alarms/indications as a minimum:

a. Rectifier on
b. Load on Inverter
c. Load on Bypass
d. UPS Failure
e. Output Overload
f. UPS in battery back-up mode
g. Low battery while in back-up mode
h. Dimensions 8.5”W x 4.5”D x 8.5”H, 10 lbs

2.9 ISOLATION TRANSFORMER

A. The system shall include a dry-type three-phase output isolation transformer for floor mounting. The transformer shall have the following features:

1. Mechanical Design

a. Powder coated NEMA 1 steel cabinet enclosure shall be suitable for indoor application with floor mounting provisions and removable panels
b. Three-phase steel core construction
c. Copper coil double wound isolation
d. Class 220 insulation
e. 150°C rise
f. Electrostatically shielded common-mode noise attenuation
g. Transformer terminations rated below 330 amps shall be supplied with suitable hardware and lugs for cable connection
h. Transformer terminations rated above 330 amps shall be provided with terminal pads only
i. CSA certified
j. UL Listed
k. Dimensions not to exceed 60"W X 35"D X 80"H
l. Weight not to exceed 3,100 lbs

2. Electrical Design

a. 500 kVA Transformer
b. 480V delta primary ± 2 x 2.5% F.C. taps, 60 Hz
c. 277/480V wye secondary
d. 3% impedance
e. NEMA TP-1 rated electrical efficiency

3. Environmental Conditions

a. 500 kVA TP-1 transformer heat rejection at full load shall be 30,700 BTU/Hr Sensible and 15,400 BTU/Hr Sensible at 50% load. When applying the transformer for Diagnostic Imaging applications, the AC unit(s) could be sized to meet the 50% load requirement of the transformer, plus any other heat loads in the space, and any other heat gains through the walls or ceiling.

PART 3 - EXECUTION

3.1 SITE PREPARATION

A. The owner shall prepare the site for installation of the equipment.

3.2 INSTALLATION

A. The UPS shall be set in place, wired and connected in accordance with the approved installation drawings and owner's/technical manual delivered with equipment.

3.3 FIELD QUALITY CONTROL

A. The equipment shall be checked out and started by a customer support representative from the equipment manufacturer. Visual and mechanical inspection of electrical installation, initial UPS startup and operational training shall be performed. A signed service report shall be submitted after equipment is operational.

B. The following inspection and test procedures shall be performed by field service personnel during the UPS startup:

1. Visual Inspection

   a. Ensure that shipping members have been removed.
   b. Ensure that interiors are free of foreign materials, tools and dirt.
   c. Check for damage (dents, scratches, frame misalignment, damage to panel devices, etc).
   d. Check doors for proper alignment and operation.

2. Mechanical Inspection

   a. Check all the power wiring connections for tightness.
   b. Check all the control wiring connections for tightness.

3. Electrical Inspection

   a. Check input and bypass for proper voltage and phase rotation.
   b. Check battery for proper voltage and polarity.

4. Start-up

   a. Energize the UPS.
   b. Check the DC output voltage and inverter output voltage.
   c. Check the inverter output voltage on battery operation.
   d. Check for the proper synchronization.
   e. Perform manual transfers and returns.

3.4 COMMISSIONING

A. Engage an organization to provide additional testing on the UPS System to assure proper operation under full load conditions as follows:

1. Provide temporary load banks, high sample rate power quality meters to monitor the input and output of the UPS System during testing
2. Electrical contractor to assist commissioning group with installation and de-installation of load bank equipment and temporary wiring
3. Provide additional meters and recording devices as required to meet the commissioning requirements
4. Provide site pictures of equipment being tested and test equipment
5. Provide initial recording of battery voltages and other pertinent data.
6. Load the UPS module using a resistive, variable load bank(s) to simulate the UPS system fully loaded – 500 kW minimum load bank(s) requirement
7. Record initial voltage, current, kW readings under full load
8. Record indoor and outdoor temperatures
9. Complete transfers from normal operation to static bypass and to maintenance bypass and assure proper operation
10. Adjust loading on UPS module to 0% loaded and perform 200 kW step load test. Record results and display current and voltage snap shots from power quality meters
11. Adjust loading on UPS module to 100 kW loaded and perform 300 kW step load test. Record results and display current and voltage snap shots from power quality meters
12. Adjust loading on UPS module to 0% loaded and perform 500 kW step load test. Record results and display current and voltage snap shots from power quality meters
13. Perform Battery Discharge test at 202 kW load profile and record DC voltage, DC current, time remaining on 30-second intervals along with power quality snapshots to verify proper operation
14. Plot curve of battery discharge and verify battery backup time matches specified time
15. Verify proper battery recharge and record charging level and DC voltage over time
16. Simulate power outage and verify proper operation of ATS and generator and verify the generator properly supports the load (This test to be performed in conjunction with the electrical contractor and site personnel)
17. Record input current harmonics, output voltage harmonics, and efficiency at 25%, 50%, 75%, and 100% loading
18. Operate load bank(s) at full load for 2 hours to verify proper operation. If air conditioning will not support 100% operation, then adjust accordingly in conjunction with owner personnel. Record input and output voltage, current, kW during extended testing utilizing power quality meters.
19. Verify and record ground current during testing
20. Provide complete report that includes all testing items noted above, documentation of input and output voltage, current, and frequency for all 3 phases and ground
21. Note any issues during testing
22. Provide copy of startup documents
23. Provide documentation of test equipment used during commissioning and load bank(s) used during commissioning
24. Correct any deficiencies with system operation

END OF SECTION

This page is intentionally left blank.

SECTION 26 33 63

CENTRAL IT UPS SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. Scope: Provide design and engineering, labor, material, equipment, related services, and supervision required, including, but not limited to, manufacturing, fabrication, erection, and installation for a solid state uninterruptible power supply (UPS) as required for the complete performance of the work, and as shown on the Drawings and as herein specified.

B. Section Includes: The work specified in this Section includes, but shall not be limited to, a three-phase, on-line, double conversion, solid state UPS. The UPS shall operate in conjunction with the existing building electrical system to provide high quality power conditioning, back-up power protection, and distribution for electronic equipment loads. The system shall consist of a solid state IGBT rectifier/inverter, power factor corrected rectifier, a 100 percent rated for continuous duty static switch, battery plant, graphical status/control panel, and synchronizing circuitry as described herein.

1.2 REFERENCES

A. General: The publications listed below form a part of this Specification to the extent referenced. The publications are referred to in the text by the basic designation only. The edition/revision of the referenced publications shall be the latest date as of the date of the Contract Documents, unless otherwise specified.

B. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
   1. ANSI/IEEE C62.41, "Recommended Practice for Surge Voltages in Low-Voltage AC Power Circuits" (copyrighted by IEEE, ANSI approved).

C. International Organization for Standardization (ISO):
   1. ISO 9001, "Quality Management Systems - Requirements."

D. National Electrical Manufacturers Association (NEMA):
   1. NEMA PE 1, " Uninterruptible Power Systems (UPS) - Specification and Performance Verification."

E. National Fire Protection Association (NFPA):

1. NFPA 70, "National Electrical Code" (copyrighted by NFPA, ANSI approved) - hereinafter referred to as NEC.

F. Underwriters Laboratories, Inc. (UL):
1. UL 1778, "Standard for Uninterruptible Power Supply Equipment" (copyrighted by UL, ANSI approved).

1.3 SYSTEM DESCRIPTION

A. General Characteristics
1. Double Conversion – Transformerless Design
2. Integrated Parallel capability
   a. Up to five UPS units for redundancy
   b. Up to four UPS units for capacity
3. Front access only required for service
4. Top or bottom cable entry
5. High efficiency (96% at low load levels from 25% to 75%)
6. Battery charging in bypass operation

B. Design Requirements:
1. The UPS shall be sized for 160 kVA load.
2. The UPS battery system shall be sized for 160 kVA at power factor 0.9 for 5 minutes.

C. System Characteristics:

1. Input: The system input shall be configurable for either single or dual utility derived from a three phase wye source. The system should facilitate both top and bottom cable entry.
   a. Input voltage: 480 volts AC, -25 percent +20 percent (+25% for 1 minute), three-phase, 3-wire (3PH + G).
   b. Frequency: 40-70 Hertz
   c. Input Power Factor Correction:
      1) 0.97 > 10% load
      2) 0.98 > 20% load
      3) 0.99 > 40% load
   d. Total Harmonic Distortion (THDI):
      1) < 3% @ 100% load
      2) < 4% @ 50% load
      3) < 6% @ 25% load
   e. Short-circuit Withstand Rating: 65 kAIC capability
   f. Protection: Built-in Backfeed Contactor.
   g. Inrush Current: Less than nominal input current for less than one cycle. Shall not exceed 800% of the rectifier/battery charger full load current.
   h. Input Surge Protection: UPS shall be equipped to withstand surges per ANSI/IEEE C62.41.

2. UPS Output:
   a. Output Voltage: 208/120 volts AC, ±1 percent steady state variation phase-to-phase voltage volts AC, three- phase, 4 wire (3PH + N + G).

b. Frequency: 50/60 hertz, ±1.0 percent (free running)
c. Output voltage range
   1) Symmetric load (0-100%):
      a) ± 1% static
      b) ± 5% after 2 ms
      c) ± 1% after 50 ms
d. Output Voltage Transient Response: The output voltage returns to within ±1% of the steady state value within 50ms.
e. Output Power Factor: 0.9
f. Ouput Voltage Transient Characteristics:
   1) 20% load step change +3%
   2) 50% load step change +3%
   3) 100% load step change +5%
g. Total Harmonic Distortion (THDU):
   1) < 2% at 100% linear load
   2) < 3% at 100% non-linear load
h. Slew Rate (Hz/sec): Programmable 0.25, 0.5, 1, 2, 4 ,6
i. Load Power Factor: 0.7 leading to 0.5 lagging without derating
j. Overload Rating:
   1) Normal Operation:
      a) 150% for 1 minute at 40°C
      b) 125% for 10 minutes at 40°C
   2) Battery Operation:
      a) 150% for 1 second at 40°C
      b) 125% for 1 minute at 40°C
   3) Bypass Operation:
      a) 1000% for 100 ms
k. System AC-AC Efficiency:
   1) Up to 96.2% in normal operation
   2) Up to 99% in ECO mode

3. Battery: The battery system should consist of (1) modular battery cabinet.
   a. Battery Voltage: 480 volts DC nominal
   b. Charging Power in % of output power:
      1) 40% charge ≤ 80% load
      2) 20% charge ≤ 100% load
   c. Battery Test: Manual or automatic (selectable)
   d. Deep Discharge Protection
   e. Recharge according to Battery Temperature
   f. Cold Start
   g. Battery Type: Valve regulated sealed lead acid (VRLA). Either in traditional top terminal or modular cabinet
   h. Maximum DC Current: Maximum DC current at cutoff voltage shall be 392 amperes.

1.4 SUBMITTALS

A. Product Data: Submit product data showing material proposed. Submit sufficient information to determine compliance with the Drawings and Specifications. Product data shall include, but shall not be limited to, the following:

1. Catalog sheets and technical data sheets to indicate physical data and electrical performance, electrical characteristics, and connection requirements.
2. Manufacturer's installation instructions indicating application conditions and limitations of use stipulated by product inspecting and testing agency. Include instructions for storage, handling, protection, examination, preparation, installation, and starting of the product. Include equipment installation outline, connection diagram for external cabling, internal wiring diagram, and written instruction for installation.

B. Shop Drawings: Submit shop drawings for each product and accessory required. Include information not fully detailed in manufacturer's standard product data, including, but not limited to, complete electrical characteristics and connection requirements. Provide detailed equipment outlines with cabinet dimensions and spacing requirements; location of conduit entry/exit paths; location of floor/seismic mounting; available battery types/sizes; cabinet weights; heat rejection and air flow requirements; single line diagram; and control and external wiring.

C. Wiring Diagrams: Submit wiring diagrams detailing power, signal, and control systems, clearly differentiating between manufacturer installed wiring and field installed wiring, and between components provided by the manufacturer and those provided by others.

D. Contract Closeout Submittals:
1. Project Record Documents: Submit a complete set of installation drawings showing all the information specified elsewhere in this Section.
2. Operation and Maintenance Data: Submit operation and maintenance data to include in operation and maintenance manuals specified in [Division 01 - GENERAL REQUIREMENTS] [Division 1 - GENERAL REQUIREMENTS], including, but not limited to, safe and correct operation of UPS functions.

1.5 QUALITY ASSURANCE

A. Qualifications:
1. Manufacturer Qualifications: Manufacturer shall be a firm engaged in the manufacture of solid state UPS of types and sizes required, and whose products have been in satisfactory use in similar service for a minimum of 20 years.
   a. The manufacturer shall be ISO 9001 certified and shall be designed to internationally accepted standards.
2. Installer Qualifications: Installer shall be a firm that shall have a minimum of five years of successful installation experience with projects utilizing solid state UPS similar in type and scope to that required for this Project.

B. Regulatory Requirements: Comply with applicable requirements of the laws, codes, ordinances, and regulations of Federal, State, and local authorities having jurisdiction. Obtain necessary approvals from such authorities.
1. The UPS shall meet the requirements of the following standards:
   a. Safety: UL 1778 4th edition
   b. EMC/EMI/RFI: FCC47 Part 15

c. Markings: UL1778
d. Transportation: ISTA 2B
e. Seismic Zone: IBC Level 2:2006

C. Source Responsibility: Materials and parts comprising the UPS shall be new, of current manufacture, and shall not have been in prior service, except as required during factory testing. Active electronic devices shall be solid state and shall not exceed the manufacturer's recommended tolerances for temperature or current to ensure maximum reliability. Semiconductor devices shall be sealed. Relays shall be provided with dust covers. The manufacturer shall conduct inspections on incoming parts, modular assemblies, and final products.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to the Project site in supplier's or manufacturer's original wrappings and containers, labeled with supplier's or manufacturer's name, material or product brand name, and lot number, if any.

B. The customer shall store materials in their original, undamaged packages and containers, inside a well ventilated area protected from weather, moisture, soiling, extreme temperatures, and humidity.

C. Products shall be packaged in a manner to prevent penetration by debris and to allow safe delivery by modes of ground transportation and air transportation where specified.

D. Prior to shipping, products shall be inspected at the factory for damage.

E. Equipment shall be protected against extreme temperature and humidity and shall be stored in a conditioned or protected environment.

F. Equipment containing batteries shall not be stored for a period exceeding three months without powering up the equipment for a period of eight hours to recharge the batteries.

1.7 PROJECT CONDITIONS

1. The UPS shall operate under the following environmental conditions:
   a. Temperature:
      1) Operating ambient temperature: 32 °F (0 °C) to 104 °F (40 °C).
      2) Storage ambient temperature with batteries: 5°F (-15 °C) to 104 °F (40 °C).
      3) Storage ambient temperature without batteries: -77°F (-25 °C) to 131 °F (55 °C).

b. Relative Humidity (Operating and Storage): 0 percent to 95 percent non-condensing.
c. Elevation:
   1) Operating:
      a) 3300 feet (1000 m): 1.000
      b) 5000 feet (1500 m): 0.975
      c) 6600 feet (2000 m): 0.950
      d) 8300 feet (2500 m): 0.925
      e) 10000 feet (3000 m): 0.900
   2) Non-Operating: 0-15000 m
d. Audible Noise:
   1) 65 dBA at 100% load and 3 feet (1 m) from surface
   2) 55 dBA at 70% load and 3 feet (1 m) from surface

1.8 WARRANTY

A. Factory Warranty: The Contractor shall warrant the work of this Section to be in accordance with the Contract Documents and free from faults and defects in materials and workmanship for period indicated below. This warranty shall extend the one year period of limitations contained in the General Conditions. The warranty shall be countersigned by the Installer and the manufacturer.
   1. UPS Cabinets: The UPS shall be covered by a full parts and labor warranty from the manufacturer for a period of 12 months from date of installation or acceptance by the Owner or 18 months from date of shipment from the manufacturer, whichever occurs first.
   2. Battery Cabinets: The battery manufacturer's warranty shall be passed through to the final Owner and shall have a minimum period of one year.

B. Additional Owner Rights: The warranty shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to and run concurrent with other warranties made by the Contractor under requirements of the Contract Documents.

1.9 MAINTENANCE

A. A complete offering of preventative and full service maintenance contracts for the UPS system and the battery system shall be available from the manufacturer.
B. The manufacturer shall, upon request, provide spare parts kits for the UPS module in a timely manner as well as provide access to qualified factory trained first party service personnel to provide preventative maintenance and service on the UPS module when required.
C. UPS subassemblies, as well as the battery, shall be accessible from the front. UPS design shall provide maximum reliability and minimum MTTR (mean time to repair). To that end, the UPS shall be equipped with a self test function to verify correct system operation. The self test function shall identify the subassembly requiring repair. The electronic UPS control and monitoring assembly shall therefore be fully microprocessor based, thus doing away with potentiometer settings. This shall allow:

1. Auto compensation of component drift.
2. Self adjustment of replaced subassemblies.
3. Extensive acquisition of information vital for computer aided diagnostics (local or remote).
4. Socket connection to interface with computer aided diagnostics system.

D. The UPS shall be repairable by replacing standard subassemblies requiring no adjustments. Communication via a modem with a remote maintenance system shall be possible.

E. The manufacturer shall offer additional preventative maintenance and service contracts covering both the UPS and the battery bank. Accredited professional service engineers employed exclusively in the field of critical power systems service shall perform maintenance and service. The manufacturer shall also offer extended warranty contracts.

PART 2 - PRODUCT

2.1 MANUFACTURERS

A. Basis of Design: Product specified is Galaxy VM by Schneider Electric. Items specified are to establish a standard of quality for design, function, materials, and appearance. Equivalent products by other manufacturers are acceptable. The Architect/Engineer will be the sole judge of the basis of what is equivalent.

2.2 MODES OF OPERATION

A. UPS module shall be designed to operate as a double conversion, on-line reverse transfer system in the following modes.
   1. Normal: The UPS system shall continuously supply power to the critical load.
   2. Battery: Upon failure of the utility AC power source, the critical load shall be supplied by the inverter, which, without any interruption, shall obtain its power from the battery.
   3. Recharge: Upon restoration of the utility AC power source (prior to complete battery discharge), the PFC rectifier shall power the inverter and simultaneously recharge the battery.
   4. Static Bypass: The static bypass switch shall be used to transfer the load to the bypass without interruption to the critical power load. This shall be accomplished by turning the inverter off. Automatic re-transfer or forward transfer of the load shall be accomplished by turning the inverter on.
   5. Maintenance Bypass: In maintenance bypass the load is supplied with unconditioned power from the bypass input.
   6. ECO Mode: The UPS system is configured to use static bypass operation as the preferred mode under predefined. Transfers to battery operation upon utility failure. Efficiency up to 99%.
   7. ECOnversion: ECOnversion allows the system to supply the active part of the load through the bypass. The inverter is kept running in parallel with the bypass source and supplies the reactive part of the load. The input power factor of the UPS is, regardless of the load power factor, maintained close to unity as the reactive part of load is significantly reduced in the UPS input current. In case if

an interruption to the utility/mains supply, the inverter immediately maintains the output voltage so that breaks or drops during this transfer are practically eliminated. UPS operates with static bypass in parallel with main inverter. Main inverter actively corrects power factor, and harmonics to provide sinusoidal main input current. Transfer time to double conversion <1milliseconds.

8. Parallel Operation: The system shall have the option to install up to 5 UPSs in parallel. This can be done for capacity (5+0) or for redundancy (4+1) with an external system bypass cabinet. In addition, the UPS can be parallel at 1+1 without a system bypass cabinet.
   a. The parallel UPSs shall be of the same design, voltage, and frequency.
   b. Output Control: A load sharing circuit shall be incorporated into the parallel control circuits to ensure that under no-load conditions, no circulating current exists between the UPSs. This feature also allows each UPS to share equal amounts of the total critical load bus. The output voltage, output frequency, output phase angle, and output impedance of each UPS shall operate in uniformity to ensure correct load sharing.
   c. Parallel System Control: The UPS shall have no single dedicated control system designed to control of the parallel system.
   d. Communication: Communication between the UPSs shall be connected so that the removal of any single cable shall not jeopardize the integrity of the parallel communication system. Load sharing communications shall be galvanically isolated for purposes of fault tolerances between UPSs. A UPS's influence over load sharing shall be inhibited in any mode where the UPS inverter is not supporting its output bus. Transfer to and from bypass can be initiated from any online UPS.
   e. Battery Runtime: Each UPS shall have its own battery solution
   f. Switchgear: Either a Galaxy VM System Bypass Cabinet or a custom switchgear shall be required for parallel operation.
9. External Synchronization: Synchronization of the output of the UPS with any other independent source for use with downstream transfer switches. The synchronization at the UPS is controlled from an input on the interface boards.

2.3 COMPONENT DESCRIPTION

A. PFC Rectifier and Battery Charger: Incoming AC power shall be converted to a regulated DC output voltage by an IGBT (insulated gate bipolar transistor) power factor correction (PFC) rectifier. The PFC rectifier shall provide high quality DC power to charge the batteries and power the inverter and shall have the following characteristics:
   1. Input Power Factor Correction (PFC): The PFC rectifier shall be power factor corrected so as to maintain an input power factor of 0.99 @ loads > 40% to unity to ensure generator compatibility and avoid reflected harmonics from disturbing loads sharing the utility power. The rectifier output shall be filtered with a ripple current not exceeding 1% rms over the allowable continous input voltage range.
   2. Input Harmonic Current Suppression: The PFC rectifier shall produce a sinusoidal input AC current on each phase with low harmonic content, limiting THD on the UPS input to below 3 percent @ 100% load.
   3. Battery Charger Current Limiting: The UPS shall be equipped with a system designed to limit the battery recharge current.
      a. 40% charger up to 80% load

b. 20% charger 80% - 100% load

B. Inverter: The UPS output shall be derived from a variable frequency Pulse Width Modulated (PWM) IGBT inverter design. The inverter shall be capable of providing the specified precise output power characteristics while operating over the battery voltage range. Inverter shall be individually fused with fast-acting fuses. UPS display shall indicate inoperable fuses.

1. Transient Response
   a. The inverter transient voltage shall not exceed the following parameters:
      1) ±5% for a 10% to 100% step load application and removal with 10% initial load or 100% initial load.
      2) ±5% for transfer of rated load from the bypass source to the UPS inverter output during automatic forward transfer of the static bypass transfer switch.
      3) 0% for loss of or return of main AC input.
2. Transient Recovery
   a. The output voltage returns to within ±1% of the steady state value within 50ms.
3. Fault Clearing
   a. The inverter shall electronically be turned off to protect against excessive overload conditions which exceed the parameters defined.
   b. UPS systems shall sense an overload condition and automatically transfer to the bypass input source which shall be used to provide the necessary fault clearing current required.
4. Inverter DC Protection
   a. The inverter shall be protected by the following features that shall be independently adjustable for maximum system flexibility.
      1) DC Over-voltage Trip.
      2) DC Under-voltage Shutdown.
      3) DC Under-voltage Disconnect annunciated by an internal visual alarm and relay contact closure.
5. Output Protection
   a. The inverter shall be electronically turned off to protect against overloads and abnormal load conditions which exceed the units rating.
   b. UPS systems shall sense an overload condition and automatically transfer to the bypass input source which shall be used to provide the necessary current required.
6. Over-current Protection
   a. The inverter shall be protected from excessive overloads, including reverse currents, by fast acting fuses to prevent damage to power semiconductors. All fuses shall be provided with a blown fuse indicator with alarm indication on the control panel.

C. Static Bypass - 100 Percent Rated, Continuous Duty: The static bypass transfer switch shall be solid state, rated for 100 percent continuous duty without mechanical contactor device in parallel for higher reliability and consistent response time and shall operate under the following conditions:

1. Uninterrupted Transfer: The static bypass transfer switch shall automatically cause the bypass source to assume the critical load without interruption after the logic senses one of the following conditions:
   a. Inverter overload exceeds unit's rating.
   b. Battery protection period expired and bypass current is available.

c. Inoperable inverter.

2. Interrupted Transfer: If the bypass source is beyond the conditions stated below, the UPS shall make an interrupted transfer (not less than 100 milliseconds in duration).
   a. Bypass voltage greater than +10 percent, -10 percent from the UPS rated output voltage.
   b. Bypass frequency tolerance is user selectable to ±0.1Hz, ±3Hz, and ±10Hz.
3. Automatic Uninterrupted Forward Transfer: The static bypass transfer switch shall automatically forward transfer power, without interruption, after the UPS inverter is turned on after an instantaneous overload induced reverse transfer has occurred and the load current returns the UPS's nominal rating or less.
4. Manual Transfer: A manual static transfer shall be initiated from the UPS control panel by turning the UPS inverter off.
5. Overload Ratings: Each static bypass transfer switch shall have the following overload characteristics:
   a. 1,000% of UPS output rating for 100 milliseconds.
   b. 150% of UPS output rating for one (1) minute.
   c. 100% of UPS ouput rating indefinitely.
   d. Each switch shall be suitable for all load conditions permitted by the upstream protective devices such that no damage is sustained during operation.

2.4 SYSTEM CONTROLS AND INDICATORS

A. Microprocessor Controlled Logic:
   1. The full UPS operation shall be provided through the use of microprocessor controlled logic. Operation and parameters shall be firmware controlled, thus eliminating the need for manual adjustments or potentiometers. The logic shall include, but shall not be limited to, a self test and diagnostic circuitry. Every printed circuit assembly or plug-in power assembly shall be monitored. Diagnostics shall be performed via a PC through the local diagnostics port on the UPS. UPS shall be microprocessor controlled.
   2. The UPS shall include, but shall not be limited to, a standard easy to use control and indicator panel. Included shall be a backlit, color graphic animated LCD display and LED indicators. The UPS panel shall include UPS on and UPS off pushbuttons that shall permit the Owner to command the UPS on or off.

B. Front Panel 7" Color Graphical Display: The UPS control panel shall provide a backlit, color graphic display with choice of 18 operating languages for indication of UPS status, metering, battery status, alarm/event log, and advanced operational features.
   1. Access: The display shall provide access to:
      a. Mimic diagram indicating UPS power flow.
      b. Measurements, status indications, and events.
      c. Personalization menu protected by a password, used to make specific settings.
      d. Event log with time stamping.
      e. Access to measurements.
   2. System Parameters Monitored: The visual display shall include, but shall not be limited to, the following system parameters based on true RMS metering:
      a. Measurements:
         1) Input voltage (Ph-Ph and PH-N).
         2) Input current per phase.
         3) Bypass voltage.

4) Bypass input frequency.
5) UPS output voltage (Ph-Ph and Ph-N).
6) UPS output current per phase.
7) UPS output frequency.
8) UPS output percent load.
9) UPS output kVA.
10) UPS output power factor.
11) Battery voltage.
12) Crest factor.
13) Battery current.
14) Battery backup time and remaining service life.

b. Status Indications and Events:
1) Load on battery.
2) Load on UPS.
3) Load on bypass.
4) Low battery warning.
5) General alarm.
6) Battery fault.
7) Remaining back-up time during operation on battery power.
8) Bypass source outside tolerances.
9) Additional indications shall provide maintenance assistance.

3. Time-Stamped Historical Events: This function shall time stamp and store important status changes, anomalies, and faults.

C. LED Status Indicators: The UPS control panel shall provide three LEDs that shall signal the following status conditions:
1. Green: The Load is protected.
2. Green + Orange: The load is protected, but the system reports a warning alarm.
3. Orange + Red: The load is unprotected and the system reports a warning and a critical alarm
4. Red: The load is unprotected and the system reports a critical alarm.

D. Buttons:
1. Inverter off
2. Inverter on

B. Audible Alarm Reset: The UPS shall provide an audible alarm that can be stopped using the user interface.

C. Emergency Power Off (EPO): The UPS shall be equipped with provisions for remote emergency power off and dry contact input that shall be used to command UPS shutdown remotely.

D. USB port: shall be provided for field diagnostics.

E. Dry Contacts: The UPS shall be provided standard with a programmable input/output relay board. This board shall have six dry contacts for inputs and six relays for output.
1. Input Contacts: Programmable as:
a. Custom Input 1
b. Custom Input 2
c. Ground Fault
d. External Battery Monitor Fault

   e. Battery Room Ventilation Fault
   f. Supplied By Genset
2. Output Relays: Programmable as:
   a. Common Alarm
   b. Normal Operation
   c. Battery Operation
   d. Maintenance Bypass
   e. Static Bypass
   f. ECO Mode
   g. Output Overload
   h. Fan Fault
   i. Battery Fault
   j. Battery Disconnected
   k. Battery Voltage Low
   l. Input Out of Tolerance
   m. Bypass Out of Tolerance
   n. Output Out of Tolerance
   o. UPS Warning
   p. UPS Critical
   q. Parallel Redundancy Lost
   r. External Fault
   s. UPS Maintenance Mode
   t. System Critical
   u. System Warning
   v. System Common Alarm
3. The contacts shall be normally open and shall change state to indicate the operating status. The contacts shall be rated at 2.0 amperes (250 volts AC/30 volts DC).

2.5 MECHANICAL DESIGN AND VENTILATION

A. Cabinet: The UPS shall be housed in two freestanding cabinets with dead front construction. The mechanical structure of the UPS shall be sufficiently strong and rigid to withstand handling and installation operations. The sheet metal elements in the structure shall be protected against corrosion by a suitable treatment, such as zinc electroplating, bi-chromating, epoxy paint, or an equivalent.

B. Cable Access: The standard UPS available shall accommodate top or bottom cable entry in standard cabinet..

C. Cabinet Weights and Dimensions: The width of the UPS shall be 98.43 inches and shall have a maximum weight of 7,765 pounds.

D. Ventilation and Heat Rejection: The UPS shall be designed for forced air cooling. Air inlets shall be provided from the front bottom of the UPS enclosure. Air exhaust shall be from the top portion of the unit. Full load heat rejection shall be 18,348 BTUs per hour.

2.6 BATTERY

A. General: The UPS module shall use a valve-regulated sealed lead acid heavy duty industrial battery, designed for auxiliary power service in an UPS application. The primary battery shall be furnished with impact-resistant plastic cases and housed in a matching cabinet(s) next to the UPS module.

B. Protection against Deep Discharge and Self-Discharge: The UPS shall be equipped with a device designed to protect the battery against deep discharge, depending on discharge conditions, with isolation of the battery by a circuit breaker. In particular, a monitoring device shall adjust the battery shutdown voltage as a function of a discharge coefficient to avoid excessive discharge at less than the rated output. A second device shall avoid self-discharge of the battery into the UPS control circuits during an extended shutdown of the UPS (over two hours).

C. Battery Self-Tests:

1. Battery Test: This feature performs a number of tests on the batteries, such as fuse-blown check, weak battery detection, and symmetry error. The battery self-test can be setup to run automatically in different time intervals between weekly and up to a year.
2. Runtime calibration: This feature is used for re-calibrating the estimated remaining runtime value.

2.7 OPTIONAL ACCESSORIES

A. StruxureWare Data Center Expert: A centralized infrastructure management platform hereafter referred to as Data Center Expert shall be available for purposes of complete system monitoring and management of all components outlined in this specification used as a single solution for small IT or part of the StruxureWare software stack providing data to systems such as Data Center Operation.
1. Monitoring - Data Center Expert shall be capable of monitoring a system through a network of Cat 5 cable and a switch supplied by the user. This switch shall relay information to Data Center Expert, which in turn shall allow access to this information via the user's public network via a single IP address.
2. Monitored Values: Data Center Expert shall be capable of monitoring alarms, general status parameters, voltage and current of the PDU.
3. Thresholds: For individualized customer needs, Data Center Expert shall allow for user configurable thresholds for alarm notification. With this feature, Data Center Expert can notify clients of reaching.
4. Public Network Monitoring: Data Center Expert shall also be capable of monitoring other Schneider Electric devices that are connected to the client's public network.

B. Battery Cabinets: Modular or classic battery cabinets are available.

1. Modular battery cabinets:
   a. The modular battery cabinet shall be matching and adjacent to UPS cabinet.
   b. Modular construction made up of redundant strings per cabinet.
   c. Modular battery shall allow trained-user to quickly replace, swap, battery modules during maintenance operation.

d. Each battery string is monitored for voltage and temperature for use by the UPS battery diagnostic.
e. UPS shall alarm user when redundant battery string needs replacement.
f. The UPS shall incorporate a battery capacity test that will be capable of determining available runtimes.

C. External Control and Communications Devices: The UPS shall contain two smart slots for the following optional control and communications devices:
1. Dry Contacts/I/O accessory (AP9810+ AP9631orAP9635): Customizable input and output contacts for the UPS network management card 2 with environmental monitoring (2 inputs/ 1 output)..
2. Temperature Sensor (AP9631 or AP9635): The temperature Sensor enables the UPS environment to be monitored by taking regular measurements of temperature. Its connection to the Network Management Card enables monitoring or notification of alarms via your computer network. If an additional temperature sensor is needed, procure (AP9335T)
3. Temperature and humidity Sensor(AP9335TH + AP9631 or AP9635): The temperature and humidity Sensor enables the UPS environment to be monitored by taking regular measurements of temperature and humidity. Its connection to the Network Management Card enables monitoring or notification of alarms via your computer network.
4. Network Management Card (AP9630): The UPS NMC display has possibility to connect to SNMP, Web, Data Center Expert, Modbus, RMS over ethernet. But in the standard display NMC it is not possible to connect sensors.

D. Seismic Anchors: ship included with the system.

E. Transformers: 208 V and 600 V.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions: Examine areas and conditions under which the work is to be installed, and notify the Contractor in writing, with a copy to the Owner and the Architect/Engineer, of any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.
1. Beginning of the work shall indicate acceptance of the areas and conditions as satisfactory by the Installer.

3.2 INSTALLATION

A. Preparation and installation shall be in accordance with reviewed product data, final shop drawings, manufacturer's written recommendations, and as indicated on the Drawings.

3.3 FIELD QUALITY CONTROL

A. Field Service Engineer Qualifications: The manufacturer shall employ a 7 x 24 nationwide (international where applicable) field service organization with rapid access to all regions of the nation. The responding service professionals shall be factory-trained engineers with an accredited and proven competence to service three-phase UPS.

B. Spare Parts: Field Engineers shall have immediate access to recommended spare parts with additional parts storage located in regional depots. Additional spare parts shall be accessible on a 7 x 24 basis from the national depot and shall be expedited on a next available flight basis or via direct courier (whichever mode is quickest).

3.4 DEMONSTRATION

A. Provide the services of a factory-authorized service representative of the manufacturer to provide start-up service and to demonstrate and train the Owner's personnel.
   1. Test and adjust controls and safeties. Replace damaged or malfunctioning controls and equipment.
   2. Train the Owner's maintenance personnel on procedures and schedules related to start-up and shutdown, troubleshooting, servicing, and preventive maintenance.
   3. Review data in operation and maintenance manuals with the Owner's personnel.
   4. Schedule training with the Owner, through the Architect/Engineer, with at least seven day's advanced notice.

3.5 PROTECTION

A. Provide final protection and maintain conditions in a manner acceptable to the Installer that shall ensure that the solid state UPS shall be without damage at time of Substantial Completion.

END OF SECTION

This page is intentionally left blank.

SECTION 26 36 00

TRANSFER SWITCHES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes transfer switches rated 600 V and less, including the following:
   1. Automatic transfer switches with load break bypass isolation.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, weights, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings: Dimensioned plans, elevations, sections, and details showing minimum clearances, conductor entry provisions, gutter space, installed features and devices, and material lists for each switch specified.
   1. Single-Line Diagram: Show connections between transfer switch, power sources, and load.

C. Qualification Data: For manufacturer and testing agency.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:
   1. Features and operating sequences, both automatic and manual.
   2. List of all factory settings of relays; provide relay-setting and calibration instructions, including software, where applicable.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: Maintain a service center capable of providing training, parts, and emergency maintenance repairs within a response period of less than 1 hour from time of notification.

B. Testing Agency Qualifications: An independent agency shall be contracted by and provided by the electrical contractor. The testing agency must have the experience and capability to conduct the testing indicated, that is a member company of the InterNational Electrical Testing Association or is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

1. Testing Agency's Field Supervisor: Person currently certified by the InterNational Electrical Testing Association or the National Institute for Certification in Engineering Technologies to supervise on-site testing specified in Part 3.

C. Source Limitations: Obtain automatic transfer switches through one source from a single manufacturer.

D. 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.

E. Comply with NEMA ICS 1.

F. Comply with NFPA 70.

G. Comply with NFPA 99.

H. Comply with NFPA 110.

I. Comply with UL 1008 unless requirements of these Specifications are stricter.

1.5 PROJECT CONDITIONS

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:
1. Notify Construction Manager and Owner no fewer than two days in advance of proposed interruption of electrical service.
2. Do not proceed with interruption of electrical service without Owner's written permission.

1.6 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Contactor Transfer Switches:
   a. Russelectric, RTS-30
   b. ASCO, 7000 Series

2.2 GENERAL TRANSFER-SWITCH PRODUCT REQUIREMENTS

A. 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.

B. Tested Fault-Current Closing and Withstand Ratings: All Transfer Switches shall be SELECTIVELY COORDINATED to comply with NEC. Transfer Switches shall be UL listed with a 3 and 30 cycle withstand and closing rating to insure that the transfer switch will be adequately protected regardless of the instantaneous setting on the electronic trip unit of the protective device ahead of the switch. The transfer switch withstand and closing rating must exceed the maximum fault current at the switch, as determined by the short circuit study. In no case shall the 30 cycle fault current rating of the transfer switch be less than 35,000 amperes.

C. The Transfer switch shall be provided with a microprocessor controller that is programmed at the factory to control specified options as detailed in the specification. The controller shall include a communication interface with Modbus TCP/IP via 10/100 Base-T Ethernet for connection to the paralleling switchgear. The controller shall be provided with power monitoring capability.

D. Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.41. Components shall meet or exceed voltage-impulse withstand test of NEMA ICS 1.

E. Electrical Operation: Accomplish by a nonfused, momentarily energized solenoid or electric-motor-operated mechanism, mechanically and electrically interlocked in both directions.

F. 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 not acceptable.
   2. Switch Action: Double throw; mechanically held in both directions.
   3. Contacts: Silver composition or silver alloy for load-current switching. Conventional automatic transfer-switch units, rated 225 A and higher, shall have separate arcing contacts.

G. Neutral Switching. All switches with a neutral shall be provided with a 100 percent rated, 4th pole, switched neutral mounted on a common shaft with the main power poles.

H. Factory Wiring: Train and bundle factory wiring and label, consistent with Shop Drawings, either by color-code or by numbered or lettered wire and cable tape markers at terminations. Color-coding and wire and cable tape markers are specified in Division 26 Section "Identification for Electrical Systems."
   1. Designated Terminals: Compression 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.

I. Enclosures: General-purpose NEMA 250, Type 1, complying with NEMA ICS 6 and UL 508, unless otherwise indicated.

2.3 AUTOMATIC TRANSFER SWITCHES

A. Comply with Level 1 equipment according to NFPA 110.

B. Switching Arrangement: Double-throw type, incapable of pauses or intermediate position stops during normal functioning, unless otherwise indicated.

C. Manual Switch Operation: Under load, with door closed and with either or both sources energized. Transfer time is same as for electrical operation.

D. All priority 2 transfer switches (or lower) shall be provided with a dual operator to allow load shedding of the switch to a center off position. In the event that the paralleling switchgear has detected an under frequency or overload condition, the switch shall automatically be signaled to shed to the center off position. The switch shall remain in that position until the paralleling switchgear calls for re-addition to the emergency bus or the normal power has returned.

E. Automatic Transfer-Switch Features:
   1. 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 is adjustable from 75 to 98 percent of pickup value. Factory set for pickup at 90 percent and dropout at 85 percent.
   2. Adjustable Time Delay: For override of normal-source voltage sensing to delay transfer and engine start signals. Adjustable from zero to six seconds, and factory set for one second.
   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 0 to 30 minutes, and factory set for 10 minutes to 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.
      Switch-Position Pilot Lights: Indicate source to which load is connected.
   6. 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."
   7. Unassigned Auxiliary Contacts: Two normally open, single-pole, double-throw contacts for each switch position, rated 10 A at 240-V ac.
   8. Load shed and block transfer circuits
   9. Engine Starting Contacts: One isolated and normally closed, and one isolated and normally open; rated 10 A at 32-V dc minimum.
   10. 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.
   11. A Microprocessor Controller with power monitoring and an Ethernet connection to the paralleling switchgear. The microprocessor controller shall monitor voltage amperes, power factor, and kilowatts.
   12. Elevator transfer switches shall be provided with a time delay relay to open a set of contacts prior to transfer (adjustable time function) in either direction. A normal status relay with from “c” contacts shall also be required.

13. All transfer switches shall be provided with a load break bypass isolation switch to allow direct bypass of the load to either source regardless of the position or condition of the transfer switch. One quick break, quick make handle shall bypass to the required source without any other steps required to bypass the load. The bypass switch shall be completely inter-bussed and interconnected at the factory.

2.4 SOURCE QUALITY CONTROL

A. Factory test and inspect components, assembled switches, and associated equipment. 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. Design each fastener and support to carry load indicated by seismic requirements and according to seismic-restraint details. See Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

B. Floor-Mounting Switch: Anchor to floor by bolting.
   1. Concrete Bases: 4 inches (100 mm) high, reinforced, with chamfered edges. Extend base no more than 4 inches (100 mm) in all directions beyond the maximum dimensions of switch, unless otherwise indicated or unless required for seismic support. Construct concrete bases according to Division 26 Section "Hangers and Supports for Electrical Systems."

C. Identify components according to Division 26 Section "Identification for Electrical Systems."

D. Set field-adjustable intervals and delays and relays.

3.2 CONNECTIONS

A. Wiring to Remote Components: Match type and number of cables and conductors to control and communication requirements of transfer switches as recommended by manufacturer. Increase raceway sizes at no additional cost to Owner if necessary to accommodate required wiring.

B. Connect wiring according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

3.3 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified independent testing and inspecting agency to perform tests and inspections and prepare test reports. The independent testing agency shall be contracted by and provided by the electrical contractor.(See Section D for requirements)

B. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust components, assemblies, and equipment installations, including connections. Report results in writing.

C. Perform tests and inspections and prepare test reports.
   1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installation, including connections, and to assist in testing.
   2. After installing equipment and after electrical circuitry has been energized, test for compliance with requirements.
   3. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
   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, 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 of 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.
      e. Perform contact-resistance test across main contacts and correct values exceeding 500 microhms and values for 1 pole deviating by more than 50 percent from other poles.
      f. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.

D. Independent Testing Agency's Tests and Inspections:
   1. After installing equipment and after electrical circuitry has been energized, test for compliance with requirements.
   2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
   3. 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.

4. After energizing circuits, 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 of 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.
   e. Perform contact-resistance test across main contacts and correct values exceeding 500 microhms and values for 1 pole deviating by more than 50 percent from other poles.
   f. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.

E. Coordinate tests with tests of generator and run them concurrently.

F. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.

G. Remove and replace malfunctioning units and retest as specified above.

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. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switch 11 months after date of Substantial Completion.
   2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
   3. 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 as specified below. Refer to Division 01 Section "Demonstration and Training."

B. Coordinate this training with that for generator equipment.

END OF SECTION

This page is intentionally left blank.

SECTION 26 41 13

LIGHTNING PROTECTION SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. All of the Contract Documents, as listed on the Table of Contents and including General and Supplementary Conditions and Division 1, General Requirements, shall be included in, and made part of, this Section.

B. Section 01 81 13 “Sustainable Design Requirements – LEED v4 for Building Design & Construction – New Construction” for sustainable design requirements and detailed sustainable design submittal requirements.

C. Section 01 74 19 “Construction and Demolition Waste Management and Disposal” for disposal of construction, demolition and packaging waste disposal requirements.

1.2 DESCRIPTION OF WORK

A. Provide a complete lightning protection system with all component parts as indicated and/or specified, and as manufactured by Boston Lightning Rod, Inc., Northeast Lightning Protection Systems, Inc., Bloomfield, Connecticut, National Lightning Protection Corporation, Warren Lightning Rod Co., Collingwood, New Jersey, or an approved equal.

B. Equipment furnished by one of the above manufacturers or an independent protection company shall be considered as equals.

C. The system shall include air terminals on the roof; bonding of roof mounted mechanical equipment and stacks; bonding of structure and other metal parts, ground conductors and ground rods; with necessary connectors, bonding straps, fasteners, clamps and all other equipment and materials necessary for a complete system for the building.

D. Sustainable Building Requirements:

1. The Owner requires the Contractor to implement practices and procedures to meet the project’s environmental performance goals, which include achieving LEED version 4 Certified level Certification. Specific project goals that may impact this area of work include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; construction waste recycling; and the implementation of a construction indoor air quality management plan. The Contractor shall ensure that the requirements related to these goals, as defined in the Articles below, are implemented to the fullest extent. Substitutions, or other changes to the work proposed by the Contractor or their Subcontractors, shall not be allowed if such changes compromise the aforementioned environmental goals and LEED certification.

1.3 RELATED WORK

A. For work to be included as part of this Section, to be furnished and installed by the Electrical Subcontractor, refer to the Related Work section of Specification Section 16010.

B. Carefully examine all of the Contract Documents, criteria sheets and all other Sections of the specifications for requirements which affect work under this Section, whether or not such work is specifically mentioned in this Section.

C. For work related to, and to be coordinated with the electrical work, but not included in this Section and required to be performed under other designated Sections, see the following:
   1. Section xxxxxx –Roofing Systems

1.4 REFERENCES

A. The lightning protection system and all components shall be designed, manufactured and installed in accordance with the latest applicable standards as follows:
   1. ANSI/NFPA 780 - Lightning Protection Code
   2. ANSI/UL 96 - Lightning Protection Components
   3. UL 96A - Installation Requirements for Lightning Protection

B. The system shall be designed and installed in accordance with the requirements of NFPA 780 and UL 96A to obtain Master Label on the building.

1.5 WARRANTY

A. Attention is directed to provisions of the General Requirements, Supplementary General Requirements, Section xxxxx – Warranties and Section xxxxx Electrical Special Conditions regarding guarantees and warranties for work under this Contract.

1.6 QUALIFICATIONS

A. Manufacturer shall be a company specializing in lightning protection equipment, with minimum of (10) years documented experience and listed in UL's Electrical Construction Materials Directory or Supplement under Lightning Protection - Lightning Conductor, Air Terminals and Fittings.

B. Installer shall be authorized installer of manufacturer with minimum of (10) years of documented experience and listed in UL's Electrical Construction Materials Directory or Supplement under Lightning Protection - Lightning Protection Installation.

1.7 SUBMITTALS

A. Prepare and submit shop drawings and product data in accordance with the requirements hereinbefore specified and with the Shop Drawings, Product Data and Samples Section 01330 in the manner described therein, modified as noted hereinafter.

B. Submit shop drawings showing layout of air terminals, grounding electrodes, and bonding connections to structure and other metal objects. Include terminal, electrode and conductor sizes, and connection and termination details.

C. Submit product data showing dimensions and materials of each component, and include indication of listing in accordance with ANSI/UL 96.

D. The manufacturer/installer shall submit for approval one reproducible drawing of installation drawings of each building, indicating all work required for this item including ground rod locations, air terminal locations and cable locations. Catalog cuts of all components shall also be submitted for approval to the Architect/Engineer. Three (3) prints of drawings shall be submitted for approval and (5) prints shall be submitted after approval.

E. Submit manufacturer's installation instructions under provisions of Section 01300.

1.8 PROJECT RECORD DOCUMENTS

A. Submit project Record Documents.

B. Accurately record actual locations of air terminals, grounding electrodes, bonding connections, and routing of system conductors.

1.9 SEQUENCE AND SCHEDULING

A. Coordinate work under provisions of Section xxxxxx.

B. Coordinate the work of this Section with roofing and exterior and interior finish installation.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Materials shall be new and first quality commercial products. Standard fittings shall be used where practicable, in preference to special fittings.

B. Materials shall comply in weight, size and composition with the requirements of ANSI/UL 96 and the NFPA Code relating to this type of structure.

C. Lightning rod equipment and fittings shall bear the UL label.

2.2 AIR TERMINALS

A. Air terminals shall be one-piece, lead coated, solid copper.

B. Air terminals mounted on flat roofs shall be minimum 24" in height.

2.3 AIR TERMINAL BASES

A. Air terminal bases shall provide a secure attachment to the structure, the air terminal and the conductor cable. The base shall be compatible with all (3) items in contact with it.

2.4 CONDUCTORS

A. Ground and bonding conductors shall be soft drawn copper with a conductivity of at least 95% of pure copper.

2.5 CONNECTOR FITTINGS

A. A connector fitting shall be constructed so that a minimum of 1 1/2" of each conductor can be secured within the connector. It shall be compatible with the material being secured.

B. Water pipe connectors shall be constructed so as to provide at least 1 1/2" contact with the water pipe and conductor. It shall be compatible with the water pipe and conductor materials or be lead coated to form a bimetallic connection.

2.6 CLIPS

A. Clips for securing copper conductors shall be not less than 0.032" thick and not less than 3/8" wide. Clips shall be placed not more than 3'-0" apart along a conductor.

2.7 GROUND ROD CLAMPS

A. Ground rod clamps shall be not less than 3/32" thick, contact the ground rod and conductor not less than 1 1/2" and be secured with at least (2) bolts.

2.8 GROUND ELECTRODES

A. Ground electrodes shall be as specified of proper size and material compatible with ground conditions and to obtain the desired minimum ground resistance.

2.9 FASTENERS

A. Fasteners shall be compatible with the materials being secured and of a size and type specified.

2.10 CADWELD

A. Bonding of lighting protection systems to building steel, ground rods, cable connections, all connections below grade, etc. shall utilize Cadweld exothermic grounding connections

PART 3 - EXECUTION

3.1 COOPERATION AND WORK PROGRESS

A. The Electrical work shall be carried on under the usual construction conditions, in conjunction with all other work at the site. The Electrical Subcontractor shall cooperate with the Architect, General Contractor, all other Subcontractors and equipment suppliers working at the site. The Electrical Subcontractor shall

coordinate the work and proceed in a manner so as not to delay the progress of the project.

B. The Electrical Subcontractor shall coordinate his work with the progress of the building and other Trades so that he will complete his work as soon as conditions permit and such that interruptions of the building functions will be at a minimum. Any overtime hours worked or additional costs incurred due to lack of or improper coordination with other Trades or the Owner by the Electrical Subcontractor, shall be assumed by him without any additional cost to the Owner.

C. The Electrical Subcontractor shall furnish information on all equipment that is furnished under this Section but installed under another Section to the installing Subcontractor as specified herein.

D. The Electrical Subcontractor shall provide all materials, equipment and workmanship to provide for adequate protection of all electrical equipment during the course of construction of the project. This shall also include protection from moisture and all foreign matter. The Electrical Subcontractor shall also be responsible for damage which he causes to the work of other Trades, and he shall remedy such injury at his own expense.

E. Waste materials shall be removed promptly from the premises. All material and equipment stored on the premises shall be kept in a neat and orderly fashion. Material or equipment shall not be stored where exposed to the weather. The Electrical Subcontractor shall be responsible for the security, safekeeping and damages, including acts of vandalism, of all material and equipment stored at the job site.

F. The Electrical Subcontractor shall be responsible for unloading all electrical equipment and materials delivered to the site. This shall also include all large and heavy items or equipment which require hoisting. Consult with the General Contractor for hoisting/crane requirements. During construction of the building, the Electrical Subcontractor shall provide additional protection against moisture, dust accumulation and physical damage of the main service and distribution equipment. This shall include furnishing and installing temporary heaters within these units, as approved, to evaporate excessive moisture and ventilate it from the room, as may be required.

G. It shall be the responsibility of the Electrical Subcontractor to coordinate the delivery of the electrical equipment to the project prior to the time installation of equipment will be required; but he shall also make sure such equipment is not delivered too far in advance of such required installation, to ensure that possible damage and deterioration of such equipment will not occur. Such equipment stored for an excessively long period of time (as determined in the opinion of the Architect) on the project site prior to installation may be subject to rejection by the Architect.

H. The Electrical Subcontractor shall erect and maintain, at all times, necessary safeguards for the protection of life and property of the Owner, Workmen, Staff and the Public.

I. Prior to installation, the Electrical Subcontractor has the responsibility to coordinate the exact mounting arrangement and location of electrical equipment to allow proper space requirements as indicated in the NEC. Particular attention shall be given in the field to group installations. If it is questionable that sufficient

space, conflict with the work of other Subcontractors, architectural or structural obstructions will result in an arrangement which will prevent proper access, operation or maintenance of the indicated equipment, the Electrical Subcontractor shall immediately notify the Contractor and not proceed with this part of the Contract work until definite instructions have been given to him by the Architect.

3.2 INSTALLATION

A. General
1. Unless specifically noted or indicated otherwise, all equipment and material specified in Part 2 of this specification or indicated on the drawings shall be installed under this Contract whether or not specifically itemized herein. This Section covers particular installation methods and requirements peculiar to certain items and classes or material and equipment.
2. The Electrical Subcontractor shall obtain detailed information from manufacturers of equipment provided under Part 2 of this specification as to proper methods of installation.
3. The Electrical Subcontractor shall obtain final roughing dimensions and other information as needed for complete installation of items furnished under other Sections or furnished by the Owner.
4. The Electrical Subcontractor shall keep fully informed of size, shape and position of openings required for material and equipment provided under this and other Sections. Ensure that openings required for work of this Section are coordinated with work of other Sections. Provide cutting and patching as necessary.
5. All miscellaneous hardware and support accessories, including support rods, nuts, bolts, screws and other such items, shall be of a galvanized or cadmium plated finish or of another approved rust-inhibiting coating.
6. The lightning protection system shall be installed in accordance with the current edition of UL 96A "Installation Requirements for Master Labeled Lightning Protection Systems".
   a. No ferrous fasteners (except stainless steel), nor ferrous holding devices of any kind shall be employed as permanent fasteners.
   b. Individual anchor bolts, employed in this installation, shall each have a pull-out resistance of not less than 100 pounds as determined by actual test.
   c. The installation shall be made in a most conspicuous manner. Conductors shall be coursed on the back side of architectural construction to conceal equipment as much as possible.

B. Air Terminal Installation
1. Air terminals shall be installed as required by UL.
2. Air terminals shall have their points aligned vertically, and their bases shall be bolted or welded to the building.

C. Conductor Installation
1. Down conductors shall be installed on buildings at intervals of 100'-0" on center, maximum. When structural building steel is used instead of down conductors, the ground conductor interval shall not average over 60'-0" on center.
2. Conductors shall be connected to the ground rods with ground clamps allowing a reasonable amount of slack conductor to allow for expansion and

contraction. Steel surfaces shall be clean and bright before applying connector plates or Cadwelding. Bends in these conductors shall have no angle more than 90°. Bends shall have a radius of not less than 8". Connectors shall, when fixed to conductors, be capable of withstanding a pull of 200 pounds.

3. Bonding conductors shall be connected to the bonding clamps allowing a reasonable amount of slack for expansion and contraction, and the conductor bonds shall be limited as stated above.
4. All metal fascia, television masts, ventilators, vents, roof drains, stacks, etc. shall be grounded.

D. Ground Installation
1. Ground terminal installation shall be made at all locations indicated on the drawings and at such other points as may be found necessary to properly ground the system.
2. All grounds shall be made by means of rods driven into the soil which shall penetrate vertically not less than 10'-0" below the finished surface of the ground and passing approximately 2'-0" away from the building foundations.
3. The Electrical Subcontractor shall add to the ground system in case the measured resistance exceeds 50 ohms per electrode, at the direction of the Architect/Engineer and at no additional cost to the Owner.
4. A stamped tag of non-corrosive metal shall be attached to the metal support for each building adjacent to each ground connection, to indicate the location and arrangement of the rods and final value of the resistance at time of installation. An as-built drawing and record of resistance values shall be submitted in addition to the stamped tag.

E. Grounding Cable Connections
1. All grounding cable connections to ground rods, structural steel and splices shall be of the exothermic welding process.

F. Where cables penetrate the roofing membrane, penetrations shall be permanently sealed per roof manufacturer's recommended methods by the Roofing Subcontractor.

3.3 EXAMINATION

A. Verify that surfaces are ready to receive work.

B. Verify that field measurements are as shown on the drawings.

C. Beginning of installation shall mean installer accepts existing conditions.

3.4 PROTECTION OF SURROUNDING ELEMENTS

A. Protect elements surrounding work of this Section from damage or disfiguration.

3.5 FIELD QUALITY CONTROL

A. Field inspection and testing will be performed under provisions of Section xxxx.

B. Obtain the services of UL to provide inspection and certification of the lightning protection system under provisions of UL 96A.

C. Obtain UL Master Label and attach to building at the location prescribed by UL 96A.

END OF SECTION

This page is intentionally left blank.

SECTION 26 43 13

SURGE PROTECTION FOR LOW VOLTAGE ELECTRICAL POWER CIRCUITS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Scope: Provide labor, material, equipment, related services, and supervision required, including, but not limited to, manufacturing, fabrication, erection, and installation for surge protection for low voltage electrical power circuits as required for the complete performance of the work, and as shown on the Drawings and as herein specified.

B. Section Includes: The work specified in this Section includes, but shall not be limited to, the following:
   1. Requirements for integrated SPDs (installed from the factory) for low voltage power distribution and control equipment.

1.3 REFERENCES

A. General: The publications listed below form a part of this Specification to the extent referenced. The publications are referred to in the text by the basic designation only. The edition/revision of the referenced publications shall be the latest date as of the date of the Contract Documents, unless otherwise specified.

B. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
   1. ANSI/IEEE C62.41.1, “Guide on the Surges Environment in Low Voltage (1000 V and Less) AC Power Circuits.”
   2. ANSI/IEEE C62.41.2, “Recommended Practice on Characterization of Surges in Low Voltage (1000 V and Less) AC Power Circuits.”
   3. ANSI/IEEE C62.45, “Guide on Surge Testing for Equipment Connected to Low Voltage AC Power Circuits.”

C. International Organization for Standardization (ISO):
   1. ISO 9001, "Quality Management Systems - Requirements."

D. National Fire Protection Association (NFPA):
   1. NFPA 70, "National Electrical Code," hereinafter referred to as NEC.

E. Underwriters Laboratories, Inc. (UL):
   1. UL 67, "Standard for Panelboards."
   2. UL 96A, "Standard for Installation Requirements for Lightning Protection Systems."
   3. UL 845, "Motor Control Centers."
   4. UL 857, "Busways."

5. UL 891, "Switchboards."
6. UL 1283, “Standard for Safety for Electromagnetic Interference Filters."
7. UL 1449, "Standard for Surge Protective Devices."
8. UL 1558, "Standard for Metal-Enclosed Low-Voltage Power Circuit Breaker Switchgear."

1.4 DEFINITIONS

A. $I_{(n)}$: Nominal discharge current rating.

B. MCOV: Maximum continuous operating voltage.

C. Protection Modes: The pair of electrical connections where the VPR applies.

D. MOV: Metal oxide varistor; an electronic component with a significant non-ohmic current voltage characteristic.

E. OCPD: Overcurrent protective device.

F. SCCR: Short circuit current rating.

G. SPD: Surge protective device.

H. VPR: Voltage protection rating.

1.5 SYSTEM DESCRIPTION

A. General SPD Requirements:
1. SPD with accessories shall be listed and labeled as defined in NEC, by UL, and marked for intended location and application.
2. Comply with UL 1449.
3. Comply with UL 1283 (applies to Type 2 SPDs).
4. Design in accordance with ANSI/IEEE C62.41.1, ANSI/IEEE C62.41.2, and ANSI/IEEE C62.45.
5. SPDs manufacturer shall be ISO 9001 certified.
6. MCOV of the SPD shall not be less than 115 percent for 480Y/277V and 125 percent for 208Y/120V nominal RMS system voltages.
7. SPDs shall be installed internal to the distribution equipment and shall be of the same manufacturer as the equipment. The equipment shall be fully tested and certified to the following UL standards:
   a. Panelboards: UL 67.
   b. Motor Control Centers: UL 845.
   c. Busway: UL 857.
   d. Switchboards: UL 891.
   e. Switchgear: UL 1558.

1.6 SUBMITTALS

A. General: See [Section 01 33 00 - Submittal Procedures] [Section 01300 - Submittals].

B. Product Data: Submit product data showing material proposed. Submit sufficient information to determine compliance with the Drawings and Specifications.

1. For each type of product indicated include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.
2. Provide verification the SPD is listed or recognized through UL to the latest safety standard, UL 1449.

C. Shop Drawings: Submit shop drawings for each product and accessory required. Include information not fully detailed in manufacturer's standard product data.

D. Operation and Maintenance Data: Submit operation and maintenance data for surge protection for low voltage electrical power circuits to include in operation and maintenance manuals.

E. Warranty Data: Submit sample of special warranties.

1.7 QUALITY ASSURANCE

A. Qualifications:
1. Manufacturer Qualifications: Manufacturer shall be a firm engaged in the manufacture of surge protection for low voltage electrical power circuits of types and sizes required, and whose products have been in satisfactory use in similar service for a minimum of five years.
2. Installer Qualifications: Installer shall be a firm that shall have a minimum of five years of successful installation experience with projects utilizing surge protection for low voltage electrical power circuits similar in type and scope to that required for this Project and shall be approved by the manufacturer.

B. Regulatory Requirements: Comply with applicable requirements of the laws, codes, ordinances, and regulations of Federal, State, and local authorities having jurisdiction. Obtain necessary approvals from such authorities.

C. Single Source Responsibility: Obtain surge protection for low voltage electrical power circuits and required accessories from a single source with resources to produce products of consistent quality in appearance and physical properties without delaying the work. Any materials which are not produced by the manufacturer shall be acceptable to and approved by the manufacturer.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials to the Project site in supplier's or manufacturer's original wrappings and containers, labeled with supplier's or manufacturer's name, material or product brand name, and lot number, if any.

B. Store materials in their original, undamaged packages and containers, inside a well ventilated area protected from weather, moisture, soiling, extreme temperatures, and humidity.

1.9 WARRANTY

A. General: See [Section 01 77 00 - Closeout Procedures] [Section 01770 - Closeout Procedures].

B. Special Warranty: Submit a written warranty executed by the manufacturer, the Installer, and the Contractor, agreeing to repair or replace surge protection for low

voltage electrical power circuits that fail in materials or workmanship within the specified warranty period.

1. Warranty Period: Warranty period shall be 10 years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis of Design: Product specified is “Surgelogic Surge Protection” as manufactured by Square D by Schneider Electric. Items specified are to establish a standard of quality for design, function, materials, and appearance. Equivalent products by other manufacturers are acceptable. The Architect/Engineer will be the sole judge of the basis of what is equivalent.

2.2 SERVICE ENTRANCE SUPPRESSORS

A. SPDs: Comply with UL 1449.
   1. SPDs installed on the line side of the service entrance OCPD shall be Type 1 SPDs. SPDs installed on the load side of the service entrance OCPD shall be either Type 1 or Type 2 SPDs.
   2. Type 2 SPDs shall also comply with UL 1283.

B. Features and Accessories: SPDs shall provide the following features and accessories:
   1. Internal fusing design capable of disconnecting the SPD before any damaging external effects to the suppressor or surroundings occur.
   2. Indicator light(s) display for power and protection status with push-to-test capabilities.
   3. Audible alarm with silencing switch.
   4. Form C contacts; one normally open and one normally closed for remote monitoring of protection status. Contacts shall reverse on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
   5. Surge counter with reset switch.

C. Surge Current Rating: The surge current rating of the SPD shall be dependent of its category/location, as follows:

Category/Location	Application	Per Phase	Per Mode
C	Service Entrance	240 kA	120 kA
B	Distribution	160 kA	80 kA

D. Protection Modes:
   1. UL 1449 VPR for grounded WYE configured circuits shall not exceed the following:

Modes	208Y/120	480Y/277	600Y/347
L-N; L-G; N-G	800 volts	1200 volts	1500 volts
L-L	1200 volts	2000 volts	2500 volts

   2. UL 1449 VPR for Delta configured circuits shall not exceed the following:

Modes	240D	480D	600D
L-G; N-G	1200 volts	2000 volts	2500 volts

E. SCCR: Per NEC 285.6, the short circuit current rating of the SPD shall be equal to or greater than the available short circuit current at the point on the system where installed.

F. Nominal Discharge Current Rating: 20 kA I(n).
   1. Surge protective devices located at service entrance locations shall carry a minimum nominal discharge current rating of 20 kA to meet the requirements of UL 96A.

2.3 DISTRIBUTION/ BRANCH PANEL SUPPRESSORS

A. SPDs: Comply with UL 1449.
   1. Type 1 or Type 2 SPDs.
   2. Type 2 SPDs shall also comply with UL 1283.

B. Features and Accessories: SPDs shall provide the following features and accessories:
   1. Internal fusing design capable of disconnecting the SPD before any damaging external effects to the suppressor or surroundings occur.
   2. Indicator light(s) display for power and protection status.
   3. Audible alarm with silencing switch.
   4. Form C contacts; one normally open and one normally closed for remote monitoring of protection status. Contacts shall reverse on failure of any surge diversion module or on opening of any current-limiting device. Coordinate with building power monitoring and control system.
   5. Surge counter with reset switch.
   6. Optional integral disconnect switch for externally mounted SPDs. SPDs integrated into factory supplied equipment shall have an input disconnect switch or circuit breaker unless indicated on the equipment drawings/data sheets.

C. Surge Current Rating: The surge current rating of the SPD shall be dependent of its category/location, as follows:

Category/Location	Application	Per Phase	Per Mode
B	Distribution	160 kA	80 kA
B	Branch	120 kA	60 kA

D. Protection Modes:
   1. UL 1449 VPR for grounded WYE configured circuits shall not exceed the following:

Modes	208Y/120	480Y/277	600Y/347
L-N; L-G; N-G	800 volts	1200 volts	1500 volts
L-L	1200 volts	2000 volts	2500 volts

   2. UL 1449 VPR for Delta configured circuits shall not exceed the following:

Modes	240D	480D	600D
L-G; N-G	1200 volts	2000 volts	2500 volts

E. SCCR: Per NEC 285.6, the short circuit current rating of the SPD shall be equal to or greater than the available short circuit current at the point on the system where installed.

F. Nominal Discharge Current Rating: 10 kA I(n).

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verification of Conditions: Examine areas and conditions under which the work is to be installed, and notify the Contractor in writing, with a copy to the Owner and the Architect, of any conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.
   1. Beginning of the work shall indicate acceptance of the areas and conditions as satisfactory by the Installer.

3.2 INSTALLATION

A. Surge protection for low voltage electrical power circuits shall be integral and factory installed in accordance with reviewed product data, final shop drawings, manufacturer’s written instructions and recommendations, and as indicated on the Drawings.

3.3 FIELD QUALITY CONTROL

A. See [Section 01 45 23 - Inspecting and Testing Services] [Section 01410 - Inspecting and Testing Services].

B. Perform the following tests and inspections.
   1. Compare equipment nameplate data for compliance with the Drawings and the Specifications.
   2. Inspect anchorage, alignment, grounding, and clearances.
   3. Verify that electrical wiring installation complies with manufacturer's written installation requirements.

C. A SPD will be considered defective if it does not pass inspections.

D. Prepare inspection reports.

3.4 DEMONSTRATION

A. Start-Up Service:
   1. Complete start-up checks according to manufacturer's written instructions.
   2. Do not perform insulation resistance tests of the distribution wiring equipment with SPDs installed. Disconnect all wires, including, but not limited to, neutral of the SPD before conducting insulation resistance tests, and reconnect them immediately after the testing is over.
   3. Energize SPDs after power system has been energized, stabilized, and tested.

3.5 PROTECTION

A. Provide final protection and maintain conditions in a manner acceptable to the Installer, that shall ensure that the surge protection for low voltage electrical power circuits shall be without damage at time of Substantial Completion.

END OF SECTION

Conformed Set, 02 Oct 2020

SECTION 26 51 00

INTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:
1. Interior lighting fixtures, lamps, and drivers.
2. Light Emitting Diode (LED) fixtures and drivers.
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/vacancy sensors, and multipole lighting relays and contactors.
2. ~~Section 260936 "Modular Dimming Controls" for architectural dimming systems.~~
3. ~~Section 260943.13 "Addressable-Fixture Lighting Controls" and Section 260943.23 "Relay-Based Lighting Controls" for manual or programmable control systems with low-voltage control wiring or data communication circuits.~~
4. Section 262726 "Wiring Devices" for manual wall-box dimmers for incandescent lamps.
5. ~~Section 265561 "Theatrical Lighting" for theatrical lighting fixtures and their controls.~~

C. Reference Standards
1. NEFA 70: National Electrical Code; National Fire Protection Association.
2. IESNA LM-63: ANSI Approved Standard File Format for Electronic Transfer of Photometric Data and Related Information.
3. IESNA LM-79: IESNA - Approved Method for Electrical and Photometric Measurements of LED Lighting Products
4. IESNA LM-80: IESNA - Approved Method for Measuring Lumen Maintenance of Lighting Emitting Diode (LED) Light Sources.
5. IESNA TM-21: Projecting Long Term Lumen Maintenance of LED Light Source.

6. OSHA 29CFR1910.7: luminaires shall be listed by nationally recognized testing laboratory approved by United Stated Department of Labor, Occupational Safety and Health Administration (OSHA)
7. UL 1310 and 8750 – LED Equipment for Use in Lighting Products.

1.3 DEFINITIONS

A. BF: Ballast factor.

B. CCT: Correlated color temperature.

C. CRI: Color-rendering index.

D. Chromaticity: The property of color of light defined by the dominant or complementary wavelength and purity aspects of the color taken together.

E. HID: High-intensity discharge.

F. L80: The extrapolated life in hours of the luminaire when the luminous output depreciates 20 percent from initial values.

G. LED: Light Emitting Diode

H. LER: Luminaire efficacy rating.

I. Lumen: Measured output of lamp and luminaire, or both.

J. Luminaire: Complete lighting fixture, including ballast housing or driver if provided.

K. MacAdam: Shape on the CIE chromaticity diagram that illustrates how much one can “stray” from the target before perceiving a difference from the target color

L. NEMA: National Electrical Manufacturers Association

M. SSL: Solid State Lighting

N. THD: Total Harmonic Distortion - The amount of higher frequency power on the power line.

1.4 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. Retain first two subparagraphs below for projects with air-handling lighting fixtures.

5. Air and Thermal Performance Data: For air-handling lighting fixtures. Furnish data required in "Action Submittals" Article in Section 233713 "Diffusers, Registers, and Grilles."
6. Sound Performance Data: For air-handling lighting fixtures. Indicate sound power level and sound transmission class in test reports certified according to standards specified in Section 233713 "Diffusers, Registers, and Grilles."
7. Life, output (lumens, CCT, and CRI), and energy-efficiency data for lamps.
8. 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.
9. LED power supplies

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. Samples: For each lighting fixture indicated in the Interior Lighting Fixture Schedule. Each Sample shall include the following:
   1. Lamps and drivers, installed.
   2. Cords and plugs.
   3. Pendant support system.

D. Manufacturer's Instructions: Include instructions for storage, handling, protection, examination, preparation, and installation of product.

1.5 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plan(s) 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. Lighting fixtures.
   2. Suspended ceiling components.
   3. Partitions and millwork that penetrate the ceiling or extends to within 12 inches (305 mm) of the plane of the luminaires.
   4. Ceiling-mounted projectors.
   5. Structural members to which suspension systems for lighting fixtures will be attached.

6. Other items in finished ceiling including the following:
   a. Air outlets and inlets.
   b. Speakers.
   c. Sprinklers.
   d. Smoke and fire detectors.
   e. Occupancy/vacancy sensors.
   f. Access panels.
7. Perimeter moldings.

B. Qualification Data: For qualified agencies providing photometric data for lighting fixtures.

C. Product Certificates: For each type of ballast for bi-level and dimmer-controlled fixtures, from manufacturer.

D. Field quality-control reports.

E. Warranty: Sample of special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For lighting equipment and fixtures to include in emergency, operation, and maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Lamps: 10 for every 100 of each type and rating installed. Furnish at least one of each type.
   2. Plastic Diffusers and Lenses: One for every 100 of each type and rating installed. Furnish at least one of each type.
   3. Globes and Guards: One for every 20 of each type and rating installed. Furnish at least one of each type.
   4. ~~Fluorescent~~ LED -fixture-mounted, emergency battery pack: One for every 20 <twenty> emergency lighting unit.

1.8 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.

F. Product submittals shall be accompanied by product specification sheets or other documentation that includes the designed parameters as detailed in this specification. These parameters include (but are not limited to):
   1. Maximum power in watts.
   2. L80 in hours, when extrapolated for the worse case operating temperature. TM21 report shall be submitted to demonstrate this.

G. LED fixtures shall comply with the following:
   1. UL Standard_8750 “Light Emitting Diode Equipment for Use in Lighting Products:, IES Standard LM-79 “Electrical and Photometric Measurements of Solid State Lighting Products”, IES Standard LM-80 “Measuring Lumen Maintenance of LED Lighting Sources”, and IES Standard TM-21 “Projecting Long Term Lumen Maintenance of LED Light Sources”.
   2. ANSI C78.377 “Specifications for the Chromaticity of Solid State Lighting Products” with LED binned within a maximum three-step MacAdam Ellipse to ensure color consistency amongst luminaires of the same type.

H. Mockups: Provide interior lighting fixtures for room or module mockups, complete with power and control connections.
   1. Obtain Architect's approval of fixtures for mockups before starting installations.
   2. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
   3. Approved fixtures in mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.9 COORDINATION

A. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, and partition assemblies.

1.10 WARRANTY

A. For non-LED lighting fixtures and components, provide a complete warranty for parts and labor for a minimum of one year from the date of Substantial Completion.

B. For LED fixtures, lamps, drivers, and components, provide a complete warranty for parts and labor for a minimum of five years from the date of Substantial Completion.

C. 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: 10 <Ten> years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining nine years.
   2. Warranty Period for Emergency Batteries ~~Fluorescent Ballast~~ and Self-Powered Exit Sign Batteries: Seven <7> years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining six years.

1.11 DELIVERY, STORAGE, AND HANDLING

A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering before shipping.

B. Store in a clean, dry space. Maintain factory wrapping or provide an additional heavy canvas or heavy plastic cover to protect units from dirt, water, construction debris, and traffic.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR LIGHTING FIXTURES AND COMPONENTS

A. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.

B. ~~Fluorescent~~ LED Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5 and NEMA LE 5A as applicable.

C. LED Fixtures: Comply with UL 1598.

D. Metal Parts: Free of burrs and sharp corners and edges.

E. Sheet Metal Components: Steel unless otherwise indicated. Form and support to prevent warping and sagging.

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.

G. 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 (3.175 mm) minimum unless otherwise indicated.
b. UV stabilized.

2. Glass: Annealed crystal glass unless otherwise indicated.

H. 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.

~~2.2 BALLASTS FOR LINEAR FLUORESCENT LAMPS~~

~~A. General Requirements for Electronic Ballasts:~~
~~1. Comply with UL 935 and with ANSI C82.11.~~
~~2. Designed for type and quantity of lamps served.~~
~~3. Ballasts shall be designed for full light output unless another BF, dimmer, or bi-level control is indicated.~~
~~4. Sound Rating: Class A.~~
~~5. Total Harmonic Distortion Rating: Less than 10 percent.~~
~~6. Transient Voltage Protection: IEEE C62.41.1 and IEEE C62.41.2, Category A or better.~~
~~7. Operating Frequency: 42 kHz or higher.~~
~~8. Lamp Current Crest Factor: 1.7 or less.~~
~~9. BF: 0.88 or higher.~~
~~10. Power Factor: 0.95 or higher.~~
~~11. Parallel Lamp Circuits: Multiple lamp ballasts shall comply with ANSI C82.11 and shall be connected to maintain full light output on surviving lamps if one or more lamps fail.~~

~~B. Luminaires controlled by occupancy/vacancy sensors shall have programmed-start ballasts.~~

~~C. Electronic Programmed-Start Ballasts for T5, T8, T5HO, T5 and T5HO Lamps: Comply with ANSI C82.11 and the following:~~
~~1. Lamp end-of-life detection and shutdown circuit for T5 diameter lamps.~~
~~2. Automatic lamp starting after lamp replacement.~~

~~D. Electromagnetic Ballasts: Comply with ANSI C82.1; energy saving, high-power factor, Class P, and having automatic-reset thermal protection.~~
~~1. Ballast Manufacturer Certification: Indicated by label.~~

~~E. Single Ballasts for Multiple Lighting Fixtures: Factory wired with ballast arrangements and bundled extension wiring to suit final installation conditions without modification or rewiring in the field.~~

~~F. Ballasts for Low-Temperature Environments:~~

~~1. Temperatures 0 Deg F (Minus 17 Deg C) and Higher: Electronic type rated for 0 deg F (minus 17 deg C) starting and operating temperature with indicated lamp types.~~
~~2. Temperatures Minus 20 Deg F (Minus 29 Deg C) and Higher: Electromagnetic type designed for use with indicated lamp types.~~

~~G. Ballasts for Residential Applications: Fixtures designated as "Residential" may use low-power-factor electronic ballasts having a Class B sound rating and total harmonic distortion of approximately 30 percent.~~

~~H. Ballasts for Low Electromagnetic-Interference Environments: Comply with 47 CFR 18, Ch. 1, Subpart C, for limitations on electromagnetic and radio-frequency interference for consumer equipment.~~

~~I. Ballasts for Dimmer-Controlled Lighting Fixtures: Electronic type.~~
~~1. Dimming Range: 100 to 5 percent of rated lamp lumens.~~
~~2. Ballast Input Watts: Can be reduced to 20 percent of normal.~~
~~3. Compatibility: Certified by manufacturer for use with specific dimming control system and lamp type indicated.~~
~~4. Control: Coordinate wiring from ballast to control device to ensure that the ballast, controller, and connecting wiring are compatible.~~

2.3 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/Remote Sign Configurations:
   a. Master Unit: Comply with requirements above for self-powered exit signs, and provide additional capacity in LED power supply 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.

~~2.4 FLUORESCENT LAMPS~~

~~A. T8 rapid-start lamps, rated 32 W maximum, nominal length of 48 inches (1220 mm), 2800 initial lumens (minimum), CRI 75 (minimum), color temperature 3500K, and average rated life 20,000 hours unless otherwise indicated.~~

~~B. T5 rapid-start lamps, rated 28 W maximum, nominal length of 45.2 inches (1150 mm), 2900 initial lumens (minimum), CRI 85 (minimum), color temperature 3000K, and average rated life of 20,000 hours unless otherwise indicated.~~

~~C. T5HO rapid-start, high-output lamps, rated 54 W maximum, nominal length of 45.2 inches (1150 mm), 5000 initial lumens (minimum), CRI 85 (minimum), color temperature 4100K, and average rated life of 20,000 hours unless otherwise indicated.~~

~~D. Compact Fluorescent Lamps: 4-Pin, CRI 80 (minimum), color temperature 3000K, average rated life of 10,000 hours at three hours operation per start unless otherwise indicated.~~
~~1. 13 W: T4, double or triple tube, rated 900 initial lumens (minimum).~~
~~2. 18 W: T4, double or triple tube, rated 1200 initial lumens (minimum).~~
~~3. 26 W: T4, double or triple tube, rated 1800 initial lumens (minimum).~~
~~4. 32 W: T4, triple tube, rated 2400 initial lumens (minimum).~~
~~5. 42 W: T4, triple tube, rated 3200 initial lumens (minimum).~~
~~6. 57 W: T4, triple tube, rated 4300 initial lumens (minimum).~~
~~7. 70 W: T4, triple tube, rated 5200 initial lumens (minimum).~~

2.5 LED FIXTURES AND COMPONENTS

A. The LED fixture shall be operated at constant and carefully regulated current levels. LEDs shall not be overdriven beyond their specified nominal voltage and current.

B. For wet and damp use, LED-based fixture itself shall be sealed, rated, and tested for appropriate environmental conditions, not accomplished by using an additional housing or enclosure.

C. LED fixture housing shall be designed to transfer heat from the LED board to the outside environment.

D. All hardwired connections to LED fixtures shall be reverse polarity protected and provide high voltage protection in the event connections are reversed or shorted during the installation process.

E. All LED fixtures and power/data supplies shall be provided by a single manufacturer to ensure compatibility.

F. Manufacturer of LED systems shall utilize an advanced production LED binning process to maintain color consistency.

G. Manufacturer shall ensure that products undergo and successfully meet appropriate design and manufacturability testing including Design FMEA, Process FMEA, Environmental Engineering Considerations and Laboratory Tests, IEC standards and UL/CE testing.

H. Manufacturer shall provide photometric data in IES file format in accordance with IES LM-63, based on test results from an independent testing lab.

I. Manufacturer shall have at least five years of experience designing, selling and supporting intelligent LED systems.

J. LED Fixtures and Drivers:
   1. LED driver shall be UL/ELT/CSA certified for use in a dry or damp location.
   2. LED lamps shall have a CRI of minimum 80, and a lumen maintenance L70 rating of 50,000 hours minimum.
   3. Driver shall be installed in an electrical enclosure.
   4. Driver shall have Class A sound rating, have a minimum efficiency of 85%, Total Harmonic Distortion Rating: 20% Maximum at all input voltage.
   5. Nominal Operating Voltage.
   6. Maximum driver case temperature not to exceed driver manufacturer recommended in- situ operation.
   7. Compatibility: Certified by manufacturer for use with individually specified luminaire and individually specified control components.

K. The lighting system shall consist of the type and manufacturer as shown on the drawings or approved equal. If other than fixture shown is submitted complete illumination calculations are required to show equality

L. LED fixtures shall be modular and allow for separate replacement of LED lamps and drivers. User serviceable LED lamps and drivers shall be replaceable from the room side. LED Boards shall be suitable for field maintenance and have plug-in connectors. LED boards shall be upgradable.

M. Retrofit LED lamps shall comply with NEMA SSL 4 “SSL Retrofit Lamps: Suggested Minimum Performance Requirements”.

N. Dimmable LED drivers shall be capable of dimming without LED strobing or flickers across their full dimming range, and shall be smooth and continuous change in level (no visible steps in transitions.

O. Individual LEDs shall be connected such that a catastrophic loss or the failure of one LED will not result in the loss of the all LEDs within the luminaire.

P. Lumen output shall not decrease by more than 20% over the minimum operational life of 50,000 hours at the rated ambient operating temperature.

Q. LED boards to be tested for color consistency and shall be within a space of 2.5 MacAdam ellipses on the CIE chromaticity chart.

R. LED's shall be Restriction of Hazardous Substances Directive (RoHS) compliant.

S. Luminaires shall have internal thermal protection.

T. Controller and Control System
   1. System electronics driver / controller to use coordinated communication protocols: DMX512, 0-10V, DALI, or proprietary as required
   2. Provide connector types and wiring as appropriate for un-interrupted communication between devices, considering distance maximums, field obstructions, and accessibility. Ensure that connection points are optically isolated for system noise reduction.
   3. For control components that are part of overall area control system see Dimming Controls Specifications.
   4. Compatibility: Certified by manufacturer for use with individually specified luminaire and individually specified power supplies and/or drivers.

2.6 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 (13-mm) steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.

C. Twin-Stem Hangers: Two, 1/2-inch (13-mm) 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 (2.68 mm).

E. Wires for Humid Spaces: ASTM A 580/A 580M, Composition 302 or 304, annealed stainless steel, 12 gage (2.68 mm).

F. Rod Hangers: 3/16-inch (5-mm) 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/Drivers: Distance between the ballast/drivers 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 (150 mm) 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 (20-mm) 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 inches (1200 mm), 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. Air-Handling Lighting Fixtures: Install with dampers closed and ready for adjustment.

G. 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. Verify that self-luminous exit signs are installed according to their listing and the requirements in NFPA 101.

C. 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.

D. Operate each luminaire after installation and connection. Inspect for improper connections and operation.

E. Test and calibrate all controls associated with luminaires, i.e. daylighting, occupancy sensors, etc.).

3.4 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting aimable luminaires to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose. Some of this work may be required after dark.
   1. Adjust aimable luminaires in the presence of Architect.

END OF SECTION

This page is intentionally left blank.

SECTION 26 56 00

EXTERIOR LIGHTING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Exterior luminaires.
2. Luminaire supports.
3. Luminaire-mounted photoelectric relays.
4. Exterior solid-state luminaires that are designed for and exclusively use LED lamp technology.

B. Related Requirements:

1. Section 260923 "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.
2. ~~Section 260926 "Lighting Control Panelboards" for panelboard-based lighting control.~~
3. ~~Section 260933 "Central Dimming Controls" or Section 260936 "Modular Dimming Controls" for architectural dimming systems specified in Section 265100.~~
4. ~~Section 260943.16 "Addressable-Luminaire Lighting Controls" and Section 260943.23 "Relay-Based Lighting Controls" for manual or programmable control systems with low-voltage control wiring or data communication circuits.~~
5. ~~Section 265613 "Lighting Poles and Standards" for poles and standards used to support exterior lighting equipment.~~

C. Reference Standards

1. IESNA LM-63: ANSI Approved Standard File Format for Electronic Transfer of Photometric Data and Related Information.
2. IESNA LM-79: IESNA - Approved Method for Electrical and Photometric Measurements of LED Lighting Products
3. IESNA LM-80: IESNA - Approved Method for Measuring Lumen Maintenance of Lighting Emitting Diode (LED) Light Sources.

4. IESNA TM-21: Projecting Long Term Lumen Maintenance of LED Light Source.
5. UL 1310 and 8750 – LED Equipment for Use in Lighting Products.

1.3 DEFINITIONS

A. CCT: Correlated color temperature.

B. CRI: Color-rendering index.

C. HID: High-intensity discharge.

D. LED: Light Emitting Diode

E. Lumen: Measured output of lamp and luminaire, or both.

F. Luminaire: Complete lighting fixture, including ballast housing or driver if provided.

G. SSL: Solid State Lighting

1.4 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. Arrange in order of luminaire designation.
2. Include data on features, accessories, and finishes.
3. Include physical description and dimensions of luminaire.
4. Lamps, include life, output (lumens, CCT, and CRI), and energy-efficiency data.
5. Photometric data and adjustment factors based on laboratory tests, complying with [IES Lighting Measurements Testing and Calculation Guides, of each luminaire type. The adjustment factors shall be for lamps and accessories identical to those indicated for the luminaire as applied in this Project] [IES LM-79] [IES LM-80].

   a. Manufacturer's Certified Data: Photometric data certified by manufacturer's laboratory with a current accreditation under the NVLAP for Energy Efficient Lighting Products.
   b. Testing Agency Certified Data: For indicated luminaires, photometric data certified by a qualified independent testing agency. Photometric data for remaining luminaires shall be certified by manufacturer.

6. Wiring diagrams for power, control, and signal wiring.
7. Photoelectric relays.
8. Means of attaching luminaires to supports and indication that the attachment is suitable for components involved.

B. Shop Drawings: For nonstandard or custom lighting fixtures. Include plans, elevations, sections, details, and attachments to other work.

1. Include plans, elevations, sections, and mounting and attachment details.
2. Include details of luminaire assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
3. Include diagrams for power, signal, and control wiring.

C. Samples: For each lighting fixture and for each color and texture indicated with factory-applied finish.

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. Luminaires.
2. Structural members to which luminaires will be attached.
3. Underground utilities and structures.
4. Existing underground utilities and structures.
5. Above-grade utilities and structures.
6. Existing above-grade utilities and structures.
7. Building features.
8. Vertical and horizontal information.

B. Qualification Data: For testing laboratory providing photometric data for luminaires.

C. Seismic Qualification Data: For luminaires, 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.

D. Product Certificates: For each type of the following:

1. Luminaire.
2. Photoelectric relay.

E. Product Test Reports: For each luminaire, for tests performed by a qualified testing agency.

F. Source quality-control reports.

G. Sample warranty.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For lighting equipment and fixtures to include in emergency, operation, and maintenance manuals.

1.7 MAINTENANCE MATERIAL SUBMITTALS

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

1. Lamps: Ten for every 100 of each type and rating installed. Furnish at least one of each type.
2. Glass, Acrylic, and Plastic Lenses, Covers, and Other Optical Parts: One for every 100 of each type and rating installed. Furnish at least one of each type.
3. Diffusers and Lenses: One for every 100 of each type and rating installed. Furnish at least one of each type.
4. Globes and Guards: One for every 20 of each type and rating installed. Furnish at least one of each type.

1.8 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Luminaire manufacturers' laboratory that is accredited under the NVLAP 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 1910.7, accredited under the NVLAP for Energy Efficient Lighting Products and complying with applicable IES testing standards.

C. Provide luminaires from a single manufacturer for each luminaire type.

D. Each luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

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

F. Mockups: For exterior luminaires, complete with power and control connections.

1. Obtain Architect's approval of luminaires in mockups before starting installations.
2. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed work.
3. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.

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

1.9 DELIVERY, STORAGE, AND HANDLING

A. Protect finishes of exposed surfaces by applying a strippable, temporary protective covering prior to shipping.

1.10 FIELD CONDITIONS

A. Verify existing and proposed utility structures prior to the start of work associated with luminaire installation.

B. Mark locations of exterior luminaires for approval by Architect prior to the start of luminaire installation.

1.11 WARRANTY

A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures, including luminaire support components.
b. Faulty operation of luminaires and accessories.
c. Deterioration of metals, metal finishes, and other materials beyond normal weathering.

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

PART 2 - PRODUCTS

2.1 LUMINAIRE REQUIREMENTS

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

B. NRTL Compliance: Luminaires shall be listed and labeled for indicated class and division of hazard by an NRTL.

C. FM Global Compliance: Luminaires for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.

D. UL Compliance: Comply with UL 1598 and listed for wet location.

E. CRI of minimum 80. CCT of 4000.

F. L70 lamp life of 50,000 hours.

G. Internal driver.

H. Nominal Operating Voltage: 120V to 277V.

I. In-line Fusing: On the primary for each luminaire.

J. Source Limitations: Obtain luminaires from single source from a single manufacturer.

K. Source Limitations: For luminaires, obtain each color, grade, finish, type, and variety of luminaire from single source with resources to provide products of consistent quality in appearance and physical properties.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.

B. Examine roughing-in for luminaire electrical conduit to verify actual locations of conduit connections before luminaire installation.

C. Examine walls, roofs, canopy ceilings and overhang ceilings for suitable conditions where luminaires will be installed.

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

3.2 TEMPORARY LIGHTING

A. If approved by the Architect, use selected permanent luminaires for temporary lighting. When construction is substantially complete, clean luminaires used for temporary lighting and install new lamps.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Comply with NECA 1.

B. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.

C. Install lamps in each luminaire.

D. Fasten luminaire to structural support.

E. Supports:

1. Sized and rated for luminaire weight.
2. Able to maintain luminaire position after cleaning and relamping.
3. Support luminaires without causing deflection of finished surface.
4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and a vertical force of 400 percent of luminaire weight.

F. Wall-Mounted Luminaire Support:

1. Attached to structural members in walls backing plate attached to wall structural members.

G. Wiring Method: Install cables in raceways. Conceal raceways and cables.

H. Coordinate layout and installation of luminaires with other construction.

I. Adjust luminaires that require field adjustment or aiming.

J. Comply with requirements in Section 260519 "Low-Voltage Electrical Power Conductors and Cables" and Section 260533 "Raceways and Boxes for Electrical Systems" for wiring connections and wiring methods.

3.4 BOLLARD LUMINAIRE INSTALLATION:

A. Align units for optimum directional alignment of light distribution.

1. Install on concrete base with top 4 inches above finished grade or surface at luminaire location. Cast conduit into base, and shape base to match shape of bollard base. Finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Section 033000 "Cast-in-Place Concrete."

3.5 INSTALLATION OF INDIVIDUAL GROUND-MOUNTED LUMINAIRES

A. Aim as indicated on Drawings.

B. Install on concrete base with top 4 inches above finished grade or surface at luminaire location. Cast conduit into base, and finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Section 033000 "Cast-in-Place Concrete."

3.6 CORROSION PREVENTION

A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.

B. Steel Conduits: Comply with Section 260533 "Raceways and Boxes for Electrical Systems." In concrete foundations, wrap conduit with 0.010-inch- (0.254-mm-) thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

3.7 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.8 FIELD QUALITY CONTROL

A. Inspect each installed luminaire for damage. Replace damaged luminaires and components.

B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.
2. Verify operation of photoelectric controls.

C. Illumination Tests:

1. Measure light intensities at night. Use photometers with calibration referenced to NIST standards. Comply with the following IES testing guide(s):

   a. IES LM-5.
   b. IES LM-50.
   c. IES LM-52.
   d. IES LM-64.
   e. IES LM-72.

2. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.

D. Luminaire will be considered defective if it does not pass tests and inspections.

E. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

3.9 DEMONSTRATION

A. Owner's maintenance personnel to adjust, operate, and maintain luminaires.

3.10 ADJUSTING

A. Occupancy Adjustments: When requested within 2 months of date of Substantial Completion, provide on-site assistance in adjusting the direction of aim of luminaires to suit occupied conditions. Make up to one visit to Project during other-than-normal hours for this purpose. Some of this work may be required during hours of darkness.

1. During adjustment visits, inspect all luminaires. Replace lamps or luminaires that are defective.
2. Parts and supplies shall be manufacturer's authorized replacement parts and supplies.
3. Adjust the aim of luminaires in the presence of the Architect.

END OF SECTION

This page is intentionally left blank.

MaineHealth

Network Engineering

Infrastructure Specifications

CSI Master Format Division 27

Revised Date: May 2017

295 Park Avenue
Portland, Maine 04101

Table of Contents

PART 1 – GENERAL

1.1 Summary 4
1.2 Related Documents 5
1.3 Submittals 5
1.4 Revisions 6
1.5 Definitions 6

PART 2 - PRODUCTS

2.1 Approved Sources 6
2.2 Approved Products 6
2.3 Product Condition and Warrantees 6
2.4 Product Handling, Storage and Delivery 7

PART 3 – EXECUTION

3.1 General Contractor Installation Responsibilities 7
3.2 Common Work Results 9
3.3 Special Work Results – Legacy Voice Installations 9
3.4 Special Work Results – CATV Systems 10
3.5 Special Work Results – Overhead Paging 10
3.6 Special Work Results- Nurse/Patient Call Systems 10
3.7 Optical Fiber Cabling 10
3.8 Commissioning and Testing 11
3.9 Documentation 12
3.10 Appendix Index 13

APPENDIX INDEX

Appendix A - Low Voltage Cabling Approved Products 14
Appendix B - Video Systems Approved Products 17
Appendix C - Nurse Call Systems Approved Products 18
Appendix D - Approved Cabling Contractors 26
Appendix E - Preferred Vendor List - Misc. Systems 27
Appendix F - Telecommunications Room Layout 28
Appendix G - Work Area Outlet Standard Configurations 29
Appendix H - Documentation Legend 32
Appendix I - Terminations Samples 33
Appendix J - Grounding and Bonding 35
Appendix K - Primary Protection 39
Appendix L - Fire Stopping 40
Appendix M – Contractor/GC Assumptions 45
Appendix N – Overhead Paging 48

SECTION 27 00 00 – COMMUNICATIONS - STRUCTURED CABLING

PART 1 – GENERAL

1.1 SUMMARY

A. This document defines the Communications Infrastructure requirements for Voice, Data (Network), CATV, Video, Paging (Public Address) and Nurse Call Systems.

B. This document, titled ”Network Engineering Infrastructure Specifications” may be incorporated by reference or attachment in construction and/or project specific documents and will be the governing requirements for approved products, installation practices, testing, acceptance and operating criteria as it relates to the Information Technology (IT) Infrastructure of all MaineHealth (MH) Facilities.

C. The current version of the document will be indicated on the cover page with the revision date clearly noted.

D. All previous versions of this document including but not limited to those titled “Telecommunications Network Services 16600 Specifications” and “Maine Medical Center D27 Version 4” dated November 2013 are obsolete and shall not be used.

E. These standards have been developed and implemented to ensure that all MH facilities have a consistent and reliable infrastructure in place that can be properly maintained, operated and serviced.

F. All work results shall produce a complete and functional system which meets the performance criteria defined within this document and all referenced external documentation.

G. Maine Health uses the Ortronics Open Systems Architecture and the Corning Cable Systems LANscape NPI manufacturer performance warrantee Systems; the applicable system(s) will be specified within the scope of work documents on a per project basis.

H. All Voice, Data, CATV and Optical Fiber Cabling and Components shall be installed by a MH approved cable installation firm as referenced in Appendix B of this document.

I. Any request for changes or deviations from these specifications must be made in writing to the designated MH project manager and must be approved by MH Network Engineering prior to any work being performed.

1.2 RELATED DOCUMENTS

J. Drawings and general provisions of the contract, including general and supplementary conditions and other CSI specification sections apply to work within this section.

K. Unless specifically indicated otherwise, all referenced documents shall be the most current version as accepted by any and all Authorities having Jurisdiction (AHJ)

L. Specifications for approved products are incorporated by reference.

M. External Codes, Standards and Ordinances are also referenced throughout this document, where no version is indicated; the most current version should be utilized.

1.3 SUBMITTALS

N. No substitution of material or equipment for that specified on the project documents will be allowed without prior approval in writing from an authorized MH Network Engineering representative.

O. No shop drawings shall be submitted for materials on the approved list in appendix A unless required by project specifications.

P. Where submittals are required, the procedure will be as follows:

   a. Submittals shall be in Electronic, Portable Document Format (PDF) and provided to the designated primary MH Network Engineering contact for the project.

   b. Submittals shall contain reference to manufacturer name and specific part number(s) including performance specific information and specifications as required to meet the MH requirements.

   c. Submittals shall include a schedule/index which lists the delivery lead times in calendar days between the time an order is placed with the distributor and the time it can be delivered to the work site. No proposed item will be reviewed without its delivery lead-time indicated.

Q. In the event a manufacturer has made changes to a part number previously approved and/or specified (new # supersedes an existing # etc.) the new number shall be provided with the old number noted as a reference and presented as a submittal for approval prior to use.

R. When printed drawings are required, they will be in ANSI Size “D” (22 x 34”) unless otherwise specified.

1.4 REVISIONS

S. This document is a major revision to the previous specification document titled "Network Engineering Infrastructure Specifications" dated November 2013, it obsoletes and replaces any and all previous versions.

T. No handwritten or otherwise modified versions of this document are permitted for any reason.

U. Requests for changes, updates or revisions should be made in writing to the MaineHealth Manager of Network Engineering, clearly stating the reason for the request and the specific area(s) of the document involved.

1.5 DEFINITIONS

ADA: Americans with Disabilities Act (ada.gov)

BICSI: Building Industry Consulting Service International (bicsi.org)

CATV: Cable Television

GCM: Global Control Module

MH: MaineHealth (www.mainehealth.org)

NEC: National Electrical Code (www.nfpa.org)

NFPA: National Fire Protection Association (www.nfpa.org)

TIA: Telecommunications Industry Association (www.tiaonline.org)

TR: Telecommunications Room

UL: Underwriters Laboratories (http://ul.com)

WAO: Work Area Outlet

PART 2 – PRODUCTS

2.1 **Approved Sources**

A. Products shall be purchased only through authorized manufacturers distribution channels that have an ISO registered quality system in place to ensure identification, traceability and product warrantee coverage.

2.2 **Approved Products**

B. Appendix A contained within this document lists the MH approved system components and products to be used.

C. Where an item is required that is not listed, a formal request for approval as a "one time" use item shall be made in writing to the Network Engineering department and must include product specifications, reason for use and intended source of supply.

2.3 **Product Condition and Warrantees**

D. All products shall be new and of current design.

E. The use of used, reconditioned, “gray market” or obsolete products is strictly forbidden.

F. Cabling installations shall be covered by a manufacturers system performance warrantee in addition to the standard product warrantee. (see also 1.1-H)

2.4 **Product Handling, Storage and Delivery**

G. Storage space at MH is at a premium at all times. Contractors should take note of this and make arrangements for delivery of project materials according to project time lines.

H. Materials shall be kept clean, dry and protected at all times against exposure to weather, adverse environmental conditions and contact with damp or wet surfaces

I. Products supplied to MH as spares or on-hand inventory shall be in the original manufacturers packaging and clearly labeled with Part Number and Project Name and where applicable, the system and/or service they are supporting.

PART 3 – EXECUTION

3.1 **General Contractor Installation Responsibilities** - 27 05 00

A. A Network Engineering Specification review meeting will be held prior to any work commencing on any MH project.

B. Contract documents shall contain methods and procedures for labeling and documentation of all terminations in conjunction with the MH defined ID schemes in this document.

C. Contractors shall submit a detailed description showing methods and procedures for labeling; testing and documenting installed cabling including the test equipment to be utilized and the credentials of the person(s) performing the testing.

D. Contractors shall have a designated project manager or single point of contact for all work sites at all times.

E. Location and installation of cables shall be accomplished according to the Project Master Floor/Site Plan.

F. The contractor shall perform all terminations at the origination (TR) and work area outlet (WAO) ends of installed cables.

G. The contractor shall supply all cable, connecting hardware and terminating equipment in compliance with the MH approved materials lists contained in this document and/or any project specific requirements.

H. All diagrams depicting rack layouts, patch panel locations, room layouts and backboard plans shall be followed exactly as detailed. No deviations from

these plans shall be acceptable without the prior written approval of MH Network Engineering.

I. All Riser cabling shall be run in a designated pathway/conduit and the Pathways will be sized based on the TIA-569 standard using applicable fill capacity tables.

J. Riser cables will be terminated and labeled according to the TIA standards using the MH specified Identifiers, including cable number, origination and destination locations as detailed in the contract documents for the project.

K. Grounding and Bonding of Pathways, Spaces and Cables shall comply with any and all NEC, TIA and BICSI Codes and Standards in conjunction with the appendix contained in this document.

L. All cables, work area outlets and connecting hardware will be labeled according to the MH designated identification scheme using machine generated, permanent labels per TIA-606.

M. Any cables terminated above ceilings shall be housed in a standard single-gang surface mount workbox or other MH approved device that is properly affixed to walls or other suitable solid building structures.

N. All cables will be bundled neatly, wrapped with hook and loop type fasteners and dressed into the terminating panels.

O. Origination and Station (WAO) locations shall be identified using the MH designated identifiers on the Master Floor Plans for the project and detailed within the Scope of Work document(s).

P. Contractors are responsible for obtaining all necessary permits, approvals and complying with all applicable Codes, Regulations, Ordinances and Standards.

Q. All Infection Control Methods and Procedures shall be followed during any Network Engineering related work performed in any MH facility. The Infection Control Risk Assessment (ICRA) survey process must be completed for all MH facilities prior to the commencement of any work. A copy of the Infection Control Procedures shall be provided to the contractor prior to any work being done. Detailed instructions on this process are part of the Contractor Orientation training.

R. Fire Stopping is an integral requirement of any work performed at any MH facility as in covered in detail within the appendix of the document.

S. Contractors are required to complete Mandatory Contractor Orientation Training prior to installing any fire stop system or component in any MH Facility.

T. Badge Access is required to be installed as part of any new construction or major renovation of a Telecommunications or Network Room.

U. Fiber terminations will be done using Corning splice on connectors. No other termination types will be allowed without prior approval by MH Network Engineering.

V. MaxCell Fabric Innerduct will be used in all conduit installations. No other product is to be used without prior approval from MH Network Engineering.

3.2 Common Work Results – 27 05 00

A. Plenum rated cable shall be used for all cabling installations.

B. MH's cabling pin-pair terminating standard is T568-A at some locations and T568-B in others (for example, MMC is T568-A) This will be further defined with an individual scope of work per project per location.

C. Service loops for cabling shall be 5 ft and within industry guidelines, including bend radius and separation.

D. Cabling shall use and be placed into designated pathways only with no weaving or passing through adjacent piping, conduits or building elements.

E. Cable in Ladder trays shall be placed to avoid coiling or looping.

F. Directional changes shall be made with sweeping 90 degree angular turns in compliance with bend radius and installation requirements as defined in the BICSI Information Technology Systems Installation Methods Manual (ITSIMM) and the NECA/BICSI-568 Standard for Installing Commercial Building Telecommunications Cabling.

G. When using existing pathways, any old cable ties shall be removed, properly disposed of and replaced with Hook and Loop type fasteners of the appropriate rating.

H. Any abandoned cabling shall be removed and disposed of in compliance with any NEC NFPA-70 Electrical Code and applicable Environmental regulations.

I. Standard Patch Panel Size will be 48 Port panels unless otherwise approved by MH Network Engineering in conformance with the approved materials list in Appendix A.

J. Sleeve size shall be determined by Scope of work document or other contract specific documents.

3.3 Special Work Results – Legacy Voice Installations - 27 15 00.16

A. Legacy Voice installations utilize a non-standard termination method consisting of splitting a 4-Pair UTP cable into two (2) each 2 pair terminations using a Single RJ-45-TI500 Track Jack Module as defined in the approved materials list.

B. Legacy Voice cabling shall be terminated at the Administration End (origination point) (TR) on hardware specified in SOW or work order.

C. These legacy voice terminations will be tested using the "Voice-2 Pair" test set parameters listed in the certification test set parameters under application

specific tests using the Category 6A UTP Cable Types and the T568A Outlet Configuration.

D. In transitional environments supporting (As determined by MH Network Engineering) Analog or Digital stations such as with new Horizontal Cable/Old Riser, Multi-Pair UTP Cable (Category 3 or 5e) will be run between the BIX field and the Racks. Horizontal Cabling will terminate on 24 or 48 Port Category 6 Patch Panels as detailed in 3.2-I.

3.4 Special Work Results – CATV Systems - 27 41 00.33

A. All materials shall conform to the approved materials list.

B. All cables shall be home runs. Splitting, tapping or splicing outside the TR is not permitted unless specified in project specific documentation for special situations or applications.

C. All Coaxial Cable connectors shall be of the compression type. The use of twist-on or crimp (hex) type connectors is forbidden.

D. All Connections shall be contained in a single gang workbox.

3.5 Special Work Results – Overhead Paging

A. Overhead paging systems vary throughout the MaineHealth System. Please see Appendix N for Site specific paging requirements.

3.6 Special Results- Nurse/Patient Call Systems -27 52 00

A. Due to the fact that there are several different Nurse Call system types and Manufacturers used across MaineHealth this section will be covered in detail per member hospital in Appendix C.

3.7 Optical Fiber Cabling – 27 13 23

A. All cable, connectors, and hardware shall comply with the approved materials list.

B. Fiber Performance Grade, Type, Jacket, and Fiber Count will be specified on a per project basis as defined in the scope of work.

C. All Cables will be Plenum Rated

D. Backbone Riser Cables will be installed within Conduit or will be of Armored Construction and will be specified in the contract documents.

E. The standard Connector Type for all New Installations of Optical Fiber Terminations is the Type LC connector as listed in the approved materials list in this document unless otherwise specified in a project SOW and approved by MH Network Engineering.

F. When armored fiber is utilized, it shall be bonded if the cable armor is metallic. The armor shall enter and be secured within the enclosure.

G. All fibers of installed cables shall be terminated and tested regardless of any fibers designation for future use or spares.

H. Fiber shall be terminated according to the TIA color code and polarity standards. All future fiber connectors will be Factory Polished Fusion Spliced.

I. All installed and Connectorized (terminated) fibers shall be covered with an appropriate dust cover made by the manufacturer of the hardware to prevent contamination and ensure the integrity of the connector end-face.

J. All optical fiber cables must be labeled with Fiber Optic warning tags within 18" of entering any enclosure (Fiber Patch Panel or Light guide Interface Unit (LIU)) as well as on either side of any penetration. Identification tags will also be placed every 50 ft. throughout the fiber run. These tags must show the fiber type, fiber count, construction and source and destination locations. This information shall also be included on each enclosure and corresponding test reports.

3.8 Commissioning and Testing - 27 08 00

A. Voice and Data Copper (UTP) Cables will be tested using an industry standard certification test set of level III or higher accuracy using the current TIA Test Limits to the Category 6A Permanent Link parameters.

B. Test results shall use the MH designated identifiers for each cable, 100% Testing of all installed cabling is required.

C. MH reserves the right to perform random testing of installed cabling prior to acceptance of final contractor results.

D. Any cable that does not pass the certification test must be re-terminated or replaced at the contractor's expense. Conditional Pass results (indicated by an asterisk) are not acceptable.

E. Optical Fiber Cable will be tested to the TIA-568-C test parameters using an industry standard certification test set with the appropriate Light Source and Power meter as defined by TIA TSB-140 for Tier 1 Testing.

F. Multi-Mode Optical fiber will be tested at both the 850nm and 1300 nm wavelengths bi-directionally.

G. Single-Mode Optical fiber will be tested at both the 1310nm and 1550nm wavelengths bi-directionally.

H. Test results must include the specified MH Identifiers and the number of connectors and/or splices as applicable with the dB loss in each direction at each of the specified wavelengths.

I. Any Fiber not passing the testing must be repaired or replaced at the contractor's expense.

J. Tier 2 Testing (Characterization-OTDR) may be requested on a project specific basis and will be performed as stated in TIA TSB-140 for the type of fiber being tested.

K. Test Results will be provided to MH Network Engineering in Portable Document Format (PDF) in email, or on Disk showing the Date, Project Name

and Location with a testing summary and then each test result on its own page, clearly stating the MH identification number and the test results for each cable.

3.9 Documentation

L. Contractors shall provide a complete set of as-built drawings to MH prior to acceptance with the as-built indicating all types and sizes of facility pathways, junctions and termination points.

M. As-Built drawings shall be provided electronically in .DWG format and printed on ”D” size paper when requested, 2 copies of each sheet and are to be in three layers as follows:

1. Voice/Data including pathways
2. Paging/Coax including Tap Locations
3. Nurse Call to include all cabling paths and locations.

3.10. **APPENDIX INDEX**

Appendix A	-	Approved Products List
Appendix B	-	Video Systems Products
Appendix C	-	Nurse Call Systems and Specifications
Appendix D	-	Approved Low Voltage Contractors
Appendix E	-	MH Preferred Vendor List (Miscellaneous)
Appendix F	-	Telecommunications Room (TR) Layouts
Appendix G	-	Work Area Outlet Standard Configurations
Appendix H	-	Telecommunications Legend (Master Floor Plan)
Appendix I	-	Telecommunications Room Terminations
Appendix J	-	Grounding and Bonding Details
Appendix K	-	Primary Protection of Communication Systems
Appendix L	-	MH Firestopping Requirements
Appendix M	-	General Contractor Assumptions List
Appendix N	-	MH Overhead Paging Systems and Specifications

Appendix A

Approved Products List

Product Number		Product Description
55053-703	**(Primary)**	Chatsworth 19” Universal Rack (Black)
55053-503		Chatsworth 19” Universal Rack (Clear)
11729-703	**(Primary)**	Chatsworth Vertical Section 6” (Black)
11729-503		Chatsworth Vertical Section 6” (Clear)
12096-703		Chatsworth Vertical Section 3” (Black)
12096-503		Chatsworth Vertical Section 3” (Clear)
10250-712		12”Universal Cable Runway (Black)
10250-718		18”Universal Cable Runway (Black)
10250-724		24”Universal Cable Runway (Black)
OR-PHD66U24		Ortronics Category 6 24 port Patch Panel **(Transitional Environment)**
OR-PHD66U48		Ortronics Category 6 48 port Patch Panel **(Transitional Environment)**
OR-TJ5E00		Clarity 5E TracJack Fog White **(Transitional Environment)**
OR-40300656		Series II Angled Bezel Fog White **(Transitional Environment)**
OR-40300144		Series II Blank Module .5 Fog White **(Transitional Environment)**
OR-PHD6AU48	**(Primary)**	**Clarity** 6A/10G 48 Port Patch Panel 2U
OR-PHD6AU24		Clarity 6A/10G 24 Port Patch Panel 1U
OR-401045292		Standard Density 48 port TracJack Patch Panel 3U
OR-401045290		Standard Density 24 port TracJack Patch Panel 2U
OR-60400426	**(Primary)**	Ortronics Cable Management Panel 2U
OR-60400129		Ortronics Cable Management Panel 1U
OR-60400199		Ortronics Bend Limiting Strain Relief Bar
OR-TJ6A	**(Primary)**	**Clarity** 6A/10G Category 6A TracJack Fog White
OR-40300545	**(Primary)**	Single Gang Faceplate Holds (6) TracJack Fog White
OR-40300555		Double Gang Faceplate Holds (6) TracJack Fog White
OR-42100002		TracJack Blanks (package of 10)
OR-63700006		TracJack F Conn 75 ohm Female to Female
OR-40300577-00		Furniture Plate Herman Miller 2.35” x 3.41” Black
OR-40300633-00		Furniture Plate 2.75” x 1.41” Black
OR-40700073-00		Furniture Plate 2.71” x 1.38” Black
OR-404TJ2		Surface Housing for TracJack
OR-403STJ1WP		Single Gang Stainless TracJack Faceplate w/Phone Studs **(IP set)**
AT630B-8		Single Gang Stainless 8p8c Faceplate w/Phone Studs **(TDM set)**
CABLOFIL		CABLOFIL Cable Tray Management System (sized per project)
CADDY CAT HP		Caddy CAT HP J-Hook system (sized per project)
WIREMOLD 2000		2000 Series Raceway, Fittings, Boxes Ivory
WIREMOLD 700		700 Series Raceway, Fittings, Boxes Ivory
LD3IW6-A		Panduit Latching Duct Surface Raceway LD3 Type
LD5IW6-A		Panduit Latching Duct Surface Raceway LD5 Type

Appendix A (Continued)

BIX Type Connections:

Belden Number	Product Description
A0270164	QMBIX10A 250 pair distribution frame
A0340836	QMBIX12E 300-pair distribution frame
A0266828	QMBIX1A5 25-pair distribution connector (5pr)
A0393146	QMBIX1A4 25-pair distribution connector (4pr)
A0270169	QMBIX20A Data plate
A0270168	QMBIX19A Distribution ring
P0748006	QCBIX1A4 Label, Blue
P0588406	QCBIX1A Label, White
P0748019	QCBIX1A Label, Grey

Station (Horizontal) Cable – Voice, Data and Valcom Paging

Product Number	Description
11082057	Berktek 4 Pair Category 6A Blue (Plenum)

Nurse Call Cable – Rauland 4000

Product Number	Description
10034514	Berktek 4 Pair Category 5E Black (Plenum)

Riser (Backbone) Cable - Copper

The following manufacturers provide an acceptable Multi-Pair Riser cable product for use throughout the MMC system. Each manufacturer noted below may provide any of the multi-pair cables noted in the description field below. Prior to any installations, all vendors shall provide MMC Network Engineering with the complete Manufacturers specifications for the intended product.

Approved Manufacturers

Ortronics
Berktek
General Cable
Superior-Essex
Mohawk

Appendix A (Continued)

Fiber Optic Cable and Hardware

Confirmation of Materials to be used is required (also see 1.3 – R). All products chosen from links below need to be approved by MH Network Engineering prior to installation.

Corning Cable Systems

MIC DX Tight Buffer Plenum

http://csmedia.corning.com/CableSystems//Resource_Documents/product_family_specifications_rl/MIC_DX_Tight_Buffered_Armored_Cable_Riser_NAFTA_AEN.pdf

MIC Interlocking Armored Tight Buffer Plenum

http://csmedia.corning.com/opcomm/Resource_Documents/product_family_specifications_rl/MIC_TB_Interlocking_Armored_Plenum_Cables_2_24_Fibers_NAFTA_AEN.pdf

Closet Connector Housings (CCH)

http://catalog.corning.com/CableSystems/en-US/catalog/MasterProduct.aspx?cid=CCH_housings_web&pid=77702&rot=fiber_optic_hardware_web

Wall-Mounted Connector Housings (WCH)

http://csmedia.corning.com/CableSystems//Resource_Documents/product_family_specifications_rl/LAN-137-EN.pdf

Connector Panels

http://catalog.corning.com/CableSystems/en-US/catalog/CategoryBrowser.aspx?cid=CCH_panels_web&rot=fiber_optic_hardware_web

Pigtailed Splice Cassettes

http://catalog.corning.com/opcomm/en-US/catalog/MasterProduct.aspx?cid=CCH_cassettes_web&pid=95363&rot=fiber_optic_hardware;

Splice-On Connectors

http://csmedia.corning.com/opcomm/Resource_Documents/product_family_specifications_rl/FuseLite_Single_Fiber_Splice_On_Connectors_NAFTA_AEN.pdf

Pretium Edge HD Solutions

http://csmedia.corning.com/CableSystems//Resource_Documents/product_family_specifications_rl/pretium_EDGE_HD_solutions_NAFTA_AEN.pdf

Pretium EDGE FX Solutions

http://csmedia.corning.com/CableSystems//Resource_Documents/product_family_specifications_rl/Pretium_EDGE_FX_Solutions_NAFTA_AEN.pdf

Additional Requirements:

Regardless of the Corning Cable Systems Product Family used, all Glass used in the Cabled assemblies shall be Corning Glass only and of the Performance Grade specified (OM3, OM4, OS2).

Appendix B

CATV Systems Approved Products List

1. Coaxial cable used in MH locations shall be Commscope, Times Fiber or Belden brand and shall be white in color, plenum rated and quad shielded.

2. All jumpers will be plenum-rated RG-6 or RG-11 with compression fitting made by any manufacturer or onsite.

3. All connectors shall be compression type that specifically matches the cable being used.

4. Faceplates and RF related inserts unless otherwise specified shall be Ortronics brand (see Appendix A)

MFG.	Part #	Description
BT	CRT-(*)	One Port Tap/Directional Coupler
BT	SXRS-2 or SCVS-2	2 Way Splitter
BT	SXRS-4 or SCVS-4	4 Way Splitter
BT	SXRS-8 or SCVS-8	8 Way Splitter
BT	F81	F-F Splice Female/Female Barrel
BT	F-59T	75 Ohm Terminator
BT	FAM-(*)	Assorted Attenuator
BT	BITA 550-50	Distribution Amp
BT	BITA-RF	Return Filter
BT	BITA-RA	Return Amp
BT	BITA-CE-4	Cable Equalizer
BT	BITA-FA-(*)	Amplifier Attenuator
HA	MCO1/4-F	TV Outlet w/Control Cable Jack (No cover Plate)
HA	JK1/4-PLT	Pillow Speaker Jack w/Single Gang St. Steel Plate
HA	WP-81SS	Stainless Steel Face Plate With “F” Barrel
HA	WP-81IV	Ivory Face Plate w/”F” Barrel

BT= Blonder Tongue
HA=Howlands Associates

Note: All above-mentioned components available from Howlands Associates.
Prior to any installations, all vendors shall provide MH Network Engineering with the complete Manufacturers specifications for the intended product.

Appendix C

Nurse Call Systems and Specifications

By MaineHealth Member

MMC

Special Results- Nurse/Patient Call Systems -27 52 00

A. Two types of Nurse-Patient Call Systems are in use at MMC, a Visual/Voice System (Rauland-Borg Responder IV and V) and a Visual Only System (The Rauland-Borg Responder 4000) Common requirements and specifications are listed first and then system specific information will follow. Due to the proprietary and critical nature of these systems, special care should be given to understanding the infrastructure requirements in addition to programming and communications protocols.

B. System design shall be performed only by factory certified personnel and must be reviewed and approved by MMC Telecommunications personnel prior to installation.

C. Installation and programming shall be performed only by factory certified personnel according to all current manufacturer standards and recommendations unless specified by MMC Telecommunications.

D. Installation of nurse call systems shall only be performed by technicians holding a valid State of Maine Low Energy license or working with a helper's license under the direct supervision of a Master Electrician or licensed Low Energy Electrician.

E. All installations of Rauland nurse call systems will be performed in strict accordance with Rauland specifications for the respective system(s) with particular attention being paid to power calculations and CGM interconnects unless otherwise specified by MMC. All installations of nurse call station components (i.e. call stations, dome lights, duty/staff stations) must be performed in strict accordance with System Owner specifications.

F. All part numbers for components and/or hardware required for the Nurse Call systems shall be identified by utilizing the appropriate Rauland installation manual.

G. All Nurse call system cabling and components shall be UL listed and installed according to NFPA 70 with all cabling tested for continuity and free from shorts and faults.

H. All Nurse Call systems installed at MMC shall be connected to Hospital Emergency Power.

I. For non-integrated pillow speaker installations, the cabling shall consist of Plenum rated, stranded 3-wire 18 gauge cable. The black, red and white

wires in the cable shall be terminated by the contractor on a standard stainless steel faceplate located on the headwall. The faceplate will contain a ¼" jack supplied by the contractor. The jack behind the TV will contain a Coaxial "F" Type connector and a ¼" jack. (See also standard faceplate configurations in the appendix of this document)

J. For integrated Pillow Speaker installations, the faceplate will be of Stainless Steel and contain only a ¼" hole for the cable to pass through with final connections being performed by the nurse call system installer.

K. If requested as part of the project SOW the contractor will provide thorough in-service training of all nursing staff assigned to applicable nursing units unless otherwise specified in contract documents will provide in-service training.

L. K. If requested as part of the project SOW the training provided the nursing staff is to enable them to fully understand the operation of the system in order to provide adequate patient support respective to the process used on their floors. A separate training room shall be set up that allows this type of individualized training utilizing an in-service training unit, prior to the cut over of the new system.

Visual/Voice Nurse Call Systems (Rauland-Borg Responder IV)

M. Rauland Responder IV Nurse Call Systems shall be installed where a visual/voice nurse/patient call system is required. This system provides two-way communications from a patient room to the nurse station as well as visual and/or audible annunciation at a variety of other devices such as corridor lamps and duty stations.

N. Under no circumstances will any programming of the nurse call systems at MMC be performed without prior review and approval from the Telecommunications department at MMC. All programming performed on the Rauland systems at MMC must be accompanied by a MMC work order describing the type of programming needed. For major changes to the system, all programming must be documented using the process described below and accompanied by factory programming forms. The forms are contained in Appendix A of the Rauland Responder IV Applications Manual, Section K11970A.

Visual Only Nurse Call Systems (Rauland-Borg Responder 4000)

O. the RaulandBorg Responder 4000 Nurse/Patient Call System shall be installed where a visual only nurse/patient call system is required

P. The Responder 4000 system utilizes Black, Category 5e, Plenum Rated UTP Cable as listed in the MMC approved materials list.

TYPICAL RESPONDER 5 NURSE CALL LAYOUT - PATIENT ROOMS

CABLE LEGEND		
LETTER	CABLE DESCRIPTION	N.F. PLENUM #
E	2 CONDUCTOR, 14 AWG, CABLE	[illegible]
I	4 PAIR CAT 5E, STP, 24 AWG	GENERIC
N	4 CONDUCTOR, 22 AWG, STRANDED	[illegible]
Q	1 CONDUCTOR, 14 AWG, 49X, THHN	GENERIC
[illegible]	[illegible]	[illegible]

Fig 1. Double Room w/Toilet & Shower

Fig 2. Double Room w/Toilet Only

Fig 3. Single Room w/Toilet & Shower

Fig 4. Single Room w/Toilet Only

Notes:

1. Responder 5 devices must be connected to a grounded metal electrical box to prevent electrostatic discharge and help eliminate any RF noise interference being introduced into the Nurse Call system. In those installations, whereby the ground is not available due to the design of the building frame, a 14 AWG wire must be run to each electrical back box location and secured on the other end to a building earth ground (i.e. ceiling metallic grid, metal pipe, etc.).
2. Cable Run for VoIP Staff Terminal (ST) to not exceed 300'.

TYPICAL RESPONDER 5 NURSE CALL LAYOUT - VoIP CONSOLE, COMMON ROOMS & NCC

CABLE NUMBERS ARE THAT OF WEST PENN WIRE CORPORATION (PLENUM GRADE CABLE)

CABLE LEGEND		
LETTER	CABLE DESCRIPTION	W.P. PLENUM #
E	2 CONDUCTOR, 14 AWG. CABLE	#25226
J	4 PAIR CAT 5E, UTP, 24 AWG.	GENERIC
N	4 CONDUCTOR, 22 AWG., STRANDED	#25241
O	1 CONDUCTOR, 14 AWG., GRN. THHN	GENERIC
Q	3 PAIR ROUND 24 AWG. (CAT3)	54998
Z	4 CONDUCTOR, 14 AWG CABLE	252468

Fig 5. Common Rooms - Duty Stations

Fig 6. VoIP Console

Cable Run not to exceed 300'.

Fig 7. Nurse Call Cabinet (NCC)

NURSE CALL CABINET – ELEVATION

TYPICAL RAULAND RESPONDER IV NURSE CALL LAYOUT - PATIENT ROOMS & COMMON ROOMS (i.e. Soiled/Clean Utility, Med Room)

RESPONDER IV NURSE CALL CABLE SCHEDULE

LETTER	CABLE DESCRIPTION	W.P. PLENUM #
A	3 pair flat, 24 AWG cable	37125
B	4 pair flat, 24 AWG cable	37129
C	2 pair round, 24 AWG cable	55826
D	3 pair round, 24 AWG cable	54980
E	3 conductor, 14 AWG cable	25236B
P	1 cond, 18 AWG, Green, THHN	GENERIC
Z	4 conductor, 14 AWG cable	25246B

RAULAND RESPONDER IV NURSE CALL CONSOLE WIRING

TYPICAL RAULAND RESPONDER 4000 NURSE CALL LAYOUT - TONE/VISUAL (NO VOICE)
EXAM ROOMS, BATHROOM & COMMON ROOMS (i.e. Soiled/Clean Utility, Med Room)

The following "SLIM" style devices may be used in lieu of the above style.

RESPONDER 4000 NURSE CALL CABLE SCHEDULE

LETTER	CABLE DESCRIPTION	W.P. PLENUM #
I	4 Pair CAT5E, UTP,24 AWG, Black	GENERIC

TYPICAL RAULAND RESPONDER 4000 NURSE CALL LAYOUT - VOICE/VISUAL PATIENT ROOMS

The following "SLIM" style devices may be used in lieu of the above style.

RESPONDER 4000 NURSE CALL CABLE SCHEDULE

LETTER	CABLE DESCRIPTION	W.P. PLENUM #
I	4 pair CAT5E, UTP, 24 AWG cable, Black	GENERIC
N	4 conductor, 24 AWG, Stranded cable	25241

MMC Approved Products and Source List

All parts and descriptions for Rauland Nurse Call systems will be supplied by Signet Electronic Systems at the design phases of the project.

Appendix D

MaineHealth
Approved Cabling Contractors

E.S. Boulos Co.
45 Bradley Drive
Westbrook, ME 04092
207-464-3706
207-464-1833 (Fax)
Contact: Dan Broy

Connectivity Point
P.O. Box 1268
Auburn, ME 04211-1268
207-782-0200
207-595-0058 (Cell)
207-753-0200 (Fax)
Contact: Tim Hooper

MTS Services
13 Delta Drive, Suite 7
Londonderry, NH 03053
603-845-1100
603-845-1119 (Fax)
Contact: Frank Cantwell

Appendix E
MaineHealth
Preferred Vendor List (Miscellaneous)

CCTV/ITV SYSTEMS
Howlands Associates
49 River Street
Plymouth, MA 02360
(508) 747-8332 (Office)
(800) 225-0256 PIN #147169 (Pager)
Contact: Ken Reardon

CATV/ITV SYSTEMS
Healthcare Television of New Eng., Inc.
26 Phillips Drive
Westford, MA 01886
(978) 692-7728 (Tech Support)
Contact: Jack Ryan
(413) 665-2844
Contact: Nancy Wilson (Sales)

NURSE-PATIENT CALL SYSTEMS (VISUAL or VOICE)
Signet Electronic Systems, Inc.
153 U.S. Route 1
Scarborough, ME 04074
781-871-5888 x2105
2-7-415-9797 (cell)
207-874-0600 (fax)

Appendix F

MH

Typical Telecommunications Room Design Plans

All Telecommunications Rooms (TRs) shall require at least one wall to be built-out with plywood material for use as a backboard in attaching systems enclosures such as nurse call, paging amplifiers, etc. Additional backboard walls may be requested as part of a project and detailed within the Scope of Work for the project. Backboard walls shall be ¾" or 1" A/C grade Fire-retardant plywood. Plywood shall be painted with 2 coats of White Fire-retardant paint (including edges) leaving any UL listings un-painted. The backboard shall be mounted flush on the drywall or concrete wall. When applicable, all cabling shall be surface mounted on the backboard using 4" or 6" D-Rings for management.

Any power or voice/data outlets installed on this wall shall be at the 18"A.F.F. height. The racks shall be securely fastened to the floor at a distance of 36"' from the wall when applicable. All layouts shall be approved before installation by MH Network Engineering.

Two Rack Example

Appendix G
MH
Standard Work Area Outlet Configurations

TYPE P1

PILLOW SPEAKER JACK

STAINLESS STEEL PLATE
HOWLANDS ASSOCIATES
#JK1/4-PLT

TYPE P2

PILLOW SPEAKER AND COAX

OR-40300545 1 GANG FACEPLATE

Appendix G (Continued)

MH

Standard Work Area Outlet Configurations

Appendix G (Continued)
MH Standard Work Area Outlet Configurations

TYPE D1
ONE CAT6A CABLE DATA

OR-40300545 1 GANG FACEPLATE

TYPE D2
TWO CAT6A CABLE DATA

OR-40300545 1 GANG FACEPLATE

TYPE D3
THREE CAT6A CABLE DATA

OR-40300545 1 GANG FACEPLATE

TYPE D4
FOUR CAT6A CABLE DATA

OR-40300545 1 GANG FACEPLATE

TYPE D5
FIVE CAT6A CABLE DATA

OR-40300545 1 GANG FACEPLATE

TYPE D6
SIX CAT6A CABLE DATA

OR-40300545 1 GANG FACEPLATE

Appendix H

MH Telecommunications Legend Standards (For use on Master Floor Plans)

Appendix I

Telecommunications Room Terminations - Data

All Category 6A terminations shall be installed in a uniform manner, which shall include a cable identification number on both ends of each cable.

Hook and Loop type fasteners shall be used for the finished install.

The Labeling for the Data Racks shall be as follows:

(On the Face of the Patch Panel) Starting from the top left and working to the top right and continuing in ascending numerical order from left to right through the remaining Patch Panels, the labeling shall be **001** through **999**.

This numbering sequence shall be adhered to throughout the MaineHealth campuses unless specifically noted in the Scope of Work for that project.

Example Rack

Appendix I (Continued)

Telecommunications Room Terminations – Voice

The Legacy Voice Frames in each TR (closet) shall be installed utilizing Belden (BIX) equipment. Typically, the Horizontal (Station) cables will be installed on the left side and labeled with Blue DESI labels. Typically, the Riser cables will be installed on the right side and labeled with White DESI labels. BIX management rings shall be installed for cross-wire installs from left to right. No BIX rings will be required on the extreme right side. **Voice Frame labeling shall be as follows:** Starting at the top left of the frame and working to the top right of the frame and continuing through to the end of the Station cable count the labeling shall be **001A** then two spaces and then **001B** in ascending numerical order to the end of the Station cables. The Riser cables shall be labeled with the next pair count from the Main Distribution Frame (MDF) and each 25 pair ID strip shall have the beginning and end pair labeled on the top and bottom of each ID strip until the complete cable has been identified. The Closet Identification number shall be included in the top and bottom center of each ID strip and shall include the cable origination point and the cable destination point and the pair count. An example of this is **0GPA3 to 0BPA1- 100pr**. This Frame Layout and numbering sequence shall be adhered to throughout the MH system unless specifically noted in the Scope of Work for that project.

Appendix J

Grounding and Bonding for Communication Systems (Supplemental Specifications and Products)

PART 1: GENERAL

1.01 SCOPE OF WORK

A. Work covered by this Section shall consist of furnishing labor, equipment, supplies, materials, and testing unless otherwise specified, and in performing the following operations recognized as necessary for the installation, termination, and labeling of grounding and bonding infrastructure as described on the Drawings and/or required by these specifications.

B. Listed manufacturers and products are preferred. MH approved equal products are also acceptable with prior written approval.

PART 2: PRODUCTS

2.01 GROUNDING BUSBARS

A. Telecommunications Main Grounding Bus bar (TMGB)

1. Predrilled, copper, non-anodized. Chatsworth #40158-012 ground bus bar with Chatsworth #10622-000 bus bar insulators.

B. Telecommunications Grounding Bus bar (TGB)

1. Predrilled, copper, non-anodized. Chatsworth #40156-12 ground bus bar with Chatsworth #10622-000 bus bar insulators.

2.02 GROUNDING JOINTS AND SPLICES

A. Grounding conductor joints/splices shall be mechanical type, copper alloy, with a minimum of two bolts and a separate section for each conductor.

B. Grounding conductor terminations (lugs) shall be single barrel, mechanical screw type, and copper alloy with machined contact surfaces.

Appendix J (Continued)

2.03 BONDING CONDUCTORS

A. Cable Tray Bonding Conductor

1. Green #6 AWG insulated bonding jumper (12" max) with appropriate lugs or manufactured braided copper grounding jumper equal to B-Line #CAM-GJ, T&B #BD12, OZ/Gedney type "FB" or Mono-Systems.

B. Bonding Conductor (BC)

1. Green insulated copper bonding conductor, size as required by NEC. The BC shall be, as a minimum, the same size as the TBB.

C. Telecommunications Bonding Backbone (TBB)

1. Green insulated copper conductor, minimum size of No. 6 AWG. The TBB shall be sized at 2 kcmil per linear foot of conductor length up to a maximum size of 3/0 AWG. Insulation shall meet fire ratings of its pathway.

PART 3: EXECUTION

3.01 TELECOMMUNICATIONS INSTALLATION

A. Bonding and Grounding

1. Bond and ground all conduits, cable trays, racks and other infrastructure as per the NEC and TIA 607A to the main building ground.
2. Clean Surfaces. Nonconductive coatings (such as paint, lacquer, and enamel) on equipment to be grounded shall be removed from threads and other contact surfaces to ensure good electrical continuity or be connected by means of fittings designed so as to make such removal unnecessary.

B. Installation of the TMGB

1. Install the TMGB at the bottom of plywood backboard near the outside plant entrance conduits in the "BDF". TMGB shall be installed so that the BC for telecommunications is as short and straight as possible. Green insulated conductor shall be installed exposed. Connection at TMGB from main electrical service ground shall be thermo-weld type. Ground resistance shall not exceed 2 ohms, unless approved by UNM. Bus bar shall be predrilled for future connections. Provide label - "Do Not Disconnect" on connection to main electrical service ground.

Appendix J (Continued)

C. Installation of the TGB

1. Install the TGB at the bottom of plywood backboard near the copper riser terminations in each “IDF”. TGB shall be installed so that the TBB for telecommunications is as short and straight as possible. Green insulated conductors shall be installed exposed. Bus bar shall be predrilled for future connections.

D. Installation of the TBB

1. Install Green insulated copper grounding conductor (refer to 2.03.D for conductor size) from the TMGB to each TGB.

E. Installation of Grounding Conductor Joints/Splices

1. Install mechanical type, copper alloy, with a minimum of two bolts and a separate section for each conductor or copper compression type with two (2) indents. Install manufactured insulating cover or heavy tape insulation over joints/splices.

F. Grounding of Cable Tray

1. Install Green #6 AWG bonding jumper (12” max) with appropriate lugs at each cable tray joint or install manufactured braided copper grounding jumper. In lieu of bonding jumpers, approved grounding type connectors to connect sections of cable tray will be permitted. Install Green #6 AWG grounding conductor with appropriate lugs from side of cable tray down to TMGB or TGB. Drill and tap side of cable tray (for appropriate size bolt, ¼” x 20 min.), making sure that bolt does not extend into wire management part of tray.

G. Grounding of Telecommunications Duct bank

1. Provide a continuous #4/0 bare stranded drawn copper conductor within the concrete at the bottom of all duct banks. Terminate to bonding ribbon in telecommunications manholes.

Appendix J (Continued)

H. Grounding of Telecommunications Maintenance Holes and Hand holes

1. Provide bonding jumper to reinforcing steel in each section. Install a bonding ribbon horizontally around the top of each manhole and attach to all cable racks and metallic hardware within the manhole. Continue installation vertically between bonding clamps so both top and bottom halves are bonded together on each side. (The bonding ribbon will be used to bond and ground all future splice cases and hardware placed within the manhole.) Provide a ground rod near the center of each manhole and hand hole. Bond to the bonding ribbon in manholes.

Note: Pre-cast maintenance holes (manholes) having reinforcing steel bonded together do not require an additional ground rod.

Appendix K

Primary Protection for Communication Systems

1. Contractors shall furnish the appropriate model, size and type of UL Listed primary (lightning) protection equipment to provide maximum protection of electronic equipment that is connected to any outside plant cabling.
2. 5-Pin Solid State modules with a voltage rating appropriate to the application shall be utilized for all protection units.
3. MaineHealth prefers to use primary (lightning) protection products from Circa. Other manufacturers such as Porta Systems are also acceptable subject to MH Network Engineering review and require written approval.
4. All Primary (lightning) protection shall be installed to manufacturer's specifications and in adherence to all UL, NEC, State and Local code requirements for primary protection units.
5. Grounding of Primary Protection units must adhere to the requirements in Appendix J of this document in addition to the manufacturer specific installation requirements.

Appendix L
Fire Stopping

PART 1 GENERAL
1.01 DEFINITION

A. Fire Stopping: Material or combination of materials to retain the integrity of fire rated construction by maintaining an effective barrier against the spread of flame, smoke, and gases.

B. Through-Penetration Firestop Systems: Material or combination of materials which are field-constructed of fill, void, or cavity materials and forming materials, designed to resist fire spread when installed as a complete Firestop system.

C. Through-Penetration Firestop Devices: Factory built products designed to resist fire spread. Complete when delivered to site; ready for installation.

1.03 SUMMARY

A. Provide labor, materials, services, coordination, and equipment necessary for complete installation of Firestopping materials.

1. Provide through-penetration Firestop systems and through-penetration Firestop devices, sealants, and related products for floor and wall penetrations (and sealing top of rated walls to deck when required by code officials). Work includes, but is not limited to conduits and low voltage cables.

1.04 SUBMITTALS

A. Product Data: Manufacturer's data indicating product characteristics, performance, and limiting criteria.

B. Proposed Installation Drawings: Show typical installation details for methods of installation.

C. Documentation of qualifications as Firestopping installer is required.

D. MSDS sheets, for each product to be used, shall be provided to the individual responsible for site coordination of MSDS information.

E. Certification is required from manufacturer that Installer has been trained in the handling and installation of their products.

Appendix L (Continued)
Firestopping

1.05 QUALITY ASSURANCE

A. Conform to applicable governing codes:

1. Maine State Building Code

B. Meet requirements of ASTM E814 through Penetration Fire Test by a nationally recognized testing agency and other ASTM Standards as applicable for the installation.

1. ASTM E84 "Test Method for Surface Burning Characteristics of Building Materials."
2. ASTM E119 "Test Methods for Fire Tests of Building Construction and Materials."
3. ASTM E136 "Test Method for Behavior of Materials in a Vertical Tube Furnace at 750 degrees C."
4. ASTM E162 "Standard Method for Surface Flammability of Materials Using a Radiant Heat Energy Source."
5. ASTM E662 "Test Method for Specific Optical Density of Smoke Generated by Solid Materials."
6. ASTM E814 "Test Method for Fire Tests of Through-Penetration Firestops."

C. Installer shall have successfully completed within the last 3 years at least 2 Firestop projects similar in type and size to that of this Project. The installers are required to have been trained by each manufacturer of products they are installing and in the proper handling and installation of that product. Additionally, all contractors must complete MH's Contractor Orientation process prior to performing any Firestopping tasks in MH facilities.

D. Obtain Firestop materials from a single manufacturer for each different application (UL Listed Solution) using only the products listed for that solution.

E. Application Certification: Upon completion of the Work, the Contractor shall furnish to the Architect certification that materials have been installed in accordance with manufacturer's installation requirements. The installer shall sign certification.

F. Contact the manufacturers of each product intended for use for a list of qualified Firestop Specialty Installers.

Appendix L (Continued)
Firestopping

1.06 PRODUCT DELIVERY AND STORAGE

A. Deliver materials to project site in manufacturer's original unopened containers with labels indicating brand names. Store and protect accepted materials in accordance with manufacturer's directions and recommendations.

1.07 SEQUENCING

A. Coordinate this Work as required with work of other trades. Coordinate with other Contractors to make or keep penetration areas accessible to Firestopping installer.

PART 2 PRODUCTS

2.01 ACCEPTABLE MANUFACTURER'S PRODUCTS

A. Penetration Sealants
(Note: These products only apply to MMC and MMP. Consult local Engineering staff for product types at other MH Member sites. All products must be approved by MH Network Engineering)

1. 3M Brand "Fire Barrier" Caulk.
2. 3M Brand Moldable Putty "Pads" and Moldable Putty "Stix".

C. Intumescent sealants and Firestopping bags for use in openings and sleeves involving plastic pipe, insulated pipe, or flexible cable:
D. 3M Brand "Fire Barrier" Caulk, with FS-195 Wrap Strip and CS-195 Composite Sheet.
E. Specified Technologies (STI) EZ-Path Series and Ready Firestop Grommets (With MH Network Engineering approval only)

C. Penetration Systems

1. 3M Quick Path/Easy Path Fire Stopping systems.
2. Specified Technologies EZ-Path Series and Ready Firestop Grommets (With MH Network Engineering approval only)

2.02 MATERIALS - GENERAL

A. Provide flame (F) rating minimum one hour, but not less than fire resistance rating of the assembly in which installed, per ASTM E814.

B. Maintain effective barrier against flame, smoke, and hot gasses per ASTM E814 and UL 1479.

C. Suitable for Firestopping of penetrations by steel, glass, plastic, and insulated pipe. Also Flexible cable, bus duct, and cable tray.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine surfaces to receive penetration sealant or foam and report unacceptable conditions to the MH Network Engineering project resource before starting Firestopping work. Start of work indicates Firestopping installer's acceptance of sizing of holes and application conditions.

B. Each trade must control sizing of their penetration holes made to accommodate their penetrating items.

3.02 PREPARATION

A. Clean penetration holes of dirt, loose materials, and foreign matter, which may affect bond or installation.

B. Remove coatings such as paint, curing compounds, water repellent, and sealers as required.

3.03 APPLICATION

A. Installation of Firestopping Materials: Install Firestopping materials, including forming, packing, and other accessory materials to fill openings around mechanical and electrical services, penetrating floors and walls to provide firestops with fire resistance ratings indicated for floor or wall assembly in which penetration occurs. Comply with installation requirements established by testing and inspecting agency.

B. Install Firestopping materials systems in strict accordance with manufacturer's installation instructions and code requirements.

C. Employ installation techniques that will ensure that Firestopping is deposited to fill and seal holes and openings.

1. Provide flame (F) rating minimum one hour, but not less than fire resistance rating of the assembly in which installed, per ASTM E814. Ensure effective smoke seal. Tool exposed surfaces of applied sealant smooth.

3.04 CLEAN-UP

Appendix L (Continued)
Fire Stopping

A. Clean surfaces adjacent to sealed joints free of excess sealant and soiling from this Work as work progresses, using solvent or cleaning agent recommended in writing by the sealant manufacturer.

B. Leave finished Work in neat, clean condition; remove excess debris and materials.

Appendix M
General Contractor Assumptions

General assumptions list for detailing IS/IT/AV/Telecom related items

1) The General Contractor (GC) will provide all cable tray, backboxes, pull strings, conduit, J hooks, and Firestopping (approved MH/MMC systems) for all IS/AV/Telecom pathways and low voltage cabling. All device locations to be shown on the electrical construction document CAD prints. That includes cable tray size and pathways.

2) All IS/IT/Telecom cabling to be provided by MH/MMC. The MH/MMC Project Management Office (PMO) in conjunction with Network Engineering will bid out this work to our approved vendors.

3) All ceiling and wall mounted power for AV equipment (cameras, plasmas, etc.…) will be provided by the GC. The Architects/Engineers will mark-up the locations on the Construction Documents (CD) per MMC IS/IT/Telecom.

4) OSP conduits will be provided by the GC to the nearest, or most accessible, Maintenance Hole (MH) to support the installation of MH/MMC dark/private fiber. OSP Conduit counts will be determined by the MH/MMC project team.

5) All new OSP conduits should have continuous interduct and pull strings in them. The MH/MMC standard for interduct is MaxCell. Any deviation from this standard will need to be approved by MH Network Engineering.

6) All nurse call end user device selection and locations to be provided by MH/MMC Telecom. All system design (loads, power calculations, core equipment requirements, cabling specifications and as-builts) and equipment (hardware and software) to be provided and installed by a MH/MMC approved vendor. Nurse call cabling to be provided and installed by a MH/MMC approved contractor (see spec list).

7) All security, alarming, fire system, white noise, and other BES/BAS cabling done by others and shall not be placed in the IS network rooms (except security). All systems not listed here will need to be approved by the Manager of MH Network Engineering.

Appendix M (Continued)
General Contractor Assumptions

8) All network rooms and equipment rooms will comply with BICSI standards. Layouts (rack locations, power, ladder tray, etc...) to be provided by the MH/MMC PMO with the support of MH Network Engineering.

9) Any radio or paging augmentations needed in the new building will be provided by the General Contractor. A survey of the design (pre-construction) and space should be conducted by RCM. That design should be signed off by MH IS/IT, Security and Engineering.

10) All new network and equipment rooms will have MH/MMC card access for security and auditing as well as the appropriate cooling (HVAC) by the GC.

11) All power required for network, nurse call, paging and any other IS item will be provided by the GC. MH/MMC IS will provide a print detailing each location and the power type (NEMA numbers if known).

12) Any payphone locations will be planned in advance and approved by MH/MMC IS. The GC will have ownership of all blocking and power needed to support these devices.

13) MH/MMC IS will work with the design team on all ceiling mounted items (WAPs, speakers, nurse call) and mark up a reflective ceiling print showing preferred locations for each item. GC will provide tile and grid specifications to allow for procurement of appropriate mounting solutions.

14) All TV and AV blocking and power to be provided by the GC. MH/MMC IS will show locations of each item.

15) Clinical Engineering and Security items are outside the scope of MH/MMC IS. Please contact the leads from those departments for any CE or Security questions related to this project.

16) Any hardware (surge protectors, PC brackets, phone chargers, etc.…) that needs to be installed on walls will be completed by the GC.

Appendix M (Continued)
General Contractor Assumptions

17) Wireless access points, cable pathway, and rough-in for the elevators and stairwells will be installed by the GC. MH/MMC to provide WAPs and cable. GC to get permit and install as specified by MH/MMC.

18) All mill work grommets to be provided by the GC. Default placement to be over all under-the-counter data locations and power outlets.

19) All back boxes noted for IS/IT use shall be painted or have colored bushings on them using the following color scheme. Clinical Engineering = Orange, Security = Pink, MH/MMC IT = Blue, MH/MMC IT wall phones = Green, Cable TV = Yellow, Nurse Call = Black, Non-Integrated Pillow Speakers = Purple. Any other systems/colors will need to be approved by the MH project team.

20) All common areas (waiting rooms, nurse stations, charting spaces, etc.….) will have power outlets with built in USB connections for charging of portable devices.

Note: If no GC, then the building owner will provide items noted above. The IS/IT budget does not cover GC or building owner items noted on this document.

Appendix N

Overhead Paging Systems and Specifications

(Systems Vary at MH Sites)

MMC Systems

Special Work Results – Overhead Paging 1 (Bogen) – 27 15 00.46

B. Bogen 100 Watt Paging Amplifiers are used at MMC. Volume control attenuators (as indicated on project prints) and speakers shall be arranged in a daisy-chain fashion. Amplifiers shall have no more than 45 speakers attached. Installations with more than 1 paging amplifier will utilize an audio distribution amplifier to control impedance and stabilize output levels.

C. Individual paging speakers are set at 2.0 Watts

D. The contractor shall perform all terminations at the speaker end using cable and UL Listed termination equipment and enclosures supplied by the contractor. All speakers will be secured independently using jack chain or approved equivalent.

E. the MH Telecommunications Dept. will perform the final connections to the paging network.

F. Cabling for Bogen overhead paging applications is Plenum rated 16 gauge, single twisted pair, double jacketed cable (West Penn catalog # 25294B or=)

G. Each speaker shall have its transformer set for 25 or 70 volts to match the paging amplifier and will be set for 2.0 Watts output with the volume control at 50%. MH Telecommunications will provide the correct voltage setting and MH Network Engineering will include it within the SOW document.

H. Speakers locations will be specified by the system owner.

I. Each speaker run will be tested to determine the load on the system using an impedance meter and this information shall be noted on the as-built documentation for the project.

Special Work Results – Overhead Paging 2 (Valcom) – 27 15 00.46

A. An alternate paging system is in use in some MMC facilities that utilizes products manufactured by Valcom. The Valcom system uses standard 4-Pair Blue Category 6A UTP cable for speakers and is a 25 Volt System. Each Speaker cable is a home run from the speaker back to the originating TR where the cables are terminated on the backboard using BIX type connecting blocks and labeled “Overhead Paging”

END OF DOCUMENT

SECTION 27 05 00

COMMON WORK RESULTS FOR COMMUNICATIONS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. 232123 Section 01 81 13 “Sustainable Design Requirements – LEED v4 for Building Design & Construction – New Construction” for sustainable design requirements and detailed sustainable design submittal requirements.

C. Section 01 74 19 “Construction and Demolition Waste Management and Disposal” for disposal of construction, demolition and packaging waste disposal requirements.

1.2 SUMMARY

A. This Section includes the premise telecommunications cabling system.

B. As a condition of Contractor’s use of these specifications, Contractor agrees (i) to name AKF as additional insured on Contractor’s insurance policies wherever permitted, (ii) to provide AKF, upon request, with a certificate of insurance and copies of specific endorsements to Contractor’s insurance policies evidencing said additional insured status, and (iii) to waive all rights of recovery against AKF by way of subrogation, assignment, or otherwise with regard to insured claims.

C. Related Sections include the following:

1. Division 26 Electrical Sections
2. Division 1 Sections

D. The work covered by this specification includes the construction described, including all labor necessary to perform and complete such construction; all materials and equipment incorporated or to be incorporated in such construction; and all services, facilities, tools and equipment necessary or used to perform and complete such construction.

1. F&I all workstation jacks, connectors, terminating devices, faceplates, and similar components required for a complete installation.
2. F&I all cable supports (J-hooks), including mounting and installation hardware required for a complete installation.
3. F&I all labeling and documentation of all cables, racks, outlets and hardware installed under this contract. The Contractor shall ensure that all labeling and numbering is in accordance with the Owner’s in-house standards.
4. Provide all testing and test documentation as described in the testing section.
5. Label and document all new and existing-to-remain cables.
6. Provide all connections to the telecommunications grounding system.

7. Provide all fire-stopping of all rated wall and floor penetrations and openings through rated walls and floors after installation of telecommunications cabling.
8. F&I all non-specified miscellaneous hardware, including, but not limited to nuts, bolts, re-enterable cable ties, spiral wrap, wire rings, supporting hardware and similar components required for a complete cabling system installation.
9. Certain terms such as “shall, provide, install, complete, etc.” are not used in some parts of these Specifications. This does not indicate that the items shall be less than completely installed or that systems shall be less than complete.

E. Sustainable Building Requirements:
1. The Owner requires the Contractor to implement practices and procedures to meet the project’s environmental performance goals, which include achieving LEED version 4 Certified level Certification. Specific project goals that may impact this area of work include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; construction waste recycling; and the implementation of a construction indoor air quality management plan. The Contractor shall ensure that the requirements related to these goals, as defined in the Articles below, are implemented to the fullest extent. Substitutions, or other changes to the work proposed by the Contractor or their Subcontractors, shall not be allowed if such changes compromise the aforementioned environmental goals and LEED certification.

1.3 SUBMITTALS

A. Product Data: For each product indicated.

B. Field Test Reports

1.4 QUALITY ASSURANCE

A. Furnish all materials in new and unused condition, free from defects, damage or corrosion. All materials shall meet all applicable codes provided a standard has been established for the material in question.

B. Comply with all applicable governmental regulations and with all Federal, State, County, City, and other applicable codes, ordinances, and regulations and the most recent edition of the following technical standards and design guidelines:

1. ANSI/TIA/EIA-568 Standard for Installing Commercial Building Telecommunications Cabling (latest edition).
2. ANSI/TAI/EIA-569 Standard for Installing Commercial building Telecommunications Pathways & Spaces, (latest edition).
3. ANSI/TIA/EIA-606 Administration Standard for Commercial Telecommunications Infrastructure (latest edition).
4. ANSI/TIA/EIA-607 Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications (latest edition).
5. BICSI, Telecommunications Distribution Methods Manual (latest edition).

C. It is the intent of these Specifications to provide a complete workable telecommunications cabling system including optical fiber, coaxial and unshielded twisted pair cable, and ready for the Owner’s use.

1.5 DELIVERY, STORAGE AND HANDLING

A. Deliver materials (except bulk materials) in manufacturer's unopened container, fully identified with manufacturer's name, trade name, type, grade, size and color.

B. Store materials suitably sheltered from the elements, but readily accessible for inspection until installed. Store all items subject to moisture damage in dry, climate controlled spaces.

C. Store all materials in a secure manner to prevent loss. Contractor shall be responsible for any loss or damage of materials prior to Owner's acceptance thereof.

1.6 COORDINATION

A. Carefully check space requirements and the physical confines of the area of work to insure that all material can be installed in the spaces allotted thereto.

B. Transmit to other trades in a timely manner all information required for work to be provided under their respective Sections in ample time for installation.

C. Wherever work interconnects with or contacts the work of other trades, coordinate with other trades to insure that all trades have the information necessary so that they may properly install all the necessary connections and equipment. Identify all items of work that require access so that the floor tile trade will know where to install tile cutouts.

D. When directed by the Owner, the Contractor shall, without extra charge, make reasonable modifications in the layout as needed to prevent conflict with work of other trades or for proper compliance with the design intent.

1.7 WARRANTY

A. Provide a Warranty in accordance with the Contract Documents.

B. All work and all items of equipment and materials shall be warranted for a minimum period of one year from the date of acceptance of the work. Where manufacturer's warranty is longer than one year, the Contractor shall offer the extended warranty.

C. Provide Maine Medical Center with both Ortronics (Legrand) and Corning Cabling Systems extended product and applications assurance warranties.

PART 2 - PRODUCTS

2.1 GENERAL

A. Any given item of equipment or material shall be the product of one manufacturer unless otherwise noted or approved.

B. Substitutions or alternates for the manufacturers listed will not be permitted without the written consent of the Consultant.

PART 3 - EXECUTION

3.1 GENERAL

A. Follow manufacturers' instructions for installing all telecommunications cabling. Where instructions are unavailable, follow approved industry practice.

B. Compare communications drawings and specifications with the drawings and specifications of other trades, report any discrepancies to the Consultant; and obtain written instructions for changes necessary in the work. Include most stringent requirements in bid.

C. Repairs or changes caused by contractor's neglect shall be made at contractor's expense. Protect finished work of other trades from damage or defacement and remedy any damages as required.

D. Clean up all debris generated by installation activities on a daily basis and discard as directed by the Construction Manager.

E. Maintain a current copy of this Specification and related Drawings at the job site at all times.

3.2 CABLE DISTRIBUTION

A. Follow room boundaries when pulling cables through ceilings for distribution into walls, conduits, wiring channels, outlets, etc.

B. All cable distribution from the communications closets to all work locations (except as noted) shall be run in the voids above ceilings as shown on drawings. Ceiling support grids and service hangers shall not be used to support cabling.

C. Cable shall be loose bundled into cable supports. Use only approved re-enterable cable ties to secure cables in overhead distribution.

3.3 EMI/RFI AVOIDANCE

A. To avoid electromagnetic interference (EMI) route cables to maintain the following minimum distances:

B. Twelve inches from high voltage lighting.

C. Thirty-six inches from power lines of 5 KVA or greater.

D. Forty inches from transformers or motors.

E. Maintain minimum twelve-inch separation between telecommunication cables running exposed in ceiling or floor voids and parallel electrical cables/conduits.

F. Telecommunication cables shall cross electrical cables/conduits only at 90 degree angles.

3.4 STAFFING

A. Designate a qualified foreman. The foreman shall be present in the field at all times during the performance of the work.

B. Provide a supervisory work force sufficient to maintain efficient performance of the contractor's responsibilities.

C. Use only skilled and reliable work force and discontinue the services of anyone employed on this project upon written request by the Owner, Architect, Construction Manager or Consultant.

D. Use personnel who are qualified (at minimum) to perform all of the installation and testing work activities required under the contract.

E. Provide and use the proper tools in good working order for the performance of the work. The consultant reserves the right to review the tools and tool maintenance procedures of the contractor and require replacements to be obtained.

F. Telephone and data industry cable installation standards, TIA/EIA and BICSI standards, and manufacturers' instructions shall be used for in-process quality control and final acceptance of the work.

3.5 CABLE SLACK

A. Provide a minimum of 12-inches of slack at each terminal box or behind each faceplate after jack installation is completed to allow for easy dismounting and extension of outlet covers and wire terminations.

B. Provide a minimum of 5-feet slack in a loop in UTP at the head of each stub-up or distribution conduit.

C. Provide a minimum of 8-feet slack in a loop in optical fiber cable at its point of entry to an equipment room.

D. Provide a minimum of 20-feet slack for overhead mounted Wireless Access Point outlets.

3.6 FIRE STOPPING

A. Seal all penetrations through fire rated walls, floors and walls created by or made on the behalf of the contractor so that the original fire rating of the floor or wall is maintained as required by Article 300-21 of the National Electric Code.

B. Use sealant material that has passed fire exposure testing in accordance with standard time-temperature curve in the standard, UL, ASTM E 119, and NFPA 251 and the hose stream test in accordance with UL 1OB.

C. Provide removable fire-stopping pillows (IPC flame safe seal bags or approved equivalent) in an approved fashion in openings greater than 4" diameter, or 4" x 4" square cross section. Provide wire mesh grate over bags as recommended by manufacturer subsequent to installation.

END OF SECTION

This page is intentionally left blank.

SECTION 27 05 26

GROUNDING AND BONDING FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Provide all labor, materials, and equipment for the complete installation of work called for in the Contract Documents.

B. 232123 Section 01 81 13 “Sustainable Design Requirements – LEED v4 for Building Design & Construction – New Construction” for sustainable design requirements and detailed sustainable design submittal requirements.

C. Section 01 74 19 “Construction and Demolition Waste Management and Disposal” for disposal of construction, demolition and packaging waste disposal requirements.

1.2 SCOPE OF WORK

A. This section includes the minimum requirements for the equipment and cable installations in communications equipment rooms (Telecommunications Closets).

B. B. Included in this section are the minimum composition requirements and installation methods for the following:
   1. Busbars
   2. Bonding accessories

C. Sustainable Building Requirements:
   1. The Owner requires the Contractor to implement practices and procedures to meet the project’s environmental performance goals, which include achieving LEED version 4 Certified level Certification. Specific project goals that may impact this area of work include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; construction waste recycling; and the implementation of a construction indoor air quality management plan. The Contractor shall ensure that the requirements related to these goals, as defined in the Articles below, are implemented to the fullest extent. Substitutions, or other changes to the work proposed by the Contractor or their Subcontractors, shall not be allowed if such changes compromise the aforementioned environmental goals and LEED certification.

1.3 QUALITY ASSURANCE

A. All cable and equipment shall be installed in a neat and workmanlike manner. All methods of construction that are not specifically described or indicated in the contract documents shall be subject to the control and approval of the Owner or Owner Representative. Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based upon the acceptable manufactures listed. Where “approved equal” is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to approval.

B. Strictly adhere to all Building Industry Consulting Service International (BICSI), Electronic Industries Alliance (EIA) and Telecommunications Industry Association (TIA) recommended installation practices when installing communications/data cabling.

C. Material and work specified herein shall comply with the applicable requirements of:
   1. ANSI/TIA/EIA – 568-B Commercial Building Telecommunications Cabling Standard, latest edition.
   2. ANSI/TIA/EIA – 569 Commercial Building Standard for Telecommunications Pathways and Spaces, latest edition.
   3. ANSI/TIA/EIA – 606-A Administration Standard for the Telecommunications Infrastructure of Commercial Buildings, latest edition.
   4. ANSI-J-STD – 607-B Joint Standard for Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications, latest edition.
   5. NFPA 70 – National Electric Code, latest edition.
   6. BICSI – Telecommunications Distribution Methods Manual, latest edition.

1.4 SUBMITTALS

A. Provide product data for the following:
   1. Manufacturers cut sheets, specifications and installation instructions for all products (submit with bid).

PART 2 - PRODUCTS

2.1 WALL-MOUNT BUSBARS

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. Chatsworth Products, Inc.

B. Telecommunications Main Grounding Busbar (TMGB)
   1. Telecommunications Main Grounding Busbar (TMGB) shall be constructed of .25” (6.4 mm) thick solid copper bar.
   2. The busbar shall be 4” (100 mm) high and 20” (510 mm) or longer and shall have multiple attachment points for two-hole grounding lugs.
   3. The hole pattern for attaching grounding lugs shall meet the requirements of ANSI-J-STD – 607-A
   4. The busbar shall include wall-mount stand-off brackets, assembly screws and insulators creating a 4” (100 mm) standoff from the wall.
   5. The busbar shall be UL Listed as grounding and bonding equipment.

C. Telecommunications Grounding Busbar (TGB)
   1. Telecommunications Grounding Busbar (TGB) shall be constructed of .25” (6.4 mm) thick solid copper bar.
   2. The busbar shall be 2” (50 mm) high and 12” (300 mm) long and shall have multiple attachment points for two-hole grounding lugs.
   3. The hole pattern for attaching grounding lugs shall meet the requirements of ANSI-J-STD – 607-A and shall accept multiple lugs with 5/8” (15.8 mm) and 1” hole centers.

4. The busbar shall include wall-mount stand-off brackets, assembly screws and insulators creating a 4” (100 mm) standoff from the wall.
5. The busbar shall be UL Listed as grounding and bonding equipment.

2.2 BONDING ACCESSORIES

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. Chatsworth Products, Inc.

B. Two Mounting Hole Ground Terminal Block
   1. Ground terminal block shall be made of electroplated tin aluminum extrusion.
   2. Ground terminal block shall accept conductors ranging from #14 AWG through 2/0.
   3. The conductors shall be held in place by two stainless steel set screws.
   4. Ground terminal block shall have two 1/4” (6.4 mm) holes spaced on 5/8” (15.8 mm) centers to allow secure two-bolt attachment to the rack or cabinet.
   5. Ground terminal block shall be UL Listed as a wire connector.

C. Compression Lugs
   1. Compression lugs shall be manufactured from electroplated tinned copper.
   2. Compression lugs shall have two holes spaced on 5/8” (15.8 mm) or 1” (25.4 mm) centers, as stated below, to allow secure two bolt connections to busbars.
   3. Compression lugs shall be sized to fit a specific size conductor, sizes #6 to 4/0.
   4. Compression lugs shall be UL Listed as wire connectors.

D. Antioxidant Joint Compound
   1. Oxide inhibiting joint compound for copper-to-copper, aluminum-to-aluminum or aluminum-to-copper connections.

E. C-Type, Compression Taps
   1. Compression taps shall be manufactured from copper alloy.
   2. Compression taps shall be C-shaped connectors that wrap around two conductors forming an irreversible splice around the conductors; installation requires a hydraulic crimping tool
   3. Compression taps shall be sized to fit specific size conductors, sizes #2 AWG to 4/0.
   4. Compression taps shall be UL Listed.

F. Pedestal Clamp With Grounding Connector
   1. Pedestal clamp shall be made from electroplated tinned copper or bronze. Installation hardware will be stainless steel.
   2. Pedestal clamps shall be sized to fit a specific size conductor, size #6 and/or 2/0, as stated below.
   3. Pedestal clamp installation hardware shall be sized to attach to round and/or square raised access floor pedestals that are 1-1/8” to 1-3/4” in diameter, as stated below.
   4. Pedestal clamp shall provide straight (in-line) or cross (intersection) support for up to two conductors.

5. Pedestal clamp shall be UL Listed as grounding and bonding equipment.

G. Pipe Clamp With Grounding Connector
1. Pipe clamp shall be made from electroplated tinned bronze. Installation hardware will be stainless steel.
2. Pipe clamp shall be sized to fit up to two conductors ranging in size from #6 to 250 MCM; conductors must be the same size.
3. Pipe clamp installation hardware shall be sized to attach to pipes, sizes 1” to 6” (.75” to 6.63” in diameter), as stated below.
4. Pipe clamp shall be UL Listed as grounding and bonding equipment.

H. Equipment Ground Jumper Kit
1. Kit includes one 24”L insulated ground jumper with a straight two hole compression lug on one end and an L-shaped two hole compression lug on the other end, two plated installation screws, an abrasive pad and a .5 once tube of antioxidant joint compound.
2. Ground conductor is an insulated green/yellow stripe #6 AWG wire
3. Lugs are made from electroplated tinned copper and have two mounting holes spaces .5” to .625” apart that accept 1/4” screws.
4. Jumper will be made with UL Listed components

PART 3 - EXECUTION

3.1 INSTALLATION

A. Wall-Mount Busbars
1. Attach busbars to the wall with appropriate hardware according to the manufacturer’s installation instructions.
2. Conductor connections to the TMGB or TGB shall be made with two-hole bolt-on compression lugs sized to fit the busbar and the conductors.
3. Each lug shall be attached with stainless steel hardware after preparing the bond according to manufacturer recommendations and treating the bonding surface on the busbar with antioxidant to help prevent corrosion at the bond.
4. The wall-mount busbar shall be bonded to ground as part of the overall Telecommunications Bonding and Grounding System.

B. Ground Terminal Block
1. Every rack and cabinet shall be bonded to the TMGB or TGB.
2. Minimum bonding connection to racks and cabinets shall be made with a rack-mount two-hole ground terminal block sized to fit the conductor and rack and installed according to manufacturer recommendations.
3. Remove paint between rack/cabinet and terminal block, clean surface and use antioxidant between the rack and the terminal block to help prevent corrosion at the bond.

C. Pedestal Clamp
1. At minimum, bond every sixth raised access floor pedestal with a minimum #6 AWG conductor to the TMGB or TGB using a pedestal clamp sized to fit the pedestal and the conductor and installed according to the manufacturer’s recommendations.
2. If pedestal clamps are used to construct a signal reference grid, bond the signal reference grid to the TMGB or TGB and bond each rack and/or cabinet

to the signal reference grid using a compression tap or similar non-reversible bonding component sized to fit both conductors.

3. Remove paint between the pedestal and pedestal clamp, clean surface and use antioxidant between the pedestal and the clamp to help prevent corrosion at the bond.
4. Remove insulation from conductors where wires attach to the pedestal clamp.

D. Pipe Clamp

1. Bond metal pipes located inside the data center computer room with a minimum #6 AWG conductor to the TMGB or TGB using a pipe clamp sized to fit the pipe and the conductor and installed according to the manufacturer's recommendations.
2. Remove paint between the pipe and pipe clamp, clean surface and use antioxidant between the pipe and the clamp to help prevent corrosion at the bond.
3. Remove insulation from conductors where wires attach to the pipe clamp.

E. Equipment Ground Jumper Kit

1. Bond equipment to a vertical rack-mount busbar or ground bar using ground jumper according to the manufacturer's recommendations.
2. Clean the surface and use antioxidant between the compression lugs on the jumper and the rack-mount busbar or ground bar to help prevent corrosion at the bond.

END OF SECTION

This page is intentionally left blank.

SECTION 27 11 00

COMMUNICATIONS EQUIPMENT ROOM FITTINGS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. 232123 Section 01 81 13 “Sustainable Design Requirements – LEED v4 for Building Design & Construction – New Construction” for sustainable design requirements and detailed sustainable design submittal requirements.

C. Section 01 74 19 “Construction and Demolition Waste Management and Disposal” for disposal of construction, demolition and packaging waste disposal requirements.

1.2 SUMMARY

A. Section Includes:
1. Telecommunications mounting elements
2. Backboards.
3. Telecommunications equipment racks and cabinets
4. Telecommunications service entrance pathways

B. Related Sections:
1. Division 27 Section "Communications Backbone Cabling" for voice and data cabling associated with system panels and devices.
2. Division 27 Section "Communications Horizontal Cabling" for voice and data cabling associated with system panels and devices.
3. Division 28 Section "Conductors and Cables for Electronic Safety and Security" for voice and data cabling associated with system panels and devices.

C. Sustainable Building Requirements:
1. The Owner requires the Contractor to implement practices and procedures to meet the project’s environmental performance goals, which include achieving LEED version 4 Certified level Certification. Specific project goals that may impact this area of work include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; construction waste recycling; and the implementation of a construction indoor air quality management plan. The Contractor shall ensure that the requirements related to these goals, as defined in the Articles below, are implemented to the fullest extent. Substitutions, or other changes to the work proposed by the Contractor or their Subcontractors, shall not be allowed if such changes compromise the aforementioned environmental goals and LEED certification.

1.3 DEFINITIONS

A. Basket Cable Tray: A fabricated structure consisting of wire mesh bottom and side rails.

B. BICSI: Building Industry Consulting Service International.

C. Channel Cable Tray: A fabricated structure consisting of a one-piece, ventilated-bottom or solid-bottom channel not exceeding 6 inches (152 mm) in width.

D. Ladder Cable Tray: A fabricated structure consisting of two longitudinal side rails connected by individual transverse members (rungs).

E. LAN: Local area network.

F. RCDD: BICSI Registered Communications Distribution Designer.

G. Solid-Bottom or Non-ventilated Cable Tray: A fabricated structure consisting of a bottom without ventilation openings within integral or separate longitudinal side rails.

H. Trough or Ventilated Cable Tray: A fabricated structure consisting of integral or separate longitudinal rails and a bottom having openings sufficient for the passage of air and using 75 percent or less of the plan area of the surface to support cables.

1.4 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Floor-mounted cabinets and cable pathways 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 and the unit will be fully operational after the seismic event."

1.5 SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for equipment racks and cabinets. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For communications equipment room fittings. 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. Equipment Racks and Cabinets: Include workspace requirements and access for cable connections.
   3. Grounding: Indicate location of grounding bus bar and its mounting detail showing standoff insulators and wall mounting brackets.

C. Qualification Data: layout technician, installation supervisor, and field inspector.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.

1. Layout Responsibility: Preparation of Shop Drawings shall be under the direct supervision of a BICSI RCDD.
2. Installation Supervision: Installation shall be under the direct supervision of a BICSI Registered Technician Level 2 Installer, who shall be present at all times when Work of this Section is performed at Project site.
3. Field Inspector: Currently registered by BICSI as an RCDD to perform the on-site inspection.

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. Telecommunications Pathways and Spaces: Comply with ANSI/TIA/EIA-569-A.

D. Grounding: Comply with ANSI-J-STD-607-C.

E. Labeling of all Telecom components shall be in accordance with/ANSI/TIA/EIA-606(A).

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install equipment frames and cable trays until spaces are enclosed and weather-tight, wet work in spaces is complete and dry, and work above ceilings is complete.

1.8 COORDINATION

A. Coordinate layout and installation of communications equipment with Owner's telecommunications and LAN equipment and service suppliers. Coordinate service entrance arrangement with local exchange carrier.
1. Meet jointly with telecommunications and LAN equipment suppliers, local exchange carrier representatives, and Owner and/or their agent to exchange information and agree on details of equipment arrangements and installation interfaces.
2. Record agreements reached in meetings and distribute them to other participants.
3. Adjust arrangements and locations of distribution frames, cross-connects, and patch panels in equipment rooms to accommodate and optimize arrangement and space requirements of telephone switch and LAN equipment.
4. Adjust arrangements and locations of equipment with distribution frames, cross-connects, and patch panels of cabling systems of other communications, electronic safety and security, and related systems that share space in the equipment room.

B. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.

PART 2 - PRODUCTS

2.1 CABLING & PATCH PANELS

A. Cat6A Patch Panels
1. Ortronics OR-PHD6AU48 (2U)
2. Ortronics OR-60400199 (Strain Relief Bar)

B. Cat6A 4-pair UTP CMP Cabling
   1. Berk-Tek 4-Pair #11082057, CAT6A Color Blue (Plenum) for Information System & Clinical Engineering.

2.2 PATHWAYS

A. General Requirements: Comply with TIA/EIA-569-A.

B. Cable Support: NRTL labeled. Cable support brackets shall be designed to prevent degradation of cable performance and pinch points that could damage cable. Cable tie slots fasten cable ties to brackets. Contractors shall note that the use of plastic cable ties is strictly prohibited.
   1. Comply with NFPA 70 and UL 2043 for fire-resistant and low-smoke-producing characteristics.
   2. Support brackets with cable tie slots for fastening cable ties to brackets.
   3. Lacing bars, spools, J-hooks, and D-rings.
   4. Straps and other devices.

C. Ladder Rack, Supports & Accessories:
   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. Chatsworth Products, Inc.
         1) 18” Ladder Rack (Black): 10250-718
         2) Rung Radius Drop: 12100-712
         3) Stringer Radius Drop: 12101-701
         4) 6” Cable Retaining Posts: 10596-706
         5) 15”W Corner Bracket: 11959-715
         6) Provide supports, splice kits and grounding as required to ensure a complete system.
   2. Ladder Rack Materials: Metal, suitable for indoors and protected against corrosion.
      a. Trays shall be provisioned 18” wide.
      b. Ladder rack shall be manufactured from 3/8” W by 1 1/2” H tubular steel,
      c. Ladder rack cross members shall be welded in between stringers on 9” centers.
      d. Finish shall be epoxy-polyester hybrid powder coat – black in color.
      e. Contractor shall be responsible for furnishing all supports fittings and transition pieces (water falls).

D. Conduit and Boxes: Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems. Flexible metal conduit shall not be used.
   1. Outlet boxes shall be no smaller than 2 inches (50 mm) wide, 3 inches (75 mm) high, and 2-1/2 inches (64 mm) deep.

2.3 BACKBOARDS

A. Backboards: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches (19 by 1220 by 2440 mm) shall be installed in all telecom spaces as noted and/or required to complete the overall scope of work. Comply with requirements for plywood backing panels specified in Division 06 Section "Rough Carpentry."

B. All backboards shall be mounted flush on the wall, as detailed in the drawings.

2.4 EQUIPMENT CABINETS, RACKS & ACCESSORIES

A. Manufacturers: Subject to compliance with requirements, provide products by the following:
   1. Chatsworth Products, Inc. (CPI) (IT Racks)
      a. 19" 2-Post Universal Equipment Rack (Black): 55053-703
      b. 6"W Double-sided Vertical Cable Manager (Black): 11729-703
      c. 12"W Double-sided Vertical Cable Manager (Black): TS1000367 (CPI Special Order).
      d. Rack Installation Kit (Concrete): 40604-001
      e. 2U Upper Jumper & Transition Tray: 12183-719
   2. Ortronics
      a. 2U Horizontal Cable Manager:OR-60400426
   3. Great Lakes (Clinical Engineering Cabinets)
      a. 84”H x 24”W x 36”D Network Cabinet w/ Mesh Front Door, Split Mesh Rear Doors & Vented Top: GL840E-2436MSP
      b. Casters: 7208-E
      c. #10-32 Mounting Rails (qty. 2-pair per cabinet): 8405-ES1P
      d. #10-32 Screws: as required
   4. Rack Solutions
      a. Adjustable Sliding Shelf: 1USHL-115

B. General Requirements:
   1. Server Cabinets: Freestanding and wall-mounting, modular-steel units designed for telecommunications terminal support and coordinated with dimensions of units to be supported.
   2. Module Dimension: Width compatible with EIA 310 standard, 19-inch (480-mm) panel mounting.
   3. Finish: Manufacturer's standard, baked-polyester powder coat – color black.

C. Floor-Mounted Racks: Modular-type, aluminum construction.
   1. Vertical and horizontal cable management channels, top cable trough, grounding lug, and associated power strips.
   2. Baked-polyester powder coat finish (Black).

D. Cable Management for Equipment Frames:
   1. Metal, ring duct for cabling.
   2. Baked-polyester powder coat finish (Black).
   3. Vertical cable management panels shall have front and rear channels.
   4. Provide horizontal crossover cable manager at the top of each relay rack, with a minimum height of two rack units each. Horizontal manage panel shall be arranged so that one panel is above and below each contractor provided patch panel.

2.5 LABELING

A. Comply with ANSI/TIA/EIA-606-A and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

B. Each new server cabinet and equipment rack shall have custom engraved, phenolic labels, front and rear.

PART 3 - EXECUTION

3.1 ENTRANCE FACILITIES

A. Contact telecommunications service provider and arrange for installation of demarcation point, protected entrance terminals, and a housing when so directed by service provider.

B. Install underground pathways complying with recommendations in TIA/EIA-569-A, "Entrance Facilities" Article.

3.2 Install underground entrance pathway complying with Division 26 Section "Raceway and Boxes for Electrical Systems" installation.

A. Comply with NECA 1.

B. Comply with BICSI TDMM for layout and installation of communications equipment rooms.

C. Cable Trays: Comply with NEMA VE 2 and ANSI/TIA/EIA-569-A-7.

D. Bundle, lace, and train conductors and cables to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

3.3 FIRESTOPPING

A. Comply with requirements in Division 07 Section "Penetration Fire-stopping." Comply with ANSI/TIA/EIA-569-A, Annex A, "Fire-stopping."

B. Comply with BICSI TDMM, "Fire-stopping Systems" Article.

3.4 GROUNDING

A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

B. Comply with ANSI-J-STD-607-C.

C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch (50-mm) 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.

1. Bond the shield of shielded cable to the grounding bus bar in communications rooms and spaces.

3.5 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with ANSI/TIA/EIA-606-A. Comply with requirements in Division 26 Section "Identification for Electrical Systems. "Comply with requirements in Division 09 Section "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.

B. See Division 27 Section "Communications Horizontal Cabling" for additional identification requirements. See Evaluations for discussion of ANSI/TIA/EIA standard as it applies to this Section. Paint and label colors for equipment identification shall comply with ANSI/TIA/EIA-606-A for Class 3 level of administration including optional identification requirements of this standard.

C. Labels shall be preprinted or computer-printed type.

END OF SECTION

This page is intentionally left blank.

SECTION 27 13 00

COMMUNICATIONS BACKBONE CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. 232123 Section 01 81 13 “Sustainable Design Requirements – LEED v4 for Building Design & Construction – New Construction” for sustainable design requirements and detailed sustainable design submittal requirements.

C. Section 01 74 19 “Construction and Demolition Waste Management and Disposal” for disposal of construction, demolition and packaging waste disposal requirements.

1.2 SUMMARY

A. Section Includes:
1. Pathways
2. UTP cable
3. Optical fiber cabling
4. Cable connecting hardware, patch panels, and cross-connects
5. Cabling identification products

B. Related Sections:
1. Division 28 Section "Conductors and Cables for Electronic Safety and Security" for voice and data cabling associated with system panels and devices.

C. Sustainable Building Requirements:
1. The Owner requires the Contractor to implement practices and procedures to meet the project’s environmental performance goals, which include achieving LEED version 4 Certified level Certification. Specific project goals that may impact this area of work include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; construction waste recycling; and the implementation of a construction indoor air quality management plan. The Contractor shall ensure that the requirements related to these goals, as defined in the Articles below, are implemented to the fullest extent. Substitutions, or other changes to the work proposed by the Contractor or their Subcontractors, shall not be allowed if such changes compromise the aforementioned environmental goals and LEED certification.

1.3 DEFINITIONS

A. BICSI: Building Industry Consulting Service International.

B. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.

C. EMI: Electromagnetic interference.

D. IDC: Insulation displacement connector.

E. LAN: Local area network.

F. RCDD: BICSI Registered Communications Distribution Designer.

G. UTP: Unshielded twisted pair.

1.4 BACKBONE CABLING DESCRIPTION

A. Backbone cabling system shall provide interconnections between communications equipment rooms, main terminal space, and entrance facilities in the telecommunications cabling system structure. Cabling system consists of backbone cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for backbone-to-backbone cross-connection.

B. Backbone cabling cross-connects may be located in communications equipment rooms or at entrance facilities. Bridged taps and splitters shall not be used as part of backbone cabling.

C. UTP Backbone Infrastructure – Contractors shall supply and install, in the pair counts as denoted on the provided drawings, all copper UTP backbone riser cabling between each identified IDF Room and the MDF Room and between the MDF room and the main campus (see drawings for exact locations). Contractors shall be responsible for providing and installing all components necessary to complete this scope of work. This work shall include but not be limited to all: termination hardware, cable supports, cable management (troughs, D-Rings or Velcro), cross-connect wiring, or any additional hardware needed for routing backbone cabling between the identified locations.

D. Fiber Optic Backbone Infrastructure – Contractors shall supply and install, in the strand counts as denoted on the provided drawings, all Single-mode MIC Tight-Buffered, Dielectric Armored Plenum-Rated fiber optic cabling between each identified IDF Room and the MDF Room and between the MDF room and the main campus (see drawings for exact locations). Contractors shall be responsible for providing and installing all components necessary to complete this scope of work, this includes but is not limited to all, termination hardware, connector panel housings, cable supports and all cable management hardware.

1.5 PERFORMANCE REQUIREMENTS

A. General Performance: Backbone cabling system shall comply with transmission standards in ANSI/TIA/EIA-568-B.1, when tested according to test procedures of this standard.

1.6 SUBMITTALS

A. Product Data: For each type of product indicated.
   1. Submit manufacturers' product data sheets for all material and equipment products proposed in bid. Only specified or accepted manufacturers or suppliers shall appear in the product data submittal.

2. Where substitutions or alternates are requested for any specified manufacturer or product, contractors shall submit complete documentation for the proposed product, including complete product data/catalog sheets, performance/engineering reports and any additional information that may be pertinent to the approval of this product.

B. Shop Drawings:
1. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by Owner.
2. System Labeling Schedules: Electronic copy of labeling schedules that are part of the cabling and asset identification system of the software.
3. Cabling administration drawings and printouts.
4. Wiring diagrams to show typical wiring schematics including the following:
   a. Cross-connects.
   b. Patch panels.
   c. Patch cords.
5. Cross-connects and patch panels. Detail mounting assemblies, and show elevations and physical relationship between the installed components.
6. Pathway (i.e. J-hook/or tray) layouts, showing route to scale, with relationship between the pathway and any adjacent structural, electrical, and mechanical elements. Include the following:
   a. Vertical and horizontal offsets and transitions.
   b. Clearances for access above and to side of cable trays.
   c. Vertical elevation of cable trays above the floor or bottom of ceiling structure.
   d. Load calculations to show dead and live loads as not exceeding manufacturer's rating for tray and its support elements.
7. Shop drawings shall be submitted (10) days prior to start of work and prior to ordering any material. Shop drawings shall consist of (1) set of reproducible drawings and (3) copies of all drawings, diagrams and/or manufacturer data in accordance with the contract documentation.
8. As-built documentation shall be provided at the completion of installation. As-built documentation shall include all floor plan views, elevations drawings, cable termination and cross connect schedules. Drawing sets shall consist of (1) reproducible set (velum and electronic) and (3) hard copies. All Schedules shall include (1) hard copy set and (1) electronic copies.
9. Contractors shall note that any electronic media sets that are to be turned in at the completion of the project should be coordinated with the end-user to ensure proper formatting and/or software compatibility.

C. Qualification Data: For layout technician, installation supervisor, and Project manager.

D. Source quality-control reports.

E. Field quality-control reports.

F. Maintenance Data: For splices and connectors to include in maintenance manuals.

G. 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.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff is recommended.
   1. Layout Responsibility: Preparation of Shop Drawings, Cabling Administration Drawings, and field testing program development by a certified designer.
   2. Installation Supervision: Installation shall be under the direct supervision of BICSI Level 2 Installer, who shall be present at all times when Work of this Section is performed at Project site.

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. Telecommunications Pathways and Spaces: Comply with ANSI/TIA/EIA-569-A.

D. Grounding: Comply with ANSI-J-STD-607-C.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.
   1. Test optical fiber cable to determine the continuity of the strands end to end. Use optical fiber flashlight or optical loss test set.
   2. Test optical fiber cable while on reels. Use an optical time domain reflectometer to verify the cable length and locate cable defects, splices, etc., 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.

B. Delivery and Storage
   1. Contractor shall be responsible for the coordination and receipt of any job related material being shipped to the site and also for ensuring the proper storage and safe guard of this material. Coordination of delivery shall include direct communications with the General Contractor, the end-user/facilities group and/or building owner (as necessary) to ensure proper scheduling and delivery requirements.

1.9 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.10 COORDINATION

A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.

1.11 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Patch-Panel Units: One of each type.

2. Connecting Blocks: One of each type.

1.12 WARRANTY

A. Cabling Contractor shall have the ability to extend to end-user a minimum warranty period of 20 years for the system(s) they intend to install. This warranty shall certify that the installation will be free from defects in performance and workmanship, as well as meet or exceed all ANSI/TIA/EIA performance requirements. Contractor will be required to submit all pre-project and post project documentation including test documentation and registration forms necessary for system coverage under this program.

B. System coverage shall but is not limited to the following components.
1. Cabling components.
2. Connecting Hardware.
3. Connectors.
4. Jacks/Outlets.

PART 2 - PRODUCTS

2.1 UTP CABLE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Berk-Tek: 25-Pair Category 3 Plenum-Rated
   a. Gray (10032111)
2. Berk-Tek: 100-Pair Category 3 Plenum-Rated
   a. Gray (10032113)
3. Superior Essex: 100-Pair, PE-89, OSP Category 3 Plenum-Rated
   a. Black (09-104-02)

B. Description: 100-ohm UTP:
1. Comply with ICEA S-90-661 for mechanical properties.
2. Comply with ANSI/TIA/EIA-568-B.1 for performance specifications.
3. Comply with ANSI/TIA/EIA-568-B.2, Category 3.
4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following type (or equivalent).
5. Type requirements in subparagraphs below are minimum requirements and may be revised to suit Project. Retain options if "permitted substitutions," as defined in NFPA 70, are appropriate for this Project.
6. Communications Plenum Cable: Type CMP

2.2 UTP CABLE HARDWARE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Ortronics & Belden:
   a. Flat 48-Port CAT6A Patch Panel (OR-PHD6AU48)
   b. 250 Pair Distribution Frame (Belden A0270164)
   c. 25 Pair Distribution Connector (Belden A0266828)
   d. Distribution Ring (Belden A0270168)

e. Data Plate (Belden A0270169)
f. Label (Belden P0588406)

B. General Requirements for Cable Connecting Hardware: Comply with ANSI/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.

2.3 COAXIAL CABLE

A. Manufacturers: Subject to compliance with requirements, provide products by the following:
1. Commscope:
a. Quad-shielded Series-11 Plenum-Rated Coaxial Cable: 2287K
b. ½ Heliax Air Dielectric Aluminum Shield Plenum Cable: AL4RPV-50-3000

B. Description:
1. 3GHz RG11 75-Ohm
2. 3GHz .500 75-Ohm

C. Jacket:
1. Jacket Color: White.
2. Imprinted with cable name, type, and aggregate length at regular intervals not to exceed 40 inches (1000 mm).

2.4 OPTICAL FIBER CABLE

A. Manufacturers: Subject to compliance with requirements, provide products by the following:
1. Corning:
a. XX-Strand MIC Tight-Buffered, Dielectric Armored Plenum-Rated Single-mode Cable: 0XXE88-33131-D3, XX=Strand Count
b. XXX-Strand Indoor / Outdoor, Armored Plenum-Rated Single-mode Cable: XXXE8P-Y3131-A3, XXX=Strand Count

B. Description: Single-mode, 9/125-micrometer (OS2), dielectric/nonconductive armored, tight buffer, optical fiber cable.
1. Comply with ICEA S-83-596 for mechanical properties.
2. Comply with ANSI/TIA/EIA-568-B.3 for performance specifications.
3. Comply with ANSI/TIA/EIA-492AAAA-B for detailed specifications.
4. Listed and labeled as complying with UL 444, UL 1651, and NFPA 70 for the following types (or equivalent).
5. Plenum Rated, Nonconductive: Type NFPA 262.
6. Maximum Attenuation: 0.65 dB/km at 1310 nm; 0.65 dB/km at 1383 nm; 0.5 dB/km at 1550 nm

C. Jacket:
1. Jacket Color: Yellow
2. Cable cordage jacket, fiber, unit, and group color shall be according to ANSI/TIA/EIA-598-B.
3. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches (1000 mm).

2.5 OPTICAL FIBER CABLE TERMINATION HARDWARE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   1. Corning:
      a. 1U Rack-mount Fiber Enclosure (CCH-01U)
      b. 2U Rack-mount Fiber Enclosure (CCH-02U)
      c. SC Single-mode Connector Panel (CCH-CP12-59)
      d. SC Single-mode Connector (900-200-41)

B. Cross-Connects and Patch Panels: Modular panels housing multiple-numbered, duplex cable connectors.
   1. Number of Connectors per Field: One for each fiber of cable or cables assigned to field, plus spares and blank positions adequate to suit specified expansion criteria.

C. Patch Cords: Factory-made, dual-fiber cables in 36-inch (900-mm) lengths. Exact length & quantity to be field coordinated with client.

D. Cable Connecting Hardware:
   1. Comply with Optical Fiber Connector Intermateability Standards (FOCIS) specifications of TIA/EIA-604-2, TIA/EIA-604-3-A, and TIA/EIA-604-12. Comply with TIA/EIA-568-B.3.
   2. Quick-connect, simplex and duplex, Type SC connectors. Insertion loss not more than 0.75 dB.

2.6 GROUNDING

A. Comply with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems." for grounding conductors and connectors.

B. Comply with ANSI-J-STD-607-B.

2.7 IDENTIFICATION PRODUCTS

A. Comply with ANSI/TIA/EIA-606-A and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

2.8 SOURCE QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate cables.

B. Factory test cables on reels according to ANSI/TIA/EIA-568-B.1.

C. Factory test UTP cables according to ANSI/TIA/EIA-568-B.2.

D. Factory test multimode optical fiber cables according to ANSI/TIA/EIA-526-14-A and ANSI/TIA/EIA-568-B.3.

E. Cable will be considered defective if it does not pass tests and inspections.

F. 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. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces, in attics, and in gypsum board partitions where unenclosed wiring method may be used. Conceal raceway and cables except in unfinished spaces.
   1. Install plenum cable in environmental air spaces, including plenum ceilings.
   2. Comply with requirements for raceways and boxes specified in Division 26 Section "Raceway and Boxes for Electrical Systems."

B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

C. Wiring within Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

3.3 INSTALLATION OF PATHWAYS

A. Cable Trays: Comply with NEMA VE 2 and ANSI/TIA/EIA-569-A.

B. Comply with requirements for demarcation point, pathways, cabinets, and racks specified in Division 27 Section "Communications Equipment Room Fittings." Drawings indicate general arrangement of pathways and fittings.

C. Comply with ANSI/TIA/EIA-569-A for pull-box sizing and length of conduit and number of bends between pull points.

D. Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems" for installation of conduits and wireways.

E. Install manufactured conduit sweeps and long-radius elbows whenever possible.

F. Pathway Installation in Communications Equipment Rooms:
   1. Position conduit ends adjacent to a corner on backboard where a single piece of plywood is installed, or in the corner of room where multiple sheets of plywood are installed around perimeter walls of room.
   2. Install cable trays to route cables if conduits cannot be located in these positions.
   3. Secure conduits to backboard when entering room from overhead.
   4. Extend conduits 3 inches (76 mm)] above finished floor.
   5. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.
   6. Contracts shall provide any additional transitional fittings to properly route and manage all cabling to its final termination point.

G. Backboards: Install backboards with 96-inch (2440-mm) dimension vertical. Butt adjacent sheets tightly, and form smooth gap-free corners and joints.

3.4 INSTALLATION OF CABLES

A. Comply with NECA 1.

B. General Requirements for Cabling:
   1. Comply with ANSI/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. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
   5. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches (760 mm) and not more than 6 inches (150 mm) from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
   6. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
   7. 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. Use lacing bars and distribution spools.
   8. 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.
   9. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
   10. In the communications equipment room, install an 8-foot- (3-m-) long service loop on each end of cable.
   11. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.

C. UTP Cable Installation:
   1. Comply with ANSI/TIA/EIA-568-B.2.
   2. Do not untwist UTP cables more than 1/4 inch (6 mm) from the point of termination to maintain cable geometry.

D. Optical Fiber Cable Installation:
   1. Comply with ANSI/TIA/EIA-568-B.3.
   2. Cable may be terminated on connecting hardware that is rack or cabinet mounted.

E. 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 (200 mm) above ceilings by cable supports not more than 60 inches (5’ ft.) on centers.
   3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

F. Group connecting hardware for cables into separate logical fields.

G. Separation from EMI Sources:
   1. Comply with BICSI TDMM and ANSI/TIA/EIA-569-A recommendations 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 (127 mm).
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches (300 mm).
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches (610 mm).
3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
   a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches (64 mm).
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches (150 mm).
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches (300 mm).
4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
   a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches (76 mm).
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches (150 mm).
5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches (1200 mm).
6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches (127 mm).

3.5 FIRESTOPPING

A. Comply with requirements in Division 07 Section "Penetration Firestopping". Comply with ANSI/TIA/EIA-569-A, Annex A, "Firestopping."

B. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.6 GROUNDING

A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

B. Comply with ANSI-J-STD-607-B.

C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch (50-mm) 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.

3.7 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with ANSI/TIA/EIA-606-A. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."
   1. Administration Class: 3.
   2. Color-code cross-connect fields and apply colors to voice and data service backboards, connections, covers, and labels.

B. Comply with requirements in Division 09 Section "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.

C. See Division 27 Section "Communications Horizontal Cabling" for additional identification requirements. See Evaluations for discussion about TIA/EIA standard as it applies to this Section. Paint and label colors for equipment identification shall comply with ANSI/TIA/EIA-606-A for Class 3 level of administration including optional identification requirements of this standard.

D. Comply with requirements in Division 27 Section "Communications Horizontal Cabling" for cable and asset management software.

E. Cable Schedule: Install in a prominent location in each equipment room and Telecom Room. 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.

F. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications rooms, backbone pathways and cables, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors.

G. Cable and Wire Identification:
   1. Label each cable within 4 inches (100 mm) of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
   2. Each wire connected to building-mounted devices is not required to be numbered at 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 25 feet (4.5 m).
   4. Label each terminal strip and screw terminal in each cabinet, rack, or panel.
      a. Individually number wiring conductors connected to terminal strips and identify each cable or wiring group being extended from a panel or cabinet to a building-mounted device 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.

H. 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, for the following:

1. For cables, use flexible vinyl or polyester that flexes as cables are bent.

3.8 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:
   1. Visually inspect UTP and optical fiber 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 ANSI/TIA/EIA-568-B.1.
   2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
   3. Test UTP copper cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.
      a. Test instruments shall meet or exceed applicable requirements in ANSI/TIA/EIA-568-B.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
   4. Optical Fiber Cable Tests:
      a. Test instruments shall meet or exceed applicable requirements in ANSI/TIA/EIA-568-B.1. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
      b. Link End-to-End Attenuation Tests:
         1) Horizontal and multimode backbone link measurements: Test at 850 or 1300 nm in 1 direction according to ANSI/TIA/EIA-526-14-A, Method B, One Reference Jumper.
         2) Attenuation test results for backbone links shall be less than 2.0 dB. Attenuation test results shall be less than that calculated according to equation in ANSI/TIA/EIA-568-B.1.

C. Data for each measurement shall be documented. 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.

D. Remove and replace cabling where test results indicate that they do not comply with specified requirements.

E. End-to-end cabling will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

END OF SECTION

SECTION 27 15 00

COMMUNICATIONS HORIZONTAL CABLING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. Section 01 81 13 "Sustainable Design Requirements – LEED v4 for Building Design & Construction – New Construction" for sustainable design requirements and detailed sustainable design submittal requirements.

C. Section 01 74 19 "Construction and Demolition Waste Management and Disposal" for disposal of construction, demolition and packaging waste disposal requirements.

1.2 SUMMARY

A. Section Includes:
1. Pathways
2. UTP cabling
3. Cable connecting hardware, patch panels, and cross-connects
4. Telecommunications outlet/connectors
5. Cabling system identification products
6. Cable management system

B. Related Sections:
1. Section 270500 - "Common Work Results for Communications"
2. Section 271100 - "Communication Equipment Room Fittings"
3. Section 270526 – "Grounding & Bonding for Communications Systems"
4. Section 271300 – "Communications Backbone Cabling"
5. Maine Medical Center – Network Engineering Infrastructure Specifications dated May 2017

C. Sustainable Building Requirements:
1. The Owner requires the Contractor to implement practices and procedures to meet the project's environmental performance goals, which include achieving LEED version 4 Certified level Certification. Specific project goals that may impact this area of work include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; construction waste recycling; and the implementation of a construction indoor air quality management plan. The Contractor shall ensure that the requirements related to these goals, as defined in the Articles below, are implemented to the fullest extent. Substitutions, or other changes to the work proposed by the Contractor or their Subcontractors, shall not be allowed if such changes compromise the aforementioned environmental goals and LEED certification.

1.3 DEFINITIONS

A. Basket Cable Tray: A fabricated structure consisting of wire mesh bottom and side rails.

B. BICSI: Building Industry Consulting Service International.

C. Channel Cable Tray: A fabricated structure consisting of a one-piece, ventilated-bottom or solid-bottom channel.

D. Consolidation Point: A location for interconnection between horizontal cables extending from building pathways and horizontal cables extending into furniture pathways.

E. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.

F. EMI: Electromagnetic interference.

G. IDC: Insulation displacement connector.

H. Ladder Cable Tray: A fabricated structure consisting of two longitudinal side rails connected by individual transverse members (rungs).

I. LAN: Local area network.

J. MUTOA: Multiuser telecommunications outlet assembly, a grouping in one location of several telecommunications outlet/connectors.

K. Outlet/Connectors: A connecting device in the work area on which horizontal cable or outlet cable terminates.

L. RCDD: BICSI - Registered Communications Distribution Designer.

M. Solid-Bottom or Non-ventilated Cable Tray: A fabricated structure consisting of longitudinal side rails and a bottom without ventilation openings.

N. Trough or Ventilated Cable Tray: A fabricated structure consisting of longitudinal side rails and a bottom having openings for the passage of air.

O. UTP: Unshielded twisted pair.

1.4 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 "permanent link," a term that is used in the testing protocols.
   1. Horizontal cabling shall contain no more than one transition point or consolidation point between the horizontal cross-connect and the telecommunications outlet/connector.
   2. Bridged taps and splices shall not be installed in the horizontal cabling.

B. 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. The maximum allowable length does not include an allowance for the length of 16 feet in the horizontal cross-connect.

C. UTP Horizontal Cabling Infrastructure – Contractors shall supply and install to each identified workstation area the quantities of cabling as denoted by the drawing

package. Contractors shall note that under this scope of work there will be several different types of workstation outlets based on their exact location and the intended users of this system.

1.5 PERFORMANCE REQUIREMENTS

A. General Performance: Horizontal cabling system shall comply with transmission standards in ANSI/TIA/EIA-568-B.1, when tested according to test procedures of this standard.

1.6 SUBMITTALS

A. Product Data: For each type of product indicated.
   1. Submit manufacturers' product data sheets for all material and equipment products proposed in bid. Only specified or accepted manufacturers or suppliers shall appear in the product data submittal.
   2. Where substitutions or alternates are requested for any specified manufacturer or product, contractor shall submit complete documentation for the proposed product, including complete product data/catalog sheets, performance/engineering reports and any additional information that may be pertinent to the approval of this product.

B. Shop Drawings:
   1. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by Owner.
   2. System Labeling Schedules: Electronic copy of labeling schedules that are part of the cabling and asset identification system of the software.
   3. Cabling administration drawings and printouts.
   4. Wiring diagrams to show typical wiring schematics, including the following:
      a. Cross-connects.
      b. Patch panels.
      c. Patch cords.
   5. Cross-connects and patch panels. Detail mounting assemblies, and show elevations and physical relationship between the installed components.
   6. Cable tray layout, showing cable tray route to scale, with relationship between the tray and adjacent structural, electrical, and mechanical elements. Include the following:
      a. Vertical and horizontal offsets and transitions.
      b. Clearances for access above and to side of cable trays.
      c. Vertical elevation of cable trays above the floor or bottom of ceiling structure.
      d. Load calculations to show dead and live loads as not exceeding manufacturer's rating for tray and its support elements.
   7. Shop drawings shall be submitted (10) days prior to start of work and prior to ordering any material. Shop drawings shall consists of (1) set of reproducible drawings and (3) copies of all drawings, diagrams and/or manufacturer data in accordance with the contract documentation.
   8. As-built documentation shall be provided at the completion of installation. As-built documentation shall include all floor plan views, elevations drawings, cable termination and cross connect schedules. Turnover sets shall consist of (1) reproducible set and (3) copies. Schedules shall include (1) hard copy set and (1) electronic.

C. Samples: For workstation outlets, jacks, jack assemblies, and faceplates, one for each size and outlet configuration for color selection and evaluation of technical features.

D. Qualification Data: For layout technician, installation supervisor, and Project Manager.

E. Source quality-control reports.

F. Field quality-control reports.

G. Maintenance Data: For splices and connectors to include in maintenance manuals.

H. 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.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.
   1. Layout Responsibility: Preparation of Shop Drawings, Cabling Administration Drawings, and field testing program.
   2. Installation Supervision: Installation shall be under the direct supervision of Level 2 Installer, who shall be present at all times when Work of this Section is performed at Project site.

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. Telecommunications Pathways and Spaces: Comply with ANSI/TIA/EIA-569-A.

D. Grounding: Comply with ANSI-J-STD-607-B.

1.8 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

B. Delivery and Storage
   1. Contractor shall be responsible for the coordination and receipt of any job related material being shipped to the site and also for ensuring the proper storage and safe guard of this material. Coordination of delivery shall include direct communications with the General Contractor, the end-user/facilities group and or building owner (as necessary) to ensure proper scheduling and delivery requirements.

1.9 COORDINATION

A. Coordinate layout and installation of telecommunications pathways and 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.

1.10 EXTRA MATERIALS

A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
   1. Patch-Panel Units: One of each type.
   2. Connecting Blocks: One of each type.
   3. Device Plates: One of each type.
   4. Multiuser Telecommunications Outlet Assemblies: One of each type.

1.11 WARRANTY

A. Cabling Contractor shall have the ability to extend to end-user a minimum warranty period of 20-years for the system(s) they intend to install. This warranty shall certify that the installation will be free from defects in performance and workmanship, as well as meet or exceed all ANIS/TIA/EIA performance requirements. Contractor will be required to submit all pre-project and post project documentation including test documentation and registration forms necessary to system coverage under this program.

B. System coverage shall but is not limited to the following components:
   1. Cabling components
   2. Connecting Hardware
   3. Connectors
   4. Jacks/Outlets

PART 2 - PRODUCTS

2.1 PATHWAYS

A. General Requirements: Comply with ANSI/TIA/EIA-569-A.

B. Cable Support: NRTL labeled for support of Category 6A cabling, designed to prevent degradation of cable performance and pinch points that could damage cable.
   1. Support brackets with cable tie slots for fastening cable ties to brackets.
   2. Lacing bars, spools, J-hooks, and D-rings.
   3. Straps and other devices.

C. Cable Trays:
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following available manufacturers offering products that may be incorporated into the Work including the following:
      a. Cablofil Inc.

   2. Cable Tray Materials: Metal, suitable for indoors, and protected against corrosion by electroplated zinc galvanizing, complying with ASTM B 633, Type 1, not less than 0.000472 inch thick, hot-dip galvanizing, complying with ASTM A 123/A 123M, Grade 0.55, not less than 0.002165 inch thick.

a. Basket Cable Trays: 18 inches wide and 4 inches. Wire mesh spacing shall not exceed 2 by 4 inches. Basket cable trays are to be used in all common hallway areas as defined on drawings T11-62, T11-62, T11-71 & T11-72.
b. Ladder Cable Trays: Nominally 18 inches wide, and a rung spacing of 12 inches. Ladder trays shall be used in all MDF / IDF closets as defined on drawing T14-01.

D. Conduit and Boxes: Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems". "Flexible metal conduit shall not be used".
1. Outlet boxes shall be no smaller than 2 inches wide, 3 inches high, and 2-1/2 inches deep.

2.2 UTP CABLE

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Berk-Tek 4-Pair #11082057, CAT6A Blue (Plenum) for Information System.
2. Berk-Tek 4-Pair #11082057, CAT6A Blue (Plenum) for CE – Clinical Engineering.

B. Description: 100-ohm, 4-pair UTP:
1. Comply with ICEA S-90-661 for mechanical properties.
2. Comply with ANSI/TIA/EIA-568-B.1 for performance specifications.
3. Comply with ANSI/TIA/EIA-568-B.2, Category 6A.
4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following type (or equivalent).
5. Type requirements in subparagraphs below are minimum requirements and may be revised to suit Project. Retain options if "permitted substitutions," as defined in NFPA 70, are appropriate for this Project.
6. Communications Plenum Cable: Type CMP

2.3 UTP CABLE HARDWARE

A. Manufacturers: For specific manufacturers and part numbers, see Section 270002, "Unit Pricing". Subject to compliance with requirements, provide products pricing of manufactures below for leveling:
1. Patch Panels:
a. Ortronics 48-Port Patch Panel - 568A Pinning (OR-PHD6AU48)

B. General Requirements for Cable Connecting Hardware: Comply with ANSI/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. Patch Panel: Modular panels housing multiple-numbered jack units with IDC-type connectors 568A pinning at each jack for permanent termination of pair groups of installed cables.
1. Number of Jacks per Field: One for each four-pair UTP cable 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. Exact length and quantity to be field coordinated with Client.

1. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure Category 6A performance. Patch cords shall have latch guards to protect against snagging.
2. Patch cords shall have color-coded boots for circuit identification.
3. Patch cords shall be manufactured by the same company as the cable plant.

2.4 TELECOMMUNICATIONS OUTLET/CONNECTORS

A. Manufacturers: Subject to compliance with requirements, provide products pricing of manufactures below:
   1. Work Area Outlets – Color to be coordinate on site with the architect
      a. Ortronics TracJack 1-Gang 6 Port Faceplate (OR-40300545)
      b. Ortronics TracJack Category 6A/10G Modular Outlet (OR-TJ6A)
      c. TracJack F Connector 75 ohm Insert (OR-63700006)
      d. Faceplate Blank Inserts 10 pack (OR-42100002)
      e. Blue Data Icon (OR-40326200)

B. Modular Outlets: 100-ohm, balanced, twisted-pair connector; four-pair, eight-position modular. Comply with ANSI/TIA/EIA-568-B.1.

C. All modular outlets shall be color coded for identification purposes. Refer to drawing package for colors and outlet configuration and/other application requirement. Verify colors with owner before purchase;

D. Work Area Outlets: connector assemblies mounted in single faceplate, as denoted on drawings.
   1. Plastic Faceplate: High-impact plastic. Coordinate color with Division 26 Section "Wiring Devices."
   2. For use with snap-in jacks accommodating any combination of UTP, optical fiber, and coaxial work area cords.
   3. Legend: Machine printed, in the field, using adhesive-tape label.
   4. Legend: Snap-in, clear-label covers and machine-printed paper inserts.

2.5 GROUNDING

A. Comply with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems" for grounding conductors and connectors.

B. Comply with ANSI-J-STD-607-C.

2.6 IDENTIFICATION PRODUCTS

A. Comply with ANSI/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 Division 26 Section "Identification for Electrical Systems."

2.7 SOURCE QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate cables.

B. Factory test UTP and optical fiber cables on reels according to ANSI/TIA/EIA-568-B.1.

C. Factory test UTP cables according to ANSI/TIA/EIA-568-B.2.

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. Wiring Method: Install cables in raceways and cable trays except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces, in attics, and in gypsum board partitions where unenclosed wiring method may be used. Conceal raceway and cables except in unfinished spaces.
   1. Install plenum cable in environmental air spaces, including plenum ceilings.
   2. Comply with requirements for raceways and boxes specified in Division 26 Section "Raceway and Boxes for Electrical Systems."

B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

C. Wiring within Enclosures: Bundle, lace, and train cables to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

3.3 INSTALLATION OF PATHWAYS

A. Cable Trays: Comply with NEMA VE 2 and ANSI/TIA/EIA-569-A-7.

B. Comply with requirements for demarcation point, pathways, cabinets, and racks specified in Division 27 Section "Communications Equipment Room Fittings." Drawings indicate general arrangement of pathways and fittings.

C. Comply with ANSI/TIA/EIA-569-A for pull-box sizing and length of conduit and number of bends between pull points.

D. Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems" for installation of conduits and wireways.

E. Install manufactured conduit sweeps and long-radius elbows whenever possible.

F. Pathway Installation in Communications Equipment Rooms:
   1. Position conduit ends adjacent to a corner on backboard where a single piece of plywood is installed, or in the corner of room where multiple sheets of plywood are installed around perimeter walls of room.
   2. Install cable trays to route cables if conduits cannot be located in these positions.
   3. Secure conduits to backboard when entering room from overhead.
   4. Extend conduits 3 inches] above finished floor.
   5. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.

G. Backboards: Install backboards with 96-inch dimension vertical. Butt adjacent sheets tightly, and form smooth gap-free corners and joints.

3.4 INSTALLATION OF CABLES

A. Comply with NECA 1.

B. General Requirements for Cabling:
   1. Comply with ANSI/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. MUTOA shall not be used as a cross-connect point.
   5. 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.
   6. Terminate conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
   7. 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.
   8. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
   9. 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.
   10. 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.
   11. Cold-Weather Installation: Bring cable to room temperature before unspooling. Heat lamps shall not be used for heating.
   12. In the communications equipment room, install a 10-foot long service loop on each end of cable.
   13. Pulling Cable: Comply with industry standards. Monitor cable pull tensions.

C. UTP Cable Installation:
   1. Comply with ANSI/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 in a wireway or pathway a minimum of 8 inches above ceilings by cable supports not more than 60 inches.
   3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

E. Group connecting hardware for cables into separate logical fields.

F. Separation from EMI Sources:
   1. Comply with BICSI TDMM and TIA/EIA-569-A 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 in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:
      a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
      b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
      c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.
   4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:
      a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
      b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.
      c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.
   5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.
   6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.

3.5 FIRESTOPPING

A. Comply with requirements in Division 07 Section "Penetration Fire-stopping."

B. Comply with ANSI/TIA/EIA-569-A, Annex A, "Fire-stopping."

C. Comply with BICSI TDMM, "Fire-stopping Systems" Article.

3.6 GROUNDING

A. Install grounding according to Section 26, "Grounding, Bonding, and Electrical Protection".

B. Comply with ANSI-J-STD-607-B.

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.

3.7 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with ANSI/TIA/EIA-606-A. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."
   1. Administration Class: 3.
   2. Color-code cross-connect fields. Apply colors to voice and data service backboards, connections, covers, and labels.

B. Using cable management system software specified in Part 2, develop Cabling Administration Drawings for system identification, testing, and management. Use unique, alphanumeric designation for each cable and label cable, jacks, connectors, and terminals to which it connects with same designation. At completion, cable and asset management software shall reflect as-built conditions.

C. Comply with requirements in Division 09 Section "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.

D. Paint and label colors for equipment identification shall comply with ANSI/TIA/EIA-606-A for Class 3 level of administration, including optional identification requirements of this standard.

E. 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.

F. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, backbone pathways and cables, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors. Follow convention of ANSI/TIA/EIA-606-A. Furnish electronic record of all drawings, in software and format selected by Owner.

G. 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 25feet.
   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.

H. 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 ANSI/TIA/EIA-606-A.
   1. Cables use flexible vinyl or polyester that flex as cables are bent.

3.8 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. 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 ANIS/TIA/EIA-568-B.1.
   2. Visually confirm Category 6A, 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. Test UTP backbone copper cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.
      a. Test instruments shall meet or exceed applicable requirements in ANSI/TIA/EIA-568-B.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
   5. UTP Performance Tests:
      a. Test for each telecommunications outlet/connector. Contractor shall test 100% of the horizontal cabling infrastructure in accordance with the requirements specified under ANSI/TIA/EIA-568-B.1 and TIA/EIA-568-B.2 as well as all the selected manufacturers certification and warranty program, including but not limited to the following tests:
         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.
   6. 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.

7. Optical Fiber Cable Tests:

a. Test instruments shall meet or exceed applicable requirements in ANSI/TIA/EIA-568-B.1. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

b. Link End-to-End Attenuation Tests:

1) Horizontal and multimode backbone link measurements: Test at 850 or 1300 nm in 1 direction according to ANSI/TIA/EIA-526-14-A, Method B, One Reference Jumper.

2) Attenuation test results for backbone links shall be less than 2.0 dB. Attenuation test results shall be less than that calculated according to equation in ANSI/TIA/EIA-568-B.1.

C. 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.

D. End-to-end cabling will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.9 DEMONSTRATION

A. Train Owner's maintenance personnel in cable-plant management operations, including changing signal pathways for different workstations, rerouting signals in failed cables, and keeping records of cabling assignments and revisions when extending wiring to establish new workstation outlets. Include training in cabling administration software if applicable and/or deemed necessary by the Owner or their agent.

END OF SECTION

This page is intentionally left blank.

SECTION 27 40 00

PUBLIC ADDRESS SYSTEM

PART 1 - GENERAL

1.1 RELATED SECTIONS

A. 232123 Section 01 81 13 “Sustainable Design Requirements – LEED v4 for Building Design & Construction – New Construction” for sustainable design requirements and detailed sustainable design submittal requirements.

B. Section 01 74 19 “Construction and Demolition Waste Management and Disposal” for disposal of construction, demolition and packaging waste disposal requirements.

1.2 SUMMARY

A. Sustainable Building Requirements:
   1. The Owner requires the Contractor to implement practices and procedures to meet the project’s environmental performance goals, which include achieving LEED version 4 Certified level Certification. Specific project goals that may impact this area of work include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; construction waste recycling; and the implementation of a construction indoor air quality management plan. The Contractor shall ensure that the requirements related to these goals, as defined in the Articles below, are implemented to the fullest extent. Substitutions, or other changes to the work proposed by the Contractor or their Subcontractors, shall not be allowed if such changes compromise the aforementioned environmental goals and LEED certification.

1.3 SCOPE OF WORK

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

1.4 PUBLIC ADDRESS SYSTEM

A. This section of the specification defines the functional details of the public address system to be furnished and installed in the MMC new space.

1.5 SYSTEM FUNCTIONAL REQUIREMENTS

A. The system design consists of a two-zone paging system: Operating Rooms (ORs) are one zone and all other areas are the second zone. All source and amplification equipment will be installed in a 2-post equipment rack in the Data Room. The equipment rack shall be furnished and installed by the IT contractor. A dedicated telephone number will be selected for paging purposes. The Phone system will require a security code to forward the call to the paging system controller. The Phone system is Owner Furnished. The system can be set to limit the duration of

the message being transmitted. Refer to drawings for quantities and locations. The functional requirements are as follows:

1. Audio System:
   a. Telephone interface module.
   b. System central processing module.
   c. Zone paging module.
   d. 120V AC/12V DC power supply to provide low voltage power to the zone paging module.
   e. Provide a rack mounting kit for the telephone interface module, central processing module and the zone paging modules.
   f. Provide a paging mixer with microphone input modules, which will combine and route the two microphone audio inputs to the paging system telephone interface module.
   g. Provide a rack mounting kit for the paging mixer.
   h. Provide RJ11 modular jack boxes and six conductor modular cable jumpers to route the microphone audio from the paging mixer to the telephone interface module. Quantities as required.
   i. 100 Watt paging amplifiers with rack mounting kits. These amplifiers will be rack mounted on plywood wallfield. Quantities as required.
   j. 35 Watt capacity, speaker zone attenuators with two (2) gang, surface mountable junction box enclosures. The attenuator junction box enclosures need to be a minimum three inches in depth to adequately house the attenuator controls. These attenuators and enclosures will be mounted adjacent to the equipment rack.
   k. 10 Watt capacity, speaker zone attenuator. These attenuators will be wall mounted in Conference Rooms.
   l. Audio distribution amplifier. For installations requiring multiple paging amplifiers tied together from a common paging input to control impedance and stabilize output levels.
   m. 8” Diameter, ceiling speaker assemblies. These assemblies consist of a speaker, transformer, enclosure, tile-bridge and grille baffle. Speaker assemblies will be recess mounted in hung ceiling areas. Refer to Communication drawings for exact speaker placement.
   n. Provide all 2-conductor, 16 gauge, shielded plenum-rated cables, connectors, etc. required to complete a full working system.
2. Miscellaneous
   a. 19" wide, 84” high 2-post equipment rack (by others).
   b. Rack-mounted UPS dedicated for PA equipment.
   c. Provide all cables, connectors, etc. required to complete a full operational / working system.

1.6 SYSTEM INTERCONNECTIONS

A. The functional interconnections of the public address system shall be as detailed on the specified drawings.

B. The audio contractor shall provide all required interconnection cable, all connectors, plates, etc. to facilitate the installation of a fully functional public address system, as detailed within these specifications and drawings.

1.7 RELATED WORK SPECIFIED ELSEWHERE

A. The following equipment and systems are NOT provided under the terms of this specification and/or contract:
   1. Power outlets.
   2. All wall junction boxes, conduit and pull boxes.

1.8 INSTRUCTIONS TO BIDDERS

A. QUALIFICATION OF BIDDERS

   1. The Bidder shall be a firm with at least five (5) years' experience in the fabrication, assembly and installation of public address systems of similar complexity, magnitude and quality as specified for the subject project, and shall submit documentation to this effect along with submission of the bid return.

1.9 DEFINITION OF TERMS

A. The term "Owner" shall refer to MMC.

B. The Term "Architect" shall refer to Perkins+Will

C. The term "Consultant" shall refer to AKF Group, LLC.

D. The term "Bidder" shall refer to any firm submitting a bid in response to these issued specifications.

E. The term "Contractor" shall refer to the Systems Contractor who has been awarded the contract for the subject project and who has responsibility for performance of the work specified herein.

F. The term "NIC" shall refer to material(s) and work, which is Not in Contract (not included in this specification) and for which the Contractor is NOT responsible except as otherwise noted and/or detailed herein.

G. The term "OFE" shall refer to Owner Furnished Equipment, which will be provided by the owner to the Contractor. The Contractor shall be responsible for collecting and/or removing such equipment from the owners premises (the equipment's present location) and installing or re-installing the equipment at the audiovisual system site in good functional order as detailed herein.

H. The term "shall" is mandatory; the term "will" is informative; the term "should" is advisory; and the term "provide" means to furnish and install.

1.10 INFORMATION TO BE SUBMITTED WITH THE BID RETURN

A. Equipment Costs
   1. The bid return (response) shall include a detailed listing "bill of materials" for all equipment to be supplied. Each equipment component shall be individually priced. Equipment costs shall reflect all required and/or requested modifications and/or accessories. Any and all substitutions for specified equipment shall be listed and individually priced on separate pages.

B. Non-Equipment Costs
   1. Non-equipment costs shall be detailed for each of the following categories:

a. Engineering: Including all required designs, drawings, run-sheets, instruction manuals, etc.
b. Pre-installation/Installation: Including all on-site installation and wiring. Coordination and supervision, testing, system check-outs, Owner training, etc. to be performed on or off the Owner's premises.
c. General and Administrative: To include all G & A expenses, shipping, insurance and guarantees.

C. Warranty Statement
1. In order to maintain certain manufacturer's warranties, system equipment must be installed, aligned and serviced by those installers recognized and authorized by said manufacturers to be capable of performing such duties. If a certain installer is NOT so authorized by a particular manufacturer, it is solely their responsibility to make such arrangements to come into such compliance and they shall bear all costs and consequences thereof.
2. The bidder shall include a statement of warranty on the entire system to be installed and on the individual equipment components of the system. The system warranty shall be for a minimum of 365 days from the date of system acceptance by the Consultant and/or the Owner's representative. This warranty shall obligate the Contractor to provide all equipment, materials, and labor for repair, at no charge to the Owner during the warranty period, in the event of system or equipment malfunction
3. All manufacturers' equipment warranties shall be activated in the Owner's name and shall commence on the date of system acceptance. In the case of Contractor-modified equipment, the manufacturer's warranty is normally voided. In such cases, the Contractor shall provide the Owner with a warranty equivalent to that of the original manufacturer.

D. Service Contract
1. The Bidder shall offer a separate annual service contract, covering all installed systems. This service contract shall cover a minimum of three (3) visits per year, at regular intervals, in order to perform operational checks of the system and equipment as recommended by respective manufacturers. The service contract shall commence immediately after expiration of the warranty period. A "per-component" price for the service contract shall be submitted with the bid.
2. The Bidder shall also submit separate pricing for other, non-routine, emergency, "on-call" service visits and an "in-shop" hourly rate for repair and maintenance work.
3. Service and service contract related costs shall NOT be commingled with the costs for the system's base-bid.

E. Schedule of Implementation
1. The bidder shall submit a scheduling plan with the bid return, indicating the various pertinent "terminal" dates after the contract award for completion of design, pre-installation work completion, on-site installation, and testing/acceptance.

F. Alternate Equipment
1. All bids shall be submitted on the basis of the recommended equipment listed in the part 2, products section of the specification.
2. The Bidder may propose alternate equipment. However, all such proposals shall be submitted separately and will be identified as "alternate(s)" with

equipment costs shown as separate and apart from the costs of the equipment "as specified."

3. Proposals for alternate equipment will receive careful and equitable consideration if differences do not result in a departure from the overall intent of the system design and operation, and are demonstrated to be in the best interests of the Owner.
4. All such proposals for alternate equipment shall be accompanied by complete technical information and specifications, and "cut-sheets" for the equipment so proposed. The Bidder shall identify any and all substantive differences between the "alternate" and "specified" equipment.

G. Exceptions and Proposed Modifications

1. Should the Bidder wish to propose recommendations which will enhance the performance of the system, or reduce costs without loss of performance, such comments shall be made in the bid submissions. All suggestions which are of value to the Owner, shall be taken into consideration in the evaluation of bid returns. All such proposals shall be made as "alternative(s)", with the appropriate cost modifications clearly shown separate and apart from the costs of the system "as specified."
2. Any and all exceptions to specifications and related drawings must be made with the bid submission. In the absence of exceptions, these specifications and related drawings shall be binding in letter and intent upon the successful Bidder. It will be further assumed that the Bidder has examined all designs and specifications in detail and is prepared to accept full responsibility for the performance of the complete system installation as designed and specified

H. Sub-Contract Information

1. If the Bidder proposes to sub-contract any portion of the system installation work, as provided for under Section 1.7 which follows, any such sub-contractors shall be clearly identified and their responsibilities and qualifications detailed in the Bidder's bid submission. Any and all work performed by a sub-contractor shall be considered fully as part of the primary Bidder's contract and responsibility.

I. Visit to Site

1. All Bidders may request to make a "Pre-Bidder's" site inspection before submission of bids. The date of the site visit shall be included in the bid return. The Bidder shall arrange for the site-visit with the Owner's representatives.

1.11 SPECIFICATION DRAWINGS

A. All drawings referred to herein are furnished with and become an integral part of this specification. These drawings and specifications shall remain the property of the Owner and shall be returned to the Owner by all unsuccessful Bidders, within ten (10) days after formal notification of contract award.

1.12 SPECIFICATION INFORMATION REQUESTS

A. Any requests for clarification, substitution, or changes to these specifications and/or drawings shall be directed to the engineer. These information requests will be entertained no later than two days before the bid closing date.

1.13 SUB-CONTRACT

A. If the Bidder proposes to sub-contract the installation and/or wiring, or any portion of this work, the Bidder shall provide direct supervision of any and all sub-contracted work.

B. As a result of the complexity and criticality of the specified public address system, the supervision of sub-contracted work shall not be intermittent, but MUST be continuous for the entire duration of such installation.

C. If it is the intent of the Bidder to "team" with one or more additional contractors, then this must be clearly stated and so identified the Bidder's bid return. The Contractor (Bidder) who is returning the bid shall be considered as the "prime" with respect to these circumstances, and will assume and accept full responsibility for the performance of all members of the "team," including themselves and all other sub-contractors and/or sub/sub-contractors engaged in the performance of the contract.

1.14 INVESTIGATION OF CONTRACTUAL AND/OR SCHEDULING QUESTIONS

A. It shall be the sole responsibility of the Bidder to investigate any and all potential contract, union-related and scheduling questions and issues, and to guarantee compliance with all requirements and regulations, which shall be in effect on the job site. Any potential problems in this regard should be clearly identified and addressed in the bid return.

1.15 AWARD OF CONTRACT

A. A single award of contract will be made for all systems as detailed in this specification. Quoted prices shall remain firm for a period of sixty (60) days.

B. The Owner reserves the right to reject any or all bids for any reason.

PART 2 - PRODUCTS

2.1 Paging System Telephone Interface Module, Rack Mounted.

A. Manufacturer: Bogen
   1. Model number: PCMTIM
   2. Include pricing for one (1) spare unit.

2.2 Paging System Central Processing Module, Rack Mounted.

A. Manufacturer: Bogen
   1. Model number: PCMCPU
   2. Include pricing for one (1) spare unit.

2.3 Paging System Zone Paging Module, Rack Mounted.

A. Manufacturer: Bogen
   1. Model number: PCMZPM
   2. Include pricing for one (1) spare unit.

2.4 Paging System Power Supply.

A. Manufacturer: Bogen
1. Model number: PCMPS2
2. Include pricing for one (1) spare unit.

2.5 Rack Mount Kit for TIM, CPU and ZPM's

A. Manufacturer: Bogen
1. Model number: RPK88

2.6 Paging Mixer, Rack Mounted.

A. Manufacturer: Bogen
1. Model number: VMIX
2. Include pricing for one (1) spare unit.

2.7 Microphone Input Module for Paging Mixer

A. Manufacturer: Bogen
1. Model number: MIC2S
2. Include pricing for one (1) spare unit.

2.8 Rack Mounting Kit for Paging Mixer

A. Manufacturer: Bogen
1. Model number: RPK87
2. Include pricing for one (1) spare unit.

2.9 Microphone with Push-to-Talk Switch

A. Manufacturer: Bogen
1. Model number: DDU-250
2. Include pricing for one (1) spare unit.

2.10 Paging Amplifier, 100 Watt, Wall Mounted

A. Manufacturer: Bogen
1. Part number: TPU100B
2. Include pricing for one (1) spare unit.

2.11 Rack Mounting Kit for Paging Amplifier

A. Manufacturer: Bogen
1. Part number: RPK82

2.12 Speaker Zone Attenuator, 35 Watt Capacity, Wall Mounted

A. Manufacturer: Bogen
1. Model number: AT35A

2.13 Speaker Zone Attenuator, 10 Watt Capacity, Wall Mounted

A. Manufacturer: Bogen
1. Model number: AT10A

2.14 8” Diameter, Drop-In Ceiling Speaker Assembly with Speaker, Transformer, Enclosure, Tile Bridge and Grille (Off White) Use in Drop ceilings only.

A. Manufacturer: Bogen
1. Model number: CSD1X2VR

2.15 8” Diameter, Ceiling Speaker Assembly with Speaker, transformer, Enclosure, Tile Bridge and Grille (Off White). Use in Solid Sheetrock, Wood or Metal ceilings only.

A. Manufacturer Bogen
1. Model number: S810T725PG8UVR

2.16 Reentrant Horn Loudspeakers. Use in all mechanical spaces and outdoor locations only.

A. Manufacturer Bogen
1. Model number SPT15A

2.17 8-Channel Audio Distribution Amplifier

A. Manufacturer: Radio Design Labs
1. Model number: RU-ADA4D
2. Include pricing for one (1) spare unit.

2.18 UPS, Rack Mounted, 1500VA w/ NEMA 5-15P input

A. Manufacturer: APC
1. Part number: SMT1500RM2U

2.19 Miscellaneous Hardware, Cable, Connectors, RJ11 Module Boxes, Six Conductor Module Cable Jumpers, etc.

A. Manufacturer: PA Contractor
1. Part number: Custom

2.20 Speaker Cable Loop Terminal Block. Quantity as required.

A. Manufacturer: GE
1. Part number: CR151B26AF

2.21 2-Conductor, Plenum-Rated Audio Cable. 16-Gauge, Shielded.

A. Manufacturer: West Penn
1. Part number: 25294B or approved equal

PART 3 - EXECUTION

3.1 CONTRACTOR'S GENERAL RESPONSIBILITIES

A. The Contractor shall be responsible for delivering a turnkey paging system to the Owner.

B. The Contractor shall furnish all equipment and materials, whether specifically mentioned within this document or not, to insure provision of a complete and fully functional system in line with the requirements of this specification. NIC and OFE equipment and materials are exempted from this requirement.

C. The Contractor shall generate all shop drawings and necessary information required for the complete installation of the audio system. The Contractor shall also provide (or sub-contract for) on-site installation and wiring, and shall provide on-going and thorough supervision and coordination of all work performed during the implementation phase.

D. The Contractor shall be responsible for initial adjustment of the public address system as described within this document and shall provide all test and operational equipment required for the system check-out and acceptance testing. The Contractor shall provide hands-on, on-site training in the operations and maintenance of the audio system for those personnel as designated by the Owner.

3.2 NOT IN CONTRACT (NIC)

A. Certain equipment and/or materials will be provided and installed by others. Unless otherwise indicated in these specifications, or on the related drawings, this equipment and material shall include the following:
   1. All conduit(s), wireways, connection boxes, pull-boxes, junction boxes and outlet boxes permanently installed in walls, floors and ceilings.
   2. All room lighting fixtures, dimmers, power receptacles, outlets, and interconnect wiring for these circuits.
   3. All electrical breaker panels required to power the paging system equipment.
   4. All structural work, wall openings, platforms, railings, stairs, fire prevention and safety devices, rough and finished trim, painting and patching, drapes, carpets, floor coverings, computer floors, glazing,
   5. Acoustical treatments and heating, ventilation, and air conditioning systems.
   6. Moveable furniture, desks, and chairs.

3.3 QUALITY OF MATERIALS AND EQUIPMENT

A. All equipment and materials provided by the contractor shall be new and shall meet or exceed the latest published manufacturer's specifications in all respects.

B. The Contractor shall supply the latest model of each piece of specified equipment available at the time of bidding.

3.4 CONTRACTOR'S DOCUMENTATION

A. Prior to system fabrication, the Contractor shall submit (to the Consultant), for approval, any and all custom designs pertaining to the audio system. Drawing submittals shall be reproducible media preferably in machine-readable form. These designs include, but are not limited to, the following:

1. Full system construction designs and point-to-point wiring schematic drawings, including all component values, and clearly showing complete letter and number identifications for all wires and cables as well as all jacks, terminals and connectors.
2. All panels, plates and designation strips, including all details relevant to terminology, engraving, finish and color.
3. Any and all custom designed support bases and shelves.
4. Schematic drawings of all custom components, assemblies and circuitry.
5. Any and all unusual equipment modifications.
6. Run-sheets or field wiring details.
7. All equipment components, whether stock manufacture or custom built, shall be supported by complete and detailed schematic drawings and replacement parts. NO "black boxes" or otherwise unidentified or unidentifiable components shall be acceptable under the terms of this specification.

B. At completion of the full system installation, the Contractor shall provide two (2) copies each of the following:
   1. Equipment manufacturer's operation manuals for each piece of installed Audio equipment.
   2. "As Built" drawings for every item indicated in Section 3.4-1.
   3. System functional block drawing identical to the AKF specification drawing with addition of all input and output circuit cable and terminal block numbers as well as all jack field circuit I.D. designations. A copy of this drawing shall be framed in protective plastic and mounted near the audio system equipment rack.
   4. One System Operations and Maintenance Manual. This manual shall be produced by the Contractor specifically for the systems installed and outlined in this specification.
      a. The "Operations" section shall describe all standard and typical procedures required to activate the system and each of its parts to provide for full system functionality as outlined in the General section of the specification.
      b. Readers of these manuals shall be assumed to be technically competent, but unfamiliar with the particular facility and installation. It is expected that this manual will require a minimum of five (5) pages.
      c. The "Maintenance" section shall provide a recommended maintenance schedule with reference to applicable pages in the manufacturer's maintenance manuals. When adequate information is not provided by the manufacturer, the Contractor shall directly provide the information necessary for proper maintenance.
      d. NOTE: One copy of all above documentation will be retained by the Owner. One additional copy shall be delivered to the Consultant prior to System Acceptance Testing.
      e. This information MUST also be provided on CD in an easily readable format (e.g. Microsoft Word, Excel, and Adobe Acrobat). The CD shall be accessible to all computers running the Windows operating system.

3.5 SUB CONTRACT

A. No sub-contracting will be allowed in the case of the Contractor's responsibilities (as defined within these specifications), unless specifically identified in the original bid submission and approved by the Consultant and Owner.

B. The Contractor shall have sole responsibility for the satisfactory implementation and delivery of the audio system, even though the Contractor may have sub-contracted some portion of the installation or had specific manufactures install their own equipment.

3.6 COOPERATION WITH OTHER TRADES

A. It shall be the Contractor's responsibility to cooperate, at all times and to the fullest extent, with any and all other trades performing work on premises in order to avoid lost-time, work stoppages, interference and other inefficiencies.

3.7 EQUIPMENT DELIVERY AND STORAGE

A. Any and all equipment delivered or received prior to system installation shall be stored by the Contractor at their place of business. Any costs of shipping, or of any unusual storage requirements shall be borne by the Contractor. The Contractor shall inform the Owner no later than seven (7) days in advance of delivery to the installation site. It shall be the responsibility of the Contractor to make all appropriate arrangements with authorized personnel at the work site for the proper acceptance, handling, protection and storage of equipment so delivered.

3.8 CLEANUP AND REPAIR

A. Upon completion of all work, the Contractor shall remove any and all refuse and rubbish from and about the Owner premises, and shall leave all areas and equipment clean and in a fully operational state.

B. The Contractor shall be responsible for the repair of any damage caused to the premises by installation activities, at no cost or hardship to the Owner.

3.9 OWNER TRAINING

A. The Contractor shall provide relevant on-the-job training (by a suitably qualified instructor) for those personnel designated by the Owner, in order to instruct them in the operation of the installed audio system. In the event that the Contractor does not have suitably qualified instructors on staff for specific highly sophisticated equipment components and/or systems, a manufacturer's representative for such equipment will be provided by the Contractor at no additional cost to the Owner. All such training shall take place after the system is fully operational, but prior to acceptance testing. There shall be a minimum of 3 hours of training provided for systems covered under this specification.

3.10 PUBLICATION

A. No information relative to the job covered under this specification may be released for publication without prior written consent and approval from the Owner and the Consultant.

3.11 INSURANCE

A. Prior to commencing work, the Contractor shall procure and maintain, for the full duration of the system installation, such comprehensive liability and property damage insurance as shall protect both themselves and the Owner from claims for

bodily injury, including accidental death, and for any claims of property damage which may arise from the operations under this contract and specification.

3.12 INSTALLATION PRACTICES

A. General
1. Installation shall be understood to include the delivery, unloading, positioning in place, securing to walls, floors, ceilings, counters or other structures as required, interconnect wiring of all system components, equipment alignment/adjustment and all other work whether or not expressly called for in this document which is necessary to result in complete and fully operational system.
2. All installation practices shall be in full accordance with, but not limited to, these specifications and drawings. Installation shall be performed in accordance with all applicable standards, requirements and recommendations of National, State and Local authorities having jurisdiction over these and other relevant matters.
3. If in the opinion of the Contractor, an installation practice is desired or required which runs contrary to these specifications and drawings, written request for modification shall be made to the Consultant. Any and all such modifications shall not take place without written approval.
4. During the system installation, and up to the date of final acceptance, the Contractor shall be under obligation to protect his finished and unfinished work against loss and/or damage. In the event of loss or damage, he shall replace or repair any and all work at no cost to the Owner.

B. Physical Installation
1. All equipment shall be firmly secured in place unless requirements of portability dictate otherwise.
2. All fastenings and supports shall be adequate to support their loads with a safety factor of at least three (3). All boxes, equipment, racks, stands, etc., shall be secured, plumb and square.
3. In the installation of equipment and cabling, full consideration shall be given not only to operational efficiency, but also to overall aesthetic factors.

C. Cable Installation
1. All wire bundles are to be neat and combed free of cable crossover. Using J-hook to support cable bundles at every 5 feet interval.
2. All cables, regardless of length, shall be clearly marked with a permanent, wrap-around number or letter cable marker at both ends. There shall be no unmarked cables at any place or position in the paging system. Marking codes used on cables shall correspond to codes shown on drawings and/or run-sheets.
3. No splices shall be permitted in any pull-boxes without prior permission from the Consultant.
4. No cable shall be installed with a bend radius less than that recommended by the cable manufacturer.

D. Connection Plate Receptacles
1. Audio (microphone or line level) - XLR type.

E. Grounding Procedures

1. In order to eliminate or minimize potential problems resulting from improper grounding, and to achieve absolute minimum signal-to-noise ratios, the following grounding procedures shall be observed:
   a. System Grounds
      1) A single, primary "system ground" shall be established for the system. All individual grounding conductors shall connect to this "system ground". The system ground shall be provided in the audio equipment area and shall consist of a copper bar of sufficient size to accommodate all secondary ground conductors.
      2) A copper conductor having a maximum of 0.1 Ohms total resistance shall connect the primary system ground to the nearest metallic electrical conduit of at least 2" in diameter. The paging Contractor shall be responsible for determining whether or not the metallic conduit is properly electrically bonded to the building ground system.
      3) If a secondary system grounding conductors is provided, this grounding conductor shall have a maximum of 0.1 Ohms of total resistance.
2. Under no condition shall the AC neutral conductor, in either the power panel or in any receptacle outlet, be used as a system ground.
   a. Audio Cable Shields:
      1) All audio cable shields shall be grounded at one (1) point only. NO exceptions shall be made. For ungrounded portable equipment, such as microphones, the shield should be connected at both ends but grounded at a single end only.
   b. General:
      1) Because of the great number of variations in grounding systems, it shall be the responsibility of the Contractor to follow good engineering practice (as outlined above) and to deviate from these practices ONLY when deemed necessary to minimize "crosstalk" and to maximize signal-to-noise ratios in the audio system.

3.13 PERFOMANCE STANDARDS

A. Unless restricted or prohibited under the terms of the published specifications of a particular equipment manufacturer, or, unless otherwise required under the terms of this Detailed Specification, the following performance standards shall be met in each case and for all systems:
   1. AUDIO:
      a. S/N (including crosstalk and hum) 65dB minimum.
      b. Total Harmonic Distortion ... 1% maximum from 30 Hz to 15,000 Hz.
      c. Frequency Response ... within plus or minus 1.0 dB, 30Hz to 15,000 Hz.

B. PERFORMANCE TEST SIGNAL PATHS:
   1. The signal paths for the above defined Performance Standards shall be as follows:
   2. Audio:
      a. From all source inputs (for microphones, etc.) through all audio equipment, etc., to all signal destinations.

b. Delineation of the above defined signal paths shall NOT exempt the Contractor from the responsibility of checking all paths and outlets for appropriate compliance with the Performance Standards.

c. During ALL Performance Testing, all equipment shall be operated under standard conditions as recommended by the manufacturer.

3.14 CONTRACTOR SYSTEM CHECK-OUT

A. Before Acceptance Tests are scheduled, the Contractor shall perform his own system check-out. He shall furnish all required test equipment and shall perform all work that is necessary to determine and/or modify/correct performance of the system in order to meet the requirements of this Specification.

3.15 SYSTEM ACCEPTANCE TESTS

A. System Acceptance Testing shall not be performed until the Contractor's own System Checkout has been completed and test results have been recorded and reviewed. The System Acceptance Tests will be supervised by the Consultant representative and will consist of the following:

1. A physical inventory will be taken of all equipment on site and will be compared to equipment lists in the contract documents.
2. The operation of all system equipment shall be demonstrated by the Contractor.
3. Both subjective and objective tests will be required by the Consultant to determine compliance with the specifications. The Contractor shall be responsible for providing test equipment for these tests.
4. All final, "as-built" drawings, run sheets, manuals, and other required documents, as detailed in Section 3.4, shall be on hand. Two complete sets of these documents shall be delivered to the Owner at this time. (One complete set shall have been delivered to the Consultant prior to scheduling of Acceptance Tests).
5. In the event further adjustment is required, or that defective equipment is discovered which must be repaired or replaced, further testing may be either suspended or continued at the option of the Consultant.
6. Any charges for additional Consultant time required to oversee system tests due to improper system installation or previously failed system tests shall be the responsibility of, and charged directly to the Contractor.

END OF SECTION

SECTION 27 52 23

NURSE CALL SYSTEM

PART 1 - GENERAL

1.1 WORK INCLUDED

A. Provide a complete working Nurse/Patient Communications Network based upon the specification outlined here to include all necessary devices that provide the functions listed in this specification for Maine Medical Center. This facility will be referenced as the OWNER in this specification.

B. Refer to Section "Communications, General" for additional requirements.

C. 232123Section 01 81 13 “Sustainable Design Requirements – LEED v4 for Building Design & Construction – New Construction” for sustainable design requirements and detailed sustainable design submittal requirements.

D. Section 01 74 19 “Construction and Demolition Waste Management and Disposal” for disposal of construction, demolition and packaging waste disposal requirements.

1.2 SCOPE

A. Maine Medical Center Campus Facility is replacing the current old system nurse call with a new Nurse Call network. The following is a schedule replacement that will occur during Construction.

B. The Network will be expanded in the future to the remaining units.

C. Sustainable Building Requirements:
   1. The Owner requires the Contractor to implement practices and procedures to meet the project’s environmental performance goals, which include achieving LEED version 4 Certified level Certification. Specific project goals that may impact this area of work include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; construction waste recycling; and the implementation of a construction indoor air quality management plan. The Contractor shall ensure that the requirements related to these goals, as defined in the Articles below, are implemented to the fullest extent. Substitutions, or other changes to the work proposed by the Contractor or their Subcontractors, shall not be allowed if such changes compromise the aforementioned environmental goals and LEED certification.

1.3 SUBMITTALS

A. Provide submittals for the entire system including:
   1. Name of supplying contractor and project name.
   2. Complete equipment list consisting of: Component quantities, equipment manufacturer, model number, and description of each component being supplied.

3. One catalog sheet per product of equipment listed in Part 2 of submittal; in the exact order as listed in Part 2 of the submittal.
4. Riser Wiring Diagram showing all devices. These drawings will show all wiring types by wire gauge, conductors and wire manufacturer. These drawings must be updated prior to completion of any work to reflect changes that may have been made during actual installation.
5. Typical terminal Wiring diagram for each type of device.
6. Terminal Wiring Diagram for the Central Equipment Panel and Nurses' Master Station.

1.4 GENERAL REQUIREMENTS

A. Make available to the Owner, within a 75 mile radius and 24 hour period, a local service department of an authorized manufacturer's distributor which shall stock the manufacturer's standard parts.

B. Provide On-the-premises service furnished during normal work hours at no cost for a period of twelve months from the date of acceptance of the system.

C. On-the-premises service furnished at other than normal working hours shall be available and may be charged by the manufacturer's representative at current labor rates, based on the difference between normal working hour rate and the associated "off-normal" working hour rate.

D. All Nurse Communications Network devices shall be UL-1069 listed. This includes routers, hubs, switches, and room control devices. The nurse call network shall be an FDA Registered Class II (or higher) medical device and the system's manufacturer shall be an FDA Registered Operator.

E. The system shall be capable of interconnecting with the hospital's LAN (Local Area Network). This connection shall be minimal and utilize only one Ethernet 100 Mbps (or optionally 1 GB) connection to accomplish all Rauland, hospital information, reporting software and information exchange. The HL7 standard shall be utilized for receipt of patient information from the Rauland system if required.

F. Field wiring shall be CAT 5E or CAT 6 cable, control wiring for power distributions and very long runs, and utilize an optional fiber backbone (when distances exceed (295 feet) normal Ethernet limitations). Wiring shall be capable of either being installed in conduit or cable trays, where shown on the plans. Nurse Communications cabling may be run along with other low voltage and data cables where permitted by code. Nurse Communications cabling to be separated out from any high voltage AC or DC wiring that exceeds 90 volts, or which violates any national or local electrical code.

G. The OWNER will provide one VPN connection. One VPN is for the servicing contractor to diagnose any maintenance issues and to maintain the system offsite. Diagnostic software shall be web based and permit e-mail notification of high level alarms. All software applications shall be HIPAA and PIPEDA compliant and shall allow for patient name aliases and alternative display methods. Complex user names, expiring passwords, granular permission settings and role based security shall be standard. All databases shall be ODBC compliant, MS SQL 2008 or later.

H. Overall Nurse Communications Network shall utilize VoIP communications between all major components: nurse consoles, staff terminals, telephones and controllers. Any nurse call console and staff terminal must be able to answer any patient call placed in the network. Systems not utilizing the VoIP standard will not be

acceptable. The communication standard shall be SIP protocol when telephones are integrated. The OWNER will not be providing any analog ports to the nurse call network. As part of this contract, the OWNER will either supply or establish that there is a telephony call network which supports the SIP protocol within the OWNER'S facility. Systems requiring digital to analog converters will not be accepted.

I. The capability to assign patients to staff shall be via a networked software infrastructure on existing OWNER workstations. There are no known software limits to the number of users or units being assigned. It shall also be possible to have multiple users logging onto system via barcode or other standard human interface devices. Log on process identifies user and the current device used that day.

J. Ethernet ports will be provided by the OWNER for HL7 integration to the entire network. Those nurse call systems requiring more than one interface to the live environment will not be acceptable. Additional servers will be provided by the OWNER on an as needed basis for those specific nurse call options that are selected. All servers will be installed in the facilities data center. All software must be capable of being diagnosed and supported by the distributor remotely.

K. The Network shall be expandable to any combination of over 15,000 bed, duty, or staff stations and 120,000 sub-stations connected as a contiguous interconnected system. Multiple buildings and intra-building connections may be linked together utilizing a fiber or an Ethernet connection. Audio communications between devices shall be digital and virtually non-blocking, so as to provide fast, instantaneous communications without queuing or delay.

L. The Network shall be capable of backward compatibility to prior generation of Rauland Nurse/Patient Communications system manufactured by same vendor via a network adapter module. This module will allow calls from the prior generation system to appear and go into audio communication from the common consoles, staff terminals, duty stations, zone lights and PC displays as well as allow patient to staff assignment via a common client application.

1.5 DESCRIPTION OF SYSTEM

A. System hardware shall consist of a nurse call network comprised of nurse consoles, PC consoles (OWNER provided), nurse call network controllers, patient stations, power supplies, battery back-up, dome lights, entertainment cords, call cords, pull cord stations, emergency push button stations, wiring and other options such as bed side-rail interfaces, wireless bed interface, computer interfaces, wireless/telephone network interfaces, staff terminals, RTLS (real time locating system) and network adapter module as shown on drawings. All necessary equipment required to meet the intent of these specifications, whether or not enumerated within these specifications, shall be supplied and installed to provide a complete and operating nurse/patient communications network.

B. System hardware and firmware shall be the product of a single, reputable manufacturer with a proven history of product reliability and sole control over all source code. Manufacturer shall provide, free of charge, product firmware/software upgrades for a period of one year from date of installation for any product feature enhancements. Manufacturer shall provide a 5 year warranty on all manufactured hardware.

C. All programming and firmware changes shall be accomplished on a working system without interruption to the normal operation of the system. Therefore, all system switches and controllers, which hold this firmware and system parameters must have DUAL storage. While updates are being made to one set of firmware, the system shall be working and fully functional on the original firmware (i.e. A and B memory blocks). It shall be possible to switch to the NEW system control software modules by a single system command. In the event of an error or failure in the update process, the system shall revert back to the previous firmware.

D. All communications shall be full duplex audio, not only on handsets, but all loud speaking devices, including patient, staff, duty, and pillow speakers.

E. Entire Network shall be supervised, including all sub-stations. Reporting of station failure shall be to any designated console, PC, e-mail, or wireless device. Remote diagnostics shall be utilized to quickly locate the source of the problem.

F. Up to 99 different staff levels may be defined within the nurse call network to facilitate work flow within and outside of normal nurse call activity (i.e. environmental services, facilities, transportation, lab, pharmacy, etc.).

G. Nurse call network shall support a VLAN configuration to separate activity in the nurse call network from other hospital LAN traffic. Nurse call network can span multiple subnets on a hospital's LAN.

H. The nurse call network shall support at least 990 call processes to facilitate work flow and call escalations to various staff and or groups.

I. Nurse call network shall support any Real Time Locating System (RTLS) via an open architectural interface.

J. Nurse call network shall support any telephone device via an open architectural interface.

K. Nurse call network shall support any Rauland system via an open architectural interface.

L. Nurse call network shall support any staff assignment system via an open architectural interface.

M. Nurse call network shall support any data backup system.

N. Nurse call network shall support HL7 integration with 3rd party systems for patient status and workflow including:
   1. Electronic Medical Records (EMR) with bi-directional room status and workflow
   2. Other systems providing HL7 status and event messages

1.6 WARRANTY

A. The supplying contractor shall provide a warranty on the system which shall include all necessary labor and equipment to maintain the system(s) in full operation for a period of one year from the date of acceptance.

B. Manufacturer shall provide, free of charge, product firmware/software upgrades throughout the 1 year warranty period for any product feature fixes.

C. In addition, the equipment (parts) warranty for all core system components including control / switching equipment, power supplies, patient stations, sub-stations, and nurse consoles shall extend to a total of at least five (5) years.

Warranty for ancillary devices such as pillow speakers and call cords shall extend to a total of at least two (2) years.

D. After the acceptance of the system(s) service shall be provided on the following basis:

Emergency Service -	Provided 24 hours a day. When a total or catastrophic failure of equipment is reported to contractor, within 2 hours of notification, a service person will be on site. (An example of a catastrophic failure would be a hub failure or a nurse console failure.)
Routine Service -	Provided within 4 business hours (9 a.m. to 5 p.m., Monday through Friday, excluding holidays) of notification. When a minor failure of equipment is reported to contractor, a service person will be on site within 24 hours of notification. (An example of a minor failure includes peripheral equipment such as control stations, entertainment speakers, corridor lights, pull-cord stations, etc. which normally affect only one patient or patient room.)

PART 2 - PRODUCTS- HARDWARE

2.1 MANUFACTURERS

A. The products specified shall be new and of the standard manufacture of a single reputable manufacturer. As a reference of standard and quality, functionality and operation, it is the request of the OWNER that bids be based only on equipment manufactured by Rauland-Borg Corporation distributed locally by SIGNET Systems.

1. Project Contact: David Vickers david.vickers@signetgroup.net

B. The intent is to establish a standard of quality, function and features. It is the responsibility of the bidder to ensure that the proposed product meets or exceeds every standard set forth in these specifications.

C. The functions and features specified are vital to the operation of this facility; therefore, inclusion in the list of acceptable manufacturers does not release the System Supplier from strict compliance with the requirements of this specification.

2.2 NURSE CALL NETWORK WIRING

A. All Nurse Call Network wiring shall be only CAT 5E or CAT 6. Plenum wire shall be used in open areas and standard CAT 5E or CAT 6 within conduit. System shall be capable of injecting DC power into a CAT 5 or CAT 6 run, for additional rooms, or long runs, by running a separate DC cable pair to a remote location.

1. Contractor shall terminate all wiring with manufacturer approved connectors. Cable terminations shall be installed in accordance to the Installation Guide KI-2093E utilizing a R4KCRIMP crimping tool. Where individual conductors need to be spliced (i.e.: pillow speaker conductors to digital television isolator

to 3-conductor cable to television), utilize crimp type connectors. The use of wire nuts is prohibited.

B. System shall employ a structured cable system consisting of standard 4-pair Category 5E or 6 cable to service all corridor lamps, and consoles.

C. All Nurse Call Network wiring shall be plenum rated CAT 5E or 6. System shall be capable of injecting DC power into a CAT 5E or 6 run, for additional rooms, or long runs, by running a separate DC cable pair to a remote location.

2.3 NURSE CALL CONTROLLER(S) [note symbol on drawings]

A. Furnish as needed in each nursing unit a nurse call network controller. Each controller shall provide the following:
   1. Non-blocking, duplex communications between consoles and rooms, sub stations and duplex pillow speakers, within each 6 station loop. Provide four loops for a total of 12 dynamically allocated speech paths.
   2. CAT 5E or CAT 6 wiring standard utilizing PoE (Power over Ethernet) between console and nurse call controllers and local wiring to power room station equipment and dome lights.
   3. VoIP audio to Nurse Call Network, VoIP Nurse Console, VoIP staff terminal, wired or wireless phones via SIP protocol. VoIP digital audio stream out to rooms without IP overhead signaling.
   4. Up to 96 corridor lights can be operated with a single controller.

B. Controller must be life safety grade meaning that it shall not require regular rebooting for continued basic functions of system and it shall be possible for controller to act as a standalone controller should loss of network communication occur. Personal Computers may not be used for this purpose. PCs will only be allowed outside of the UL-listed nurse call network on the customer supported LAN.

C. Nurse call controller(s) are connected to the hospital's LAN via Ethernet switches. The nurse call servers also connected to the hospital's LAN are running specialized software for using hospital data resources and telephone communications resources.

D. Make: Rauland Responder 5 Series Model - 351001 (design equipment)

2.4 NURSES MASTER STATION [note symbol on drawings]

A. Furnish as shown on plans, a UL-1069 listed VoIP nurse console capable of the following functions:
   1. Full duplex audio
   2. Display up to 3 incoming calls each with an individual elapsed timer which increments time since call was placed. Also provide the ability to scroll to see more incoming calls.
   3. Power over Ethernet powered connection to UL-1069 listed Ethernet controller. No local power supplies required.
   4. Choice of hands-free duplex communications through built in speaker and separate microphone or private handset conversation.
   5. Ability to create up to 32 soft keys, user-configurable.
   6. Optional tone/mute of calls in progress.
   7. Ability to swing an individual room or any group of rooms by touching one labeled touch point. Room(s) and consoles may be located anywhere within hospital nurse/patient communications network.

8. Console can be programmed to be the receiver of any call that is not answered by another console, or can be programmed to receive any call from a console that has failed or has been unplugged, or otherwise not receiving the call (call orphaning).
9. Self-contained unit which shall not occupy more than 88 square inches of desk space and is desk or wall-mountable.
10. Make: Rauland Responder 5 Series Model - 351205 (design equipment)

2.5 CENTRAL EQUIPMENT CABINET [note symbol on drawings]

A. Provide a central equipment cabinet for each Area / Unit where shown on the drawings.

B. Central Equipment Cabinet to house:
   1. Power Supplies (Furnish as needed)
   2. Battery Backups (Furnish as needed)
   3. System Controllers & Switches (Furnish as needed)

C. Make: Rauland Responder 5 Series Model – NC2828 (design equipment).

2.6 PATIENT STATIONS

A. Provide single patient [note symbol on drawings] or dual patient station [note symbol on drawings] as shown on plans.
   1. Each patient station shall be capable of the following functions:
   2. Separate speaker and microphone for full duplex audio. Entertainment audio to be muted when intercom in use.
   3. One DIN pillow speaker receptacle per bed that shall have a tilt design, with automatic release of pillow speaker plug when pillow speaker cord is pulled at any angle.
   4. Station shall support an optional module to feature bed side rail control on station to indicate the bed is disconnected. LED on station shall indicate that the bed is disconnected and that a bed out call is active.
   5. Built in lighting control that interfaces directly to low voltage controllers.
   6. One universal 1/4” jack for auxiliary alarm input/call cord per bed. Call priority of these receptacles shall be independent of any other button or receptacle.
   7. Cancel button shall cancel any call on this station and any other station in room that is programmed for universal room cancel.
   8. Supply where noted the Enhanced Single Patient Station [note symbol on drawings] that includes all the features above, and additionally, two programmable buttons: code blue and staff assist.

B. Supply where noted for the Enhanced Single Patient Station an optional Clear Button Cover to prevent accidental initiation of the additional programmable buttons. Cover is easy to install and has an easy to lift cover to access the buttons.

C. Unit shall mount in a standard 3-gang non-gangable electrical box.

D. Make: Rauland Responder 5 Series Model – 353000, 353001, & 353010 (design equipment).

2.7 SUB-STATIONS

A. Provide as shown on plans, sub-stations which shall be flush mounted in a single gang box. All sub-station cancel buttons will follow the cancel policy as defined in the system configuration. Typically canceling a high priority call can only be accomplished by the station initiating a call, while lower priority calls may be cancelled by any associated station in the room.

B. Individual sub-stations shall be:

1. Pull cord station [note symbol on drawings] shall be water resistant with a replaceable PVC pull-cord, and easily cleaned surface. The pull-cord shall have a large, easy to pull plastic "bell" attached. This station may only be cancelable with the room and not cancelable from the nurse console. Make: Rauland Responder 5 Series Model – 354001(design equipment).
2. Pull cord station with Call button [note symbol on drawings] shall the same characteristics as above, with the addition of one extra pushbutton for call-in. This button shall be programmable separately from the pull-cord to indicate a different call process (i.e. call caregiver to return to bed) than the pull cord which may indicate an emergency situation. Although this station trims out to a double gang faceplate, the mounting is in a single gang box. Make: Rauland Responder 5 Series Model – 354002(design equipment).
3. Pull cord station with Speaker [note symbol on drawings] shall have all the capabilities of the pull cord station with call button, and include a built in speaker and microphone for communications with the patient. Although this station trims out to a double gang faceplate, the mounting is in a single gang box. Make: Rauland Responder 5 Series Model – 354000(design equipment).
4. Single call button station and Dual button stations [note symbol on drawings] shall be water resistant. The buttons shall be back lit and have the ability for a user defined customized call label corresponding to the 990 call priorities available within the system. An elapsed timer may be activated by any call button to start a count up timer on any clock that accepts remote activation. Make: Rauland Responder 5 Series Model – 354011, 354012, & 354015 (design equipment).
5. Single and Dual call button station can have an optional Clear Cover to prevent accidental initiation of the call buttons. Clear Cover is easily lifted to access buttons and does not cover the Cancel button for easy cancelation of calls. Make: Rauland Responder 5 Series Model – 350008 (design equipment).
6. Staff Registration station [note symbol on drawings] shall have four backlit buttons that allow by default three levels of staff and one Staff Assist Button. Any button can be configured as a staff registration or call button to provide maximum flexibility. Although this station trims out to a double gang faceplate, the mounting is in a single gang box. Make: Rauland Responder 5 Series Model – 354017 (design equipment).
7. Bed Status station [note symbol on drawings] shall have four backlight buttons: Transport, Cleaning Needed, Cleaning in Progress, Bed Ready. The buttons will indicate the room condition and alert transportation personnel to this room. When the Transport button is depressed, the transport person assigned to this area receives a wireless message to transport this patient, or alternately, transportation dispatcher receives an on screen display. Environmental Services staff will receive a wireless message that this bed requires cleaning. Environmental Services and nursing supervisors are alerted to the bed's state. Alternately, customized descriptions can be assigned to

this station for specific facility needs. Canceling an event maybe accomplished by pressing a button a second time, using the cancel button, or by pressing another button in the chain of events. Make: Rauland Responder 5 Series Model – 354016 (design equipment).

8. A two jack auxiliary alarm station [note symbol on drawings] shall allow the connection of external patient monitoring devices via two (2) ¼ inch jacks. This allows individual annunciation of patient alarms to nurse call consoles and wireless devices. Each jack may be programmed for one of 990 call processes and may be configured for latching or non-latching. A call in timer may be set within system configuration to buffer a device that produces intermittent alarms. Make: Rauland Responder 5 Series Model – 354018 (design equipment).
9. Remote Tilt Release Pillow Speaker Station [note symbol on drawings] shall provide a remote connection for the standard 9 pin DIN connector associated with a patient station. This allows the remote installation of the patient station, while keeping the 9 pin receptacle close to the patient. Make: Rauland Responder 5 Series Model – 350300 (design equipment).

2.8 CORRIDOR LIGHTS, ZONE LIGHTS, AND DOMELESS CONTROLLERS [note symbol on drawings]

A. Provide as shown on plans, the proper type of corridor light or domeless controller. Corridor lights shall contain four sections, each lighted by a long life, RGB LED capable of producing 7 colors. Each section shall have a diffusion lens which allows for 180 degree horizontal visibility of call lights. The corridor lights shall be capable of the following:
   1. All segments of corridor light can indicate a call in any of the following 7 colors:
      a. Blue, Red, White, Green, Orange, Yellow, or Pink.
   2. Custom call patterns (any combination of light segments, such as all segments blue for code blue).
   3. Flash any single color or strobe the sections of the light in any color pattern.

B. Intelligence in the corridor light and domeless controller shall support up to 16 room devices and allow for the ability of any room station to be associated with any other room in the system. This allows special functions where needed, such as associated call stations and cancelling options, (i.e. door monitoring).

C. Staff registration shall be indicated by a custom color associated with that staff level (i.e. Green= Nurse, Orange=LPN, Yellow=Aide).

D. Domeless controllers shall have all the function of the corridor light, less LED's.

E. In the unexpected event of communications loss with the nurse call controller, corridor lights and domeless controllers shall enter a local room failsafe mode showing all calls in the hallway via the LED indicators.

F. Corridor lights and domeless controllers may be hot-swapped on the room-to-room communication line without the loss of communications to other devices on the local network.

G. Make: Rauland Responder 5 Series Model – 352010, & 352021 (design equipment).

2.9 PATIENT ENTERTAINMENT SPEAKER / CALL CORDS

A. Provide one (1) pillow speaker per bed station unless noted. The pillow speaker shall have a mating 9 pin DIN plug and nurse call button. TV control shall be programmed as a system function to allow pillow speakers to work with any standard hospital grade TV. Lighting control is optional to control up to two lights. All pillow speakers to have call assurance and monitor LED's (specification writer choose one model):

1. Standard Model: Digital TV control with full duplex communications via built in microphone and separate speaker. There shall be three additional buttons for the use by the patient for special needs, such as "pain", "water", and "toilet". The system shall have the ability to discern the difference between these calls and send it to the appropriate care level. Controls for up/down volume, up/down channel. TV mute, closed caption and TV on/off shall be standard. Make: Rauland Responder 5 Series Model – 350227 (design equipment).
2. Enhanced Model: Digital TV control with full duplex communications via built in microphone and separate speaker. There shall be three additional buttons for the use by the patient for special needs, such as "pain", "water", and "toilet". The system shall have the ability to discern the difference between these calls and send it to the appropriate care level. Controls for up/down volume, up/down channel. TV mute, closed caption and TV on/off shall be standard. A direct entry key pad gives patient ability to enter channel number. Make: Rauland Responder 5 Series Model – 350207 (design equipment).
3. Basic Model: Analog TV control with pillow speaker audio for communications and TV audio. Provide buttons for TV channel change/ON-OFF and volume control potentiometer. Make: Rauland Responder 5 Series Model – 350242 (design equipment).

B. Provide one (1) call cord per bed station unless noted. The call cord shall have a mating 9 pin DIN plug and nurse call button.

C. Make: Rauland Responder 5 Series Model – 350100 (design equipment).

2.10 STAFF STATION [note symbol on drawings]

A. Provide as shown on plans as staff station. Unit shall provide two-way hands free duplex intercom to its assigned nurse console(s) by pushing a call in button. Station shall support an optional module to feature bed side rail control on station to indicate bed connection. LED on station shall indicate bed connection. Unit shall mount in a standard 3-gang electrical box.

B. Make: Rauland Responder 5 Series Model – 353101 (design equipment).

2.11 DUTY STATION [note symbol on drawings]

A. Provide as shown on plans as duty station. Unit shall provide remote annunciation of assigned patient stations and sub-stations via 4 LED's and multiple call tones. Duty station faceplate LED's shall mimic corridor light activity for the assigned nursing area. Also provides two-way duplex intercom to the assigned nurse console(s) through separate speaker and microphone. Call tones generated at duty station must be identical and repeat in synch with tones produced at closest nurse console. It shall be possible to mute the call in tone, without cancelling call. The next call in, assigned to this duty station, will un-mute the station. Muting feature

may be defeated in those jurisdictions that do not allow muting of duty station. The duty station shall be capable of being programmed for a specific time that a day/night mode takes place, allowing a volume change to the call-in tones. This feature is required to minimize noise for patients. Unit shall mount in a standard 3-gang electrical box.

B. Make: Rauland Responder 5 Series Model – 353100 (design equipment).

2.12 STAFF TERMINAL [note symbol on drawings]

A. Furnish as shown on plans, as part of the nurse call communications network, a UL 1069 listed VoIP Staff Terminal. This dynamic device shall serve as a patient or procedure room communications tool while providing staff with “soft” touch-points to initiate an instantaneous notification of an in-room need. Additionally this terminal may be used as a functional nurse call console.

B. The following functions shall be provided:
1. Color touchscreen display.
2. Ability to create up to 60 soft keys, user-configurable, up to 8 screens per terminal.
   a. Sends specific need for that location. Examples: Emergency, Staff Assist, Cleaning Needed, Lifting Help, Transport, Order, Stat Order, Rounding, etc.
   b. Speed dial to any location
3. Power over Ethernet powered connection to UL-1069 listed Ethernet switch. Local power not required.
4. Full duplex audio
5. Hands-free duplex communications through built in speaker and separate microphone.
6. Display up to 3 incoming calls each with an individual elapsed timer which increments time since call was placed. Also provide the ability to scroll to see more incoming calls.
7. Ability to dial through touch key pad.
8. Ability to capture an individual nursing unit, selected units, or all units in hospital by touching single custom labeled touch point.
9. Ability to Bi-Directionally interface to the EMR in order to allow Staff Terminal workflow events to be logged in the EMR and have EMR events (i.e. Fall Risk) activate workflow in the Staff Terminal including corridor light illumination, call placement and wireless messaging.

C. Make: Rauland Responder 5 Series Model – 351310 (design equipment).

2.13 SPARE PARTS

A. Provide the following spare parts:

ITEM	QUANTITY
(Enhanced) Single Patient station	2
Pull cord station	2 of each type used
Push Button station	2 of each type used
2 Jack station	2 of each type

ITEM	QUANTITY
	used
Pillow speaker – call cord	4 of each type used
Console	1
Staff Terminal	1

B. Turn spare parts over to Owner and obtain a signed receipt. Submit receipt for review.

PART 3 - PRODUCTS – SOFTWARE

3.1 PC CONSOLE DISPLAY – Optional

A. Provide a PC console display on any networked OWNER provided PC that meets the system manufacturer's minimum specifications, whether it utilizes touch screen or standard mouse control. Also, OWNER provided wall mounted PC displays shall have the global option provided in this software package of a touch screen keyboard.

B. The following additional functions shall be provided at each one of these users' screens:
1. Full display of all calls, including corridor light color sequence.
2. Complete electronically generated census of patients showing assigned caregiver, current patient needs as sent by service reminder process, time patient has been waiting for call answering, or need, list of caregivers on duty and staff location.
3. Customizable views including 1 window with 8 columns, 2 windows with 4 columns, and 3 windows with 3 columns.
4. Ability to text message to any single individual, group of users, or all users, a text message to a wireless phone display.
5. Ability to display calls in a centralized display format (i.e. Centralized Code Blue display).
6. Ability to display and route calls in a de-centralized workflow environment.
7. Ability to display all staff information, staff status, wireless extension and their location.
8. Ability to initiate a room status or call from the PC console.

C. Provide software to make caregiver to patient assignments from any OWNER provided PC workstation within the hospital by easy user sign on. Assignment process shall be intuitive and indicate to that Supervisor making the assignment, each caregiver's patient load based on number of patients and patient difficulty. These assignments shall stay in queue until each individual signs on duty. The assignment is released when the caregiver goes off duty.

D. The following additional functions shall be provided:
1. Unlimited assignment of caregivers to patients, patients to caregivers.
2. Group assignments.
3. Assignments may be made up to 7 days in advance.
4. Easy display of prior day's assignment and easy click to accept if you want to keep assignment the same.
5. Display pertinent HL7 fields for patient.
6. Allow for assigning advanced call escalation for un-answered calls.

7. Staff member shall have ability to use Bar Code for ID and wireless devices.
8. User's assignment can print out to a local printer.
9. User shall have the ability to go ON and OFF break forwarding their device to another caregiver and reflecting this activity in the reporting software.
10. Put staff on and off duty and assign a phone.
11. Conduct device based assignments as well as staff based assignments.

3.2 WIRELESS DEVICE INTERFACES – Optional

A. The Telephone Interface shall receive, via an Ethernet connection, VoIP connectivity using the standard SIP protocol. This module shall support at least 60 simultaneous voice connections between wired/wireless phones and the nurse call network. There shall be four different possibilities (specification writer choose one method):
   1. The facility will utilize a VoIP/SIP wireless phone system and an IP/SIP PBX. The software module shall directly support an interface through the OWNER provided Telephony/SIP Call server that communicates to the nurse call network gateway server. Any nurse call system that only utilizes analog station/trunk ports to communicate with SIP wireless phones will not be acceptable.
   2. The facility will utilize a VoIP/SIP wireless phone system with a non-SIP PBX. The software module shall directly support an interface through the OWNER provided Telephony/SIP Call Server that communicates to the nurse call network gateway server. OWNER will also provide a Telephony/SIP Gateway. Any nurse call system that only utilizes analog station/trunk ports to communicate with SIP wireless phones will not be acceptable.
   3. The facility will utilize a wireless phone system which is not SIP compatible and a VoIP/SIP PBX. The software module shall directly support an interface through the OWNER provided Telephony/SIP Call Server that communicates to the nurse call network gateway server. The supplying contractor is to provide middleware which interfaces the non-SIP wireless phone system display to the nurse call system software module. OWNER provides wireless phone system OAI. OWNER will also provide a Telephony/SIP Gateway.
   4. The facility will utilize a wireless phone system which is not SIP compatible and a non-SIP PBX. The software module shall directly support an interface through the OWNER provided Telephony/SIP Call Server that communicates to the nurse call network gateway server. The supplying contractor is to provide middleware which interfaces the non-SIP wireless phone system display to the nurse call system software module. OWNER provides wireless phone system OAI. OWNER will also provide a Telephony/SIP Gateway.

B. Wireless SIP interface will allow for the display of the patient name attached to an incoming nurse call event.

C. SIP devices will have the ability to escalate nurse call events from the handset.

D. SIP integration must differentiate between a status notification and a patient call.

3.3 ADT INTERFACE – Optional

A. Provide a HL7 compliant interface for the purpose of receiving relevant patient information.

B. This interface shall be capable of the following:

1. Mapping of standard Rauland segment field components and subcomponents to nurse call fields.
2. All updates shall be real time, but software shall buffer data for any interruption of service.

3.4 LOCATION INTERFACE (RTLS -Real Time Locating System) – Optional

A. Provide an interface (OAI) to integrate with the facilities Real Time Locating System (specified or provided elsewhere) and the nurse call network. Nurse call features and location of staff shall communicate per standard API published by manufacturer of nurse call.

B. The full integration shall include, but not be limited to the following:

C. Staff location.

D. Ability to choose specific calls to be canceled as a staff member walks into room.

E. Optionally lights corridor light to show staff in room with specific staff color.

F. Ability to locate staff throughout the facility on networked PC.

G. Reporting on said functionality

3.5 REPORTING SOFTWARE – Optional

A. Provide software that may be accessed by any networked PC work station that gives management patient call details in clear readable format. HL7 integration shall make all pertinent patient details available, including the ability to search by patient name and/or patient ID number for those nurse call records associated for that patient during their stay, regardless of room/bed occupied. All reports shall be fully historical.

B. In addition, the reporting software shall provide the following functions:
1. Standard, global reports
2. Summary reports
3. Detailed reports
4. Graphic reports
5. Productivity reports
6. Staff coverage reports
7. Reports shall be viewed in Adobe Acrobat Reader
8. Any trained individual may utilize standard ODBC compliant reporting software to generate more enhanced reporting.
9. Does not require additional off-the-shelf software for the generation of reports.
10. Uses SQL Reporting Services for report generation.

PART 4 - EXECUTION

4.1 NEEDS ASSESSMENT

A. Manufacturer shall provide a one-on-one meeting with the particular nursing manager of each unit affected by the installation of the new networked nurse/patient communications equipment. This meeting shall include reviewing the floor plan drawing, educating the nursing manager with the functions of the

equipment that is being provided and gathering details specific to the individual units; coverage and priorities of calls; staffing patterns; and other pertinent details that will affect the training. In-service Scheduling materials and sample of training materials will be provided. A staff member list, if needed, will be filled out for inclusion in the software. Information gathered will be provided to Contractor to program the network software.

4.2 INSTALLATION, EQUIPMENT

A. Contractor shall terminate all wiring with manufacturer approved connectors. The use of wire nuts is prohibited.

B. All wiring shall be free from shorts and faults. Wiring shall be UL listed, NEC and NFPA 70, Article 25 approved.

C. Nurse patient communications network wiring shall not be run in the same conduit with other systems (i.e. Class 1 AC power distribution, fire alarm, entertainment systems, lighting controls, etc.).

D. It shall be the responsibility of the Electrical Contractor to provide a dedicated 120 VAC, 60 HZ conduit feed into the equipment cabinet. This power feed shall not have any other devices connected directly to it. A 20 AMP circuit breaker located in the electrical sub-panel labeled “nurse call” will control this circuit. This electrical circuit will be connected to the hospital’s emergency power system for automatic power switch over during loss of utility power.

E. Large hospital systems may require multiple equipment cabinets that are separated between floors and buildings.

4.3 IN-SERVICE TRAINING

A. Manufacturer shall provide thorough training of all nursing staff assigned to those nursing units receiving needs assessment of new networked nurse/patient communications equipment. This training shall be developed and implemented to address all types of staff determined at the needs assessment. Floor nurses/staff shall receive training appropriate to their needs, and likewise, unit secretaries (or any person whose specific responsibilities include answering patient calls and dispatching staff) shall receive operational training appropriate to their needs and charge nurses (or any person whose specific responsibilities include scheduling staff to patient assignments) shall receive operational training appropriate to their needs. A separate training room will be set up if available that allows this type of individualized training utilizing in-service training unit.

B. Provide a minimum of [ ] hours of instruction to the nursing staff and operating personnel, schedule in advance.

4.4 TESTING

A. Submit a written test report from an authorized representative of the equipment manufacturer that each device and overall system operation has been 100% tested.

B. Provide 2 sets of keys to all equipment cabinets and submit a receipt for review.

C. Submit [3] bound Operator Manuals that shall include as a minimum:
   1. Bill of Materials.

2. Manufacturer's equipment description for each type of device and control module type used.
3. Provide record wiring diagrams showing typical connection diagrams for each type of device and a complete riser diagram showing all devices, zones, and wiring requirements, as installed. Wiring diagrams shall show terminal connections at the central equipment cabinet.
4. Instruction report stating when instruction was given and who was in attendance, signed by those given instruction.
5. Manufacturer's authorized representative written test report.
6. Statement of warranty called for.

END OF SECTION

SECTION 27 53 19

DISTRIBUTED ANTENNA SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. American National Standard ANSI/TIA/EIA Telecommunications Building Wiring Standards.

B. Drawings and general provisions of the Contract, including General and Supplemental Conditions and other Division 1 Specification Sections, apply to this Section

C. 232123Section 01 81 13 “Sustainable Design Requirements – LEED v4 for Building Design & Construction – New Construction” for sustainable design requirements and detailed sustainable design submittal requirements.

D. Section 01 74 19 “Construction and Demolition Waste Management and Disposal” for disposal of construction, demolition and packaging waste disposal requirements.

1.2 SUMMARY

A. The Maine Medical Center MMC (the Owner) is developing new facilities at the East Tower 6 & 7 Building in Portland, Maine. A Distributed Antenna System (DAS) is included in the new installation.

B. This specification describes the technical and performance criteria for a Neutral-Host Distributed Antenna System (DAS) capable of supporting Wireless Service Providers (WSP’s) initially with the capability to support Public Safety Networks (PSN) in the future by the addition of PSN-specific active and passive components (including EMI filtering) without modifications to the basic passive portions (coverage antennas, optical fiber, coax cabling, splitters, connectors, etc.) of the DAS infrastructure.

C. This Section specifies requirements for furnishing, installing and testing the DAS, including all required parts, cabling and components required to provide a fully operational system that meets all technical and functional requirements and is ready for the Owner’s use

D. The DAS shall provide coverage for the WSPs initially and PSNs at a future date, (to be determined), on all frequencies currently being used by the designated WSPs and PSNs in the vicinity of the hospital, including: Verizon Wireless, AT&T Wireless, T-Mobile and Sprint, as well as designated PSNs. The DAS shall also be capable of future expansion to accommodate future 2300 MHz and 2500 MHz WSP frequency bands by the addition of 2300/2500 MHz-specific active and passive components without modifications to the basic passive portions (coverage antennas, optical fiber, coax cabling, splitters, connectors, etc.) of the DAS infrastructure

E. RELATED SECTIONS
   1. Refer to the following specification sections for coordination and scope definition
      a. Section 271300 – Backbone Cabling
      b. Section 271500 - Communications Horizontal Cabling
      c. Section 270526 – Grounding and Bonding for Communications Systems

d. Section 271100 – Communications Equipment Room Fittings

F. Sustainable Building Requirements:

1. The Owner requires the Contractor to implement practices and procedures to meet the project's environmental performance goals, which include achieving LEED version 4 Certified level Certification. Specific project goals that may impact this area of work include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; construction waste recycling; and the implementation of a construction indoor air quality management plan. The Contractor shall ensure that the requirements related to these goals, as defined in the Articles below, are implemented to the fullest extent. Substitutions, or other changes to the work proposed by the Contractor or their Subcontractors, shall not be allowed if such changes compromise the aforementioned environmental goals and LEED certification.

1.3 ABBREVATIONS

A. ACG - Automatic Gain Control

B. AHJ – Authority(ies) Having Jurisdiction

C. ATP - Acceptance Test Plan

D. AWS - Advanced Wireless Service

E. BDA - Bi-Direction Amplifier

F. BOM - Bill-of-Material

G. BRS - Broadband Radio Service

H. BTS - Base Transceiver Station

I. CDMA - Code Division Multiple Access

J. C/N - Carrier-to-Noise Ratio

K. CWDM - Coarse Wave Division Multiplexing

L. DAS - Distributed Antenna System

M. DWDM - Dense Wave Division Multiplexing

N. EBS - Educational Broadband Service

O. ESMR - Enhanced Specialized Mobile Radio

P. FCC - Federal Communications Commission

Q. GUI - Graphical User Interface

R. iDEN - Integrated Enhanced Digital Network

S. LMR - Land Mobile Radio

T. LTE - Long Term Evolution

U. MHz – Millions of Hertz

V. MTBF - Mean Time Before Failure

W. MTTR – Mean Time to Repair

X. NFPA - National Fire Protection Association

Y. NMS - Network Management System

Z. PCS - Personal Communications System

AA. PSN - Public Safety Network

BB. ROF - Radio Over Fiber

CC. RoHS - Restriction of Hazardous Substances

DD. RSL -Received Signal Level

EE. RSSI – Received Signal Level Indication

FF. SISO - Single-Input, Single-Output

GG. SMR - Specialized Mobile Radio

HH. SMS - Short Message Service

II. SNIR - Signal-to-Noise Interference Ratio

JJ. SNMP - Simple Network Management Protocol

KK. SOW - Statement of Work

LL. VSWR - Voltage Standing Wave Ratio

MM. WSP - Wireless Service Provider

1.4 DEFINITIONS

A. Acceptance – Expressed approval by the Owner

B. Active Components - DAS components that require AC/DC power for operation

C. Carrier Approval - Expressed approval by WSP to connect to WSP network

D. Channel – a path for RF communications

E. Component – a main element of the DAS

F. EMI - Electromagnetic interference

G. RCDD - Registered Communications Distribution Designer

H. Owner – Maine Medical Center

I. Passive Components – DAS components not requiring AC/DC power for operation

J. RCDD - Registered Communications Distribution Designer

1.5 SCOPE OF WORK

A. Design, furnish, configure, install and test the new DAS as indicated on the Contract Drawings including as required, but not limited to: Donor Antennas, Coverage Antennas, Coax Cable, Coax Connectors, Splitters, Combiners, Couplers, Fiber-Optic Cable, Fiber-Optic Connectors, and Fiber-Optic Jumpers, Bi-Directional Amplifiers (BDAs), Fiber-Optic Master Unit and Fiber-Optic Remote Units.

B. Design and install the DAS to be fully be fully capable of receiving WSP and PSN approval for interoperation with their respective networks.

C. Negotiate on behalf of the Owner all required retransmission agreements with WSPs

D. Assist the Owner in negotiating any potential cost and revenue sharing agreements with WSPs

E. When prior approval of the PSN deployment is required by code or ordinance, assist the Owner with obtaining all required approvals from authorities having jurisdiction

F. Obtain on behalf of Owner any required licenses or permits associated with the DAS installation and operation

G. Note that some of the work required for the DAS will be provided by others. Review Contract Documents and coordinate with Owner and other contractors to ensure that there is no unnecessary duplication of effort or interference with other portions of the work.

1.6 SYSTEM DESIGN AND PERFORMANCE REQUIREMENTS

A. All work, including but not limited to: wiring, equipment, installation, workmanship, maintenance and testing shall comply with the latest editions of the National Electrical Code, National Electrical Safety Code, all applicable local rules and regulations, equipment manufacturer's instructions, and the National Electrical Contractors Association (NECA) Standard of Installation. In case of conflicts among the requirements noted above, the contractor shall satisfy the most stringent requirements.

B. Requirements set forth by first-responder code, ordinance, or the PSN Authorities Having Jurisdiction shall supersede the requirements described herein and shall be met in their entirety. It is the Contractor's responsibility to ensure that the DAS complies with local code, ordinances or requirements established by the PSN authorities.

C. The DAS architecture shall employ an active optical backbone between the DAS headend and distributed remote units. Horizontal distribution from remote units to coverage antennas shall be entirely passive.

D. The system shall be capable of future modifications and upgrades within the specified frequency bands without disturbing the passive portions of the system:

Service	Uplink, MHz	Downlink, MHz
Cellular	824 - 849	869 - 894
PCS	1850 - 1920	1930 - 2000
AWS	1710 - 1780	2110 - 2180
WCS (Future)	2305-2315	2350-2360
Commercial 700 Bank	698 - 716, 776-787	728 - 746
Narrow Band Public Safety 700 Band (Future)	799 – 817	769 - 775
800 Band	806 - 824	851 - 869
BRS/EBS (Future)	2496 - 2690	

E. The downlink Received Signal Level for each frequency band shall meet or exceed the following over 95% of the interior spaces:
   1. Lower 700 MHz, BRS/EBS: -75 dBm
   2. Cellular, PCS, AWS, Commercial 800/900 MHz: -85 dBm
   3. Public Safety (future) 380-512, 700, 800 MHz: -95dBm

F. The DAS shall have capabilities to support the following WSPs deployed in a SISO antenna environment as well as the following Narrow Band PSN and VHF/UHF frequencies without changes to the passive DAS infrastructure. Any additional active

components required for system expansion shall comply with all specifications of this Section.

1. AT&T Wireless
2. Verizon Wireless
3. T-Mobile
4. Sprint

G. The DAS shall have a Network Management System (NMS) capable of alarm, monitor, configuration and control of all active components. The DAS NMS shall be capable of integration with 3rd party SNMP based NMS products for alarm purposes

1.7 REFERENCES

A. Military Standards
1. MIL-C-17 - Standards for Radio Frequency Coaxial Cables

B. Telecommunications Industry Association (TIA)/Electronic Industries Alliance (EIA):
1. 1568-B - Commercial Building Telecommunications Cabling Standard.
2. 569 – Commercial Building Standard for Telecommunications Pathways and Spaces
3. 222-H - Structural Standard for Antenna Supporting Structures and Small Wind Turbine Structures.

C. Institute of Electrical and Electronics Engineers (IEEE):
1. SO/TR 21730:2007 – Use of mobile wireless communications and computing technology in healthcare facilities – Recommendations for electromagnetic compatibility with medical devices.

D. Underwriters Laboratories Inc. (UL):
1. 910 - Test for Flame - Propagation and Smoke - Density Values for Electrical and Optical-Fiber Cables Used in Spaces Transporting Environmental Air
2. 1581 - Reference Standard for Electrical wires, Cables and Flexible Cords
3. 1666 - Test for Flame Propagation Height of Electrical and Optical – Fiber Cables Installed Vertically in Shafts
4. 1685 - Standards for Safety Vertical Tray Fire Propagation and Smoke Release Test for Electrical and Optical Fiber Cables
5. National Public Safety Telecommunications Council (NPSTC)
6. Best Practices for In-Building Communications

1.8 SUSTAINABLE DESIGN REQUIREMENTS

A. Provide Energy Star and Restriction of Hazardous Substances (RoHS) compliant components meeting the requirements of this Section, as available

1.9 QUALITY ASSURANCE

A. Perform all equipment and cable installation using qualified workers with prior experience in installing active and passive radio frequency equipment, optical fiber cable, copper cable, operating software and low voltage power supplies. Work experience shall include the successful installation of at least three other DAS Installations of similar scope and complexity to the Work of this Contract. In addition, at least one of the installation contractor employees shall hold a current BICSI RCCD certification and be certified by the equipment manufacture(s) in the installation and testing of the proposed DAS

B. Equipment and software manufacturers shall be regularly engaged in manufacturing DAS equipment and associated products of the types, sizes, and characteristics specified in this section and on the Contract Drawings.

C. All components of each kind shall be the product of a single manufacturer.

D. Radio system equipment shall be electromagnetically compatible (EMC) and not cause electromagnetic interference with other systems.

1.10 SUBMITTALS

A. As applicable, submit the following prior to beginning work:
   1. Manufacturer datasheets for the following components:
      a. Donor and Coverage Antennas
      b. Coaxial Cable and Connectors
      c. Splitters, Combiners and Couplers
      d. Bi-Directional Amplifiers (BDA)
      e. Optical Fiber Cable and Connectors
      f. Fiber-Optic Master Unit
      g. Fiber-Optic Remote Units
      h. Power Supplies, UPS, Batteries
      i. Racks and Cabinets
   2. Contractor's System Warranty.
   3. Manufacturer's Extended Warranty.
   4. Maintenance Service Contract
   5. Acceptance Test Plan and test equipment to be used
   6. Shop Drawings:
      a. RF link budget
      b. Cable route diagrams for all cabling
      c. Plans and elevations of all major equipment, racks, components and devices
      d. Antennas and mounting details
      e. Indoor propagation/coverage maps demonstrating compliance with coverage requirements Hardware and software manuals
      f. Detailed product specifications
      g. Mean Time Between Failure (MTBF) data for each Active Component
      h. Independent test results verifying the product specifications
      i. For active components serving the WSP's, written documentation from the WSP's that the component(s) are approved for use within the WSP's networks
      j. Signal to Noise Interference Ratio (SNIR) Map
      k. Bill-of-Material (BOM)
   7. Comprehensive Acceptance Test Plan including proposed testing procedures and specification of test equipment.
   8. Any requirements for Owner-provided infrastructure, networks, servers or software
   9. Current BICSI RCCD Certification

B. Submit Record Documents at completion of work:
   1. Field test reports indicating and interpreting test results including certified final test reports for all DAS equipment and cable runs and certification of all test equipment used for testing.

2. One reproducible set and four sets of prints of the Shop Drawings that reflect the actual as built condition of the entire DAS.
3. Four sets of system parts, maintenance and operation manuals.
4. System scheduled maintenance requirements.
5. A complete list of recommended spare parts, which shall include those spare parts required to be furnished in compliance with the requirements of this Section.

C. DELIVERY, STORAGE, AND HANDLING
1. Deliver to the worksite all equipment, components, cabling and hardware properly packaged in factory-fabricated packaging.
2. Store all equipment, components, cabling and hardware in clean dry space in original containers, protected from weather, theft, vandalism, damaging fumes, construction debris and traffic.
3. Handle equipment, components cabling and hardware carefully to avoid braising, damage or undue wear.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Acceptable manufacturers of DAS passive and active components (as applicable) include: Andrew/CommScope, Bird Technologies, Comprod, Belden, Corning, Times Microwave, RFS, Trilogy Communications, EMR Corp, JMA Wireless, Cobham, Galtronics or functional equivalent subject to compliance with requirements of this Section and prior approval by the Owner.

B. No alternative component(s) shall be accepted as equal to the components and manufacturers specified in this document unless they are of equal of superior specifications and quality, and that they have been used in similar projects of size and complexity for no less than 3 years.

2.2 WARRANTY

A. Manufacturer Warranty:

B. Splitters, Couplers, and Coverage Antennas: 5-year warranty from date of system acceptance.

C. Coaxial Cable and Connectors: 10-year warranty from date of system acceptance.

D. Fiber-Optic Cable: 20-year warranty from the date of system acceptance.

E. Active Components: The earliest of 1-year warranty from date of system installation or 15 months from date of shipment.

F. Contractor Warranty: Contractor shall warrant the system performance as specified herein for one year.

2.3 QUALITY CONTROL

A. Factory inspection. The owner shall have the right to inspect the manufacturer's quality control, manufacturing, and testing facilities at any time during the procurement process. Inspection may include visual examination of the equipment,

cables and all related documentation to ensure that the system is being fabricated in accordance with the specifications.

B. Manufacturer shall maintain ISO Quality Control registration for the facilities that manufacture the products used in the DAS.

PART 3 - EXECUTION

3.1 PREPARATION

A. Examine raceways and other equipment spaces to receive cable and equipment for compliance with installation tolerances and other adverse conditions. Do not proceed with installation until unsatisfactory conditions have been corrected.

B. Refer to Contract Documents to define work provided by others and work to be provided by this Contractor.

3.2 INSTALLATION

A. Comply with manufacturer's requirements and written instructions. Observe manufacturer's requirements for bending radius, pulling force and support intervals. Install all cable connectors in accordance with manufacturer's instructions using manufacturer's recommended tools. Weatherproof all coaxial connections using manufacturer's recommended weatherproofing kit.

B. Install cable and equipment in locations as shown on the Contract Drawings by experienced workers in a careful professional manner.

C. Make variations to indicated antenna locations as needed to ensure required RF performance.

D. Restore fire rating of all interior wall and floor penetrations. Seal and weather proof all exterior wall and roof penetrations.

E. Use CMR and CMP rated cables as applicable

3.3 ACCEPTANCE TESTS

A. After installation of the system, the Contractor shall perform the field acceptance tests:

B. All tests shall be performed by the Contractor and witnessed as required.

C. All equipment, personnel and supervision necessary to conduct the tests shall be provided by the Contractor.

D. All test results shall be recorded and reports delivered to the Engineer upon completion of the tests.

E. The entire installation shall be inspected for conformance to this Section and code requirements. Non-conforming installations shall be corrected prior to the start of testing at no additional cost to the Authority and reported to the Engineer.

F. Thirty days prior to the field test specified hereinafter submit a comprehensive testing plan to the Engineer for review and approval. The testing plan shall include testing

procedures approved by the Engineer and any additional tests required by the Engineer.

G. The entire installation shall be tested to show compliance with this Section. The Contractor shall perform any repairs or modifications required to comply with the test requirements at no additional cost to the Owner. Testing shall continue until all results are met to the requirements of this Section and to the satisfaction of the Owner.

H. Each designated coverage area shall be divided into a grid of approximately twenty (20) equal areas. Locate a spot approximately in the center of a grid area for the test. Once the spot has been selected, prospecting for a better spot within the grid area will not be permitted. Test each grid area will for transmission/reception. Measure and record individual channel signal levels. Measure and record individual channel signal levels at the portable input port. If signal strength fails to meet the requirement, the grid area shall be marked as a fail. If the 95% area coverage requirement is not met, adjust the system to meet requirements.

END OF SECTION

This page is intentionally left blank.

SECTION 28 10 00

SECURITY SYSTEM

PART 1- GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

B. Section 01 81 13 "Sustainable Design Requirements – LEED v4 for Building Design & Construction – New Construction" for sustainable design requirements and detailed sustainable design submittal requirements.

C. Section 01 74 19 "Construction and Demolition Waste Management and Disposal" for disposal of construction, demolition and packaging waste disposal requirements.

1.2 SUMMARY

A. This Section includes the electronic Access Control, Intrusion detection and IP CCTV Video System and Video Management System.

B. Card holder information/enrollment existing.

C. Related Sections include the following:
1. Division 16 Section "Raceways and Boxes."
2. Division 16 Electrical Sections
3. Division 08
4. Division 27

D. The work covered by this specification includes the construction described, including all labor necessary to perform and complete such construction; all materials and equipment incorporated or to be incorporated in such construction; and all services, facilities, tools and equipment necessary or used to perform and complete such construction.

E. Provide the following:
1. Furnish, install, terminate, test and document new electronic access control system, including proximity card readers, door contacts, request to exit devices, control panels, cabling, software and interface with Owner's networks/central station and integrated with local fire alarm system. ALL MECHANICAL DOOR HARDWARE IS FURNISHED & INSTALLED BY OTHERS. COORDINATE WITH ARCHITECT. Security Contractor is responsible for final terminations.
2. Furnish, install, terminate, test and document new electronic alarm system, including door and window contacts, PIR motion detectors, duress alarms, tamper switches, aural and visual alarm enunciators, control panels, cabling, software and interface with Owner's networks/central station and local fire alarm system.

3. Furnish, install, and terminate, test and document new IP CCTV system, including cameras, camera mounts, camera power supplies, network video recorders, monitors, cabling, licenses and all other required components.
4. Access Control RS2 Enterprise server existing.
5. CCTV Server/Video management existing (ONSSI Enterprise)
6. It is the intent of these design/build specifications to procure a complete, workable and programmed Security System, compatible with the Owner's planned and existing systems and ready for the Owner's use. Any item not specifically shown on the drawings or called for in the Specifications, but normally required to conform to the intent, is to be considered as part of the Contract.
7. Any given item of equipment, material or software shall be the product of manufacturers indicated within this specification or approved equal, throughout the facility. Multiple manufacturers of any one item shall not be permitted, unless specifically noted otherwise or approved by the Owner.
8. These Specifications are equipment and performance Specifications. Any discrepancies found between the Specifications and Drawings shall be brought to the attention of the Consultant. Installation and details indicated on the Drawings shall govern if they differ from the Specifications.
9. Bidders are encouraged to proposed alternative solutions that are fully compliant with the Client's requirements.
10. Certain terms such as "shall, provide, install, complete, etc." are not used in some parts of these Specifications. This does not indicate that the items shall be less than completely installed or that systems shall be less than complete.

F. Sustainable Building Requirements:
1. The Owner requires the Contractor to implement practices and procedures to meet the project's environmental performance goals, which include achieving LEED version 4 certified level Certification.
2. Specific project goals that may impact this area of work include: use of recycled-content materials; use of locally-manufactured materials; use of low-emitting materials; construction waste recycling; and the implementation of a construction indoor air quality management plan.
3. The Contractor shall ensure that the requirements related to these goals, as defined in the Articles below, are implemented to the fullest extent. Substitutions, or other changes to the work proposed by the Contractor or their Subcontractors, shall not be allowed if such changes compromise the aforementioned environmental goals and LEED certification.

1.3 SUBMITTALS

A. Submit manufacturers' product data sheets for all material and equipment products proposed in bid. Only specified or accepted manufacturers or suppliers shall appear in the product data submittal.

B. Provide physical samples of products if requested by Consultant.

C. Where substitutions or alternates are requested for any specified manufacturer or product, submit complete documentation for the product proposed, including complete product data and catalog cut sheets, engineering test and performance reports and any other information pertinent to the product.

D. Submit shop drawings for review ten (10) days prior to start of work and prior to ordering of material to consist of one (1) set of reproducible and three (3) sets of

prints of drawings, diagrams, and/or manufacturers' data in accordance with the contract documents.

E. At completion of installation, furnish a complete set of as-built documents, including plan view and elevation drawings, device schedules, test and acceptance documentation, equipment manuals and operating instructions.

F. As-built drawings shall consist of one (1) set of reproducible and three (3) sets of prints, and one (1) computer format CD.

1.4 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. Comply with NFPA 70, "National Electrical Code."

C. Comply with applicable SIA Industry Standards.

D. Codes, Regulations And Standards
   1. Comply with the most recently issued requirements, standards, recommendations, rules, and regulations of authorities having jurisdiction over the project.
   2. Follow the most restrictive code or recommendations. Where there are ambiguities, refer to the Consultant for interpretation.

PART 2 - PRODUCTS

2.1 GENERAL

A. Provide the products called out below and on drawings or approved equal. Where a specific manufacturer has not been called out, provide industry standard products of first quality and fully compatible with the system.

B. All equipment shall be equal to or exceed the applicable minimum requirements of NEC, IEEE, ASME, ANSI and UL.

C. All products and materials shall be new, clean, and free of defects or damage and of first quality.

D. Coordinate device quantities, locations, types and finishes with architect.

E. The work covered by this specification includes the construction described, including all labor necessary to perform and complete such construction; all materials, software and equipment incorporated or to be incorporated in such construction; and all services, facilities, tools and equipment necessary or used to perform and complete such construction.

2.2 ACCESS CONTROL SYSTEM (Existing) RS2 Enterprise

A. Furnish & Install a PC-based Access Control Management System (ACMS) detailed below, complete with all hardware necessary for a complete and functional system.

B. The system shall have ample capacity to accommodate future growth, integrate with the fire alarm system and shall have an open architecture which allows importing

and exporting of data from other applications. The system shall be capable of stand-alone operation. Provide the following components:

1. The SMS shall be an integrated system that utilizes a single, industry-standard relational database management system for the storage and manipulation of related data. The SMS shall include a server with operating system and applications software, operator and administrator terminals with appropriate software, hard copy printers and fixed magnetic storage media. The security devices shall communicate with the field panels via a dedicated cable network. The field panels shall communicate to the server via a Fast Ethernet 10/100, TCP/IP network or a serial (RS-232, RS-485) connection.
2. The SMS shall employ a standard Windows 7, Windows 2003 Server, or later graphical user interface (GUI). A mouse and keyboard shall be the primary operator interface with the system. Operator screens shall utilize all standard Windows-style functions such as drop-down menus, context menus, radio buttons, and lists, as appropriate. The interface shall utilize a 'tree structure' similar to Windows Explorer.
3. The ACMS shall be flexible and scalable in architecture, permitting expansion of both capacity and functionality, to be implemented progressively as needed, through software licensing and/or software upgrades.
4. The ACMS shall employ distributed processing technology, allowing the host to function almost entirely as an application/database server. The majority of the real time, day-to-day decisions shall be made locally by intelligent control panels. The control panels shall be the direct field interface for all access control, alarm sensing, and input/output-controlled devices.
5. The ACMS shall manage and automatically download in real-time, all database changes made at all operator workstations, to the control panels that require notification of the specific database changes or updates.
6. The SMS hardware shall be comprised of modular components that connect over standard interfaces to one another. There shall be a Data Gathering Unit storage and processing module (DGU), and once data has been downloaded to the DGU it shall locally make access control decisions. Access granted or denied decisions shall be made in under 0.5 seconds
7. The DGU shall store firmware in non-volatile flash memory to allow for convenient updates through the head-end software application. The DGU shall store the cardholder and configuration database information in battery-backed memory so that loss of primary power will not cause the loss of the database.
8. The DGU shall support configurations that include: 16 card readers, 96 monitored input points, or 32 auxiliary output points.
9. There shall be an intelligent controller (communications, memory, CPU, and reader/door functions integrated). The 8-door controller shall provide an integrated on-board RS-232 interface, and shall have provisions for modular expandable memory.
10. There shall be an option for hardware made with a lead-free manufacturing process to meet RoHS requirements.
11. Communication Schemes
    a. Hardwired Communications
        1) The field panels shall be located convenient to the access and monitor points that they control, and shall be interconnected in a chain configuration to a serial port of a convenient client PC on the system.

2) The system shall support a minimum of 31 intelligent field panels (nodes) daisy-chained together such that they communicate back to a single serial communications port at the host.

b. Bi-Directional Communications

1) A chain of field panels shall be wired in a loop configuration, by the addition of a cable from the last controller and connecting it into a second port on the PC. When this configuration is installed, should a break in the cable occur, the PC shall be able to communicate with the nodes after the break, via the secondary port.

12. Network Communications

a. The first field panel in a chain of panels shall have the ability to communicate with its monitoring client PC over the local or wide area network. This shall be achieved by the addition of a network interface option module and provide a cost effective alternative configuration to a direct connection via a client PC's serial port. The network interface shall support both "10 base T" and "100 base TX" (10/100) communications speeds. The network interface shall support encryption utilizing either TwoFish or AES algorithms.

b. An optional modem and telephone line shall be configured to provide an alternative path for the reporting of alarms. The fallback to dial-up alarms reporting shall be automatic in the event of detecting a network communications failure.

13. Efficient Memory Management

a. Controllers shall be capable of supporting cardholder populations of at least 200,000, or be configured to a learning mode that allows the cards most frequently used to have their access rights stored locally in the panel's memory.

b. When a card is presented which is not resident in the local panel, a verification request shall be made to the central database, if the card is valid the details shall be downloaded. If the card memory is full, the card with the oldest transaction date shall be deleted to make space for the card requested. This shall allow automatic management of cardholders, based upon frequent users having "instant" response and infrequent users learned when required.

14. Database Synchronization

a. To ensure synchronization of the distributed controllers' databases with a region's main database an internal checking process shall be provided within each controller. In the event of corruption of a controller's local database then it shall be able to detect this condition and automatically request the relevant data to be downloaded from its local server. This action shall not require Operator intervention.

b. The system shall continue to provide access control functionality during this re-synchronization process.

15. Door lock release relays shall be minimally rated for 3 A @ 30 VDC.

16. Readers supporting various technologies shall provide data from card presentations or biometric authentications through a door control unit (DGP) that includes the electrical interface to the reader as well as inputs for door sensors and form C relays for outputs.

17. The DGP shall support Wiegand communications to the reader. In order to provide higher levels of security, the DGP shall support bi-directional, supervised, and encrypted communications to the reader. Door controllers that

do not support encryption and supervision of reader communications are not considered equal.

18. The system shall support an option to store cardholder biometric information (e.g. fingerprint or hand geometry templates) at the panel (as part of the cardholder record). Storage of the template data at the reader shall be unacceptable. An acceptable alternative is to store individual templates on secure smart cards.
19. The SMS hardware shall support all of the following options for supervision of the monitored input points:
    a. 2-state supervision – in which only secured and alarm state are indicated.
    b. 3-state supervision – in which the input state can be secure, alarm or open circuit.
    c. 4-state supervision – supports secure, alarm, short circuit and open circuit states.
    d. 6-state supervision – supports secure, alarm, short or open circuit for the sensor in addition to tamper alarm and tamper short circuit states.
20. High Availability and Disaster Recovery (Provide as alternate)
    a. To provide greater client software availability, software shall be installed so that in the event of a database server failure, client machines will quickly and without operator intervention, automatically connect to a standby server machine.
    b. This configuration shall utilize the industry standard Microsoft clustering solution and allow for an installation with a large number of client machines, the ability to continue to operate without interruption, while the cause of the main server failure is investigated.
    c. The SMS product shall be capable of supporting options for 99.99% and 99.999% availability.
21. Bandwidth Utilization
    a. The proposal shall include documented manufacturer's evidence of network bandwidth utilization including plots and supporting data, covering all aspects of normal system operation. Proposal submissions without supporting documentation will not be considered or evaluated.
22. Encryption
    a. Encryption falls into two distinct areas, firstly between clients and their Server, secondly between client and local area network panels (LAN Nodes).
    b. LAN node links shall support Two Fish and AES encryption between the supervising client PC and its LAN Chains.
    c. For client to server connections, the SMS shall support a solution using industry standard network cards, such as the Intel Pro 100s, which support IPsec and 3DES encryption.
    d. Web-based (thin client) SMS clients shall use 128-bit SSL encryption.
23. Required Standard Software Features
    a. The following software features shall be part of the standard product offering without requiring additional purchase or licensing.
    b. The installation of the server and client software shall utilize a "wizard" interface to guide users through the appropriate installation steps.
    c. The SMS shall start up as part of the Operating System. The SMS shall run as a service in the OS, and there shall be no requirement to run an application after the operating system is ready.

d. The SMS shall support a Graphical User Interface that minimizes training needs for even inexperienced users. The software shall include on line help displays to eliminate operator reference manuals.

24. It shall be possible to select any function, within a given Operators permission, independent of the currently displayed screen. Functions will be accessed via tool bar Icons, which will include help prompts that will appear when the mouse pointer dwells on the selection button. It shall also be possible to link any standard Windows application to a custom toolbar icon.
25. A print screen command icon shall be provided, subject to an individual Operator's permission, for all screens and will allow the currently displayed information and screen presentation to be printed.
26. The system shall support an unrestricted number of time codes. Furthermore, the system shall support a minimum of 10 intervals per time code.
27. The SMS shall support an unrestricted number of time intervals. A time interval is a defined span of time such as "08:00 to 17:00" as "Business Hours". Time intervals shall be permitted to span midnight, such as "20:00 to 05:00" as "Third Shift".
28. The system shall be scalable to a multiple-server implementation where each region (either geographical or logical) has a server capable of making local decisions and configuration changes. The Global head-end server responsible for managing the entire enterprise including all regional servers shall support a minimum of 999 regional servers.
29. Operator Permissions
    a. System operators shall be associated with a log in Name and Password. A system option will determine whether strong operator passwords will be used. The minimum definition of a strong password shall be a password that contains at least one upper case character, one lower case character, one numeral and one punctuation mark, with a minimum password length of six characters. Additionally the password cannot contain any full word of the operator's username.
    b. The option to use a Secure Biometric or Smart card for system logon shall be provided. When used, this option will force the operator to present their Name, Password and Biometric or Smart card.
    c. Operators shall be assigned to permission profiles. This will determine the functions that will be available to that operator when logged-on to the system. Each operator is required to only see the functions for which s/he has access. The system shall support an option to hide Personal Identification Numbers of cardholders when an operator is viewing a record.
    d. Card record data entry shall be divided into operator permission areas, allowing separate permission categories to be assigned for the viewing of personal data, ID badge printing and access right management.
    e. The SMS shall support an unrestricted number of operators and operator permission profiles.
    f. For all operators, a means of re-arranging their Icon tool bar shall be provided to allow the most frequently used Icons to be repositioned by the operator.
    g. The system shall store operator preferences based on logon information. This feature shall allow an operator to work with their preferred configuration independent of which workstation they occupy.
30. Operator Interface

a. The SMS shall use a single client application interface for system configuration, administration, management, and monitoring operations.
b. The SMS shall provide a mouse-driven, java-based, graphical user interface allowing operator(s) to open and work on multiple windows simultaneously, at host server and client workstation(s) with minimal degradation to system performance.
c. The SMS shall provide a Web Browser based client-less interface that is capable of accessing the system from any authorized computer on the network regardless of the client computer operating system without requiring the loading or maintenance of any client software. The Web Browser interface must support industry standard SSL 128bit encryption.
d. The ACMS shall provide on-line context sensitive help files to facilitate operators in the configuration and operation of the ACMS.
e. The ACMS shall implement National Language Support (NLS) in a manner that allows simultaneous multi-lingual operation, based on individual operator language preference.
f. The ACMS shall support defining an unlimited number of operators; application access via workstation(s) shall be restricted by operator login and password. Operator profiles shall be configurable to include form level and field level permissions, database partition views, and language preference.
g. The ACMS shall provide primary and secondary menus that lead to input forms (screens) to add, change or delete information.
h. All ACMS forms shall support custom forms and templates that can be created based on an existing record or modifying a blank record.
i. All forms can be customized to include the fields and tabs of the operator's choice and be set as a default
j. The templates can them be used to generate new records with the necessary links already set up.
k. The ACMS shall provide the capability to create custom lists to appear on the operator's forms to satisfy specific requirements – such as a list box of company or division names
l. The ACMS shall provide definable templates for configuration wizards allowing an operator to create master templates for generating new records with the necessary links predefined
m. When a template is run, a Wizard guides the operator through the necessary steps to create a new record for the form
n. The system shall support generation of reports detailing the system operation. The following reports shall be available in the software:
    1) Cards on site
    2) Hours on site
    3) Cardholders with access to each door
    4) Access rights of each cardholder
    5) System Configuration
    6) Scheduled and Conditional Commands defined
    7) System operator transaction history
o. It shall be possible to replay video clips associated with events by directly interacting with the report as published to the computer screen.
p. The system shall demonstrate the ability to export data, for example reports, to other standard office word processing packages such as Microsoft Word.

q. The system shall provide system management reporting, including detailed listings for all the operator actions and the current cardholder database for output to the display screen, printer or disk media.

r. The system shall have the ability to save frequently used report configurations and associate them with a “Title”. Such predefined reports shall be available from a list to simplify the report selection. It shall be possible to request these reports to run immediately or schedule them to occur at a specified date and time.

s. Scheduled reports shall additionally have the option to be automatically repeated by specifying the number of days and reporting period to be included, for example a weekly report of Alarms to run at 10:30 am each Monday and including the previous 7 days of Alarms.

t. The system shall allow custom reporting options by providing an interface to a commercially available ‘off the shelf’ reporting product, such as Crystal Reports. The interface shall present all database fields in a structured format, which does not require detailed knowledge of the database design and table relationships.

u. History Reporting

1) Extensive reporting shall be included to provide the ability to review all system alarms, access control activity and operator actions. These reports shall be available for review on the operator’s display, to a printer, or to a file.

2) Extensive sort parameters shall include any of the personal details fields of information such as by department, job title, vehicle registration, contractor company name or any other reference appropriate for each site.

3) Frequently run report configurations shall be saved allowing them to be selected and run on demand, or scheduled to run automatically as required. When scheduled to run automatically this shall have the ability to be repeated.

4) Total Hours Spent On-Site

a) This report shall provide a detailed audit of the arrival and departure times for cardholders and calculates the total time spent on site for the chosen reporting period. This report shall be filtered by any of the personal data fields of information associated with each cardholder.

5) Cards On-Site Reporting

a) This report shall provide a list of cardholders currently on the site. This may be for all persons within the site or just who, for a particular department or a particular contractor company, is currently present. The report may also be run to cover just a part of the site, for example, cardholders is in a particular building or room.

31. The SMS server shall communicate to all clients (operator workstations and field hardware) through WIN32 services. The SMS server shall not require that an application be run for proper system operation.

32. Clients

a. The system shall support an unrestricted number of clients to suit growing enterprise requirements. The system shall provide the means for multiple operators to simultaneously administer the system from convenient locations connected via a local area network (LAN) or across a wide area network (WAN).

b. Systems that operate on the MSDE database server that restrict the number of clients shall be upgradeable to a fully unrestricted version of the software without the need for a database conversion.
c. Clients shall not use mapped drives for server connections.
d. Clients shall not use UDP messaging.
e. System shall support a minimum of two client pc monitors. The system shall additionally store the last position and size of all open dialog boxes and screens upon exiting the application on a per operator basis. The next time the operator logs into the application, the screen positions shall be restored. Such operation shall be independent of which workstation the operator uses.

33. Addition of Cardholders to the System Database
a. The system shall provide a means of assigning access control rights to each cardholder. Access control rights determine which access points are accessible to the cardholder based on date and time of day. The system shall support an unrestricted number of access rights.
b. The software shall also provide an ALTERNATE set of Access rights to a cardholder on a temporary basis. The change may be initiated at any time by an authorized operator, or automatically between specified dates. This shall provide the facility of automatically changing a card's rights between a specified date range, after which the card will revert to its normal Doors and Times. Alternate access rights shall be able to be configured for multiple date ranges.
c. Each cardholder shall either be associated with standard door timings, for door release, door open and door pre-held or be given extended timings for disabled persons or someone who has to push a cart.
d. Cardholders who have not used a reader for some time shall be readily listed to allow their card's status to be reviewed. An additional feature shall allow cardholders to be automatically set inactive and therefore access denied should the card have not been presented at any reader on the system for a defined number of days.
e. Cardholders shall be assigned an expiration date, and more specifically an expiry time, after which a card shall automatically become inactive and therefore be rejected at all readers on the system. To further simplify card administration, the system shall have the ability to be configured to automatically purge expired cardholder records after a configurable number of days from the date of expiration.
f. The system shall allow for the definition of Access control rights to be associated with a badge design. Each user that selects that badge design shall be provided with the associated access control rights that can further be customized for the specific cardholder.
g. The system shall allow access control rights to be defined for a cardholder on a reader basis. A time code will be associated with each reader as it is assigned to the cardholder's access control rights.
h. The system shall allow access control rights to be defined for a cardholder on a reader group basis. Reader groups are groups of readers. A timecode will be associated with each reader group as it is assigned to the cardholder's access control rights.
i. The system shall allow access control rights to be defined for a cardholder on an access code basis. An access code is a group of access control rights.

j. The system shall have a note field associated with each cardholder record. The note field shall be free form text and shall support a minimum of 256 characters. The note field shall further support the ability to attach a file (of any type or size) to the cardholder record.

k. When viewing a cardholder record the last twenty-five (25) valid door access transactions shall be displayed to help locate a cardholder.

l. A driver's license scanner shall be supported to simplify data entry of cardholder information. The scanner support shall include, at a minimum, the ability to automatically read, through optical character recognition, the most common fields from valid driver's licenses issued by all 50 states; and populate these fields into the appropriate user-defined personal data fields in the cardholder record.

m. The system shall support a field for assigning an approving official to the cardholder record that defines the individual who authorized the assignment of a credential. Approving officials shall have an associated validity period and image of their signature. As an option, the assignment of an approving official shall be mandatory.

n. The SMS shall allow the user to enroll biometric data as part of the cardholder enrollment process. The number of verifications to determine applicability of the enrolled biometric data shall be configurable.

34. Cardholder Details

a. Cardholder information shall include first and last name, card number, PIN code and valid period to provide automatic expiration. Each cardholder record shall also incorporate at least 50 user-defined personal data fields, independent of user-defined fields for visitor management.

b. Data entry shall be simplified by remembering previous entries of personal data and allowing selection from a pick list to minimize repetitive typing when creating each cardholder's record. The cardholder database and the history log shall also be sorted by any of the additional fields of information making them a powerful tool for filtering data.

c. Personal data fields shall support free entry text, picking an entry from a previously configured list, or picking an entry from an updatable list. Each of these entries shall further be categorized as a date, a time, general input, or customized input. Each category shall support the masking of input data to assure data integrity. For instance, a date mask might look like "mm/dd/yyyy" to indicate that the date input should be a two-digit month followed by a two-digit day followed by a four-digit year all separated by the slash character. The mask shall be required for customized input.

d. Personal data fields shall have the option of being configured as mandatory.

35. Locator

a. This feature shall provide a quick method of locating cardholders by displaying the last 25 valid history events along with the time, date and access point used. This information shall be available for an individual or group of persons by name, card number or by personal data.

36. Card Watch Feature

a. Any cardholder shall be easily tracked as they move around a large site by selecting card watch. As the person uses their access control card, the system shall have the ability to automatically notify the operator of the person's presence at each location.

37. Key Card Mode

a. Key card mode authority shall be assigned to special cardholders, such as site key holders, and can be enabled on a per reader basis. This shall allow a person when vacating an area or building to change the reader's mode of operation from normal access control to Key Card Out operation.
b. When in this condition only persons with key card privileges shall gain access through the door, all non-key card users are rejected regardless of their card's current access rights.
c. This special feature shall be activated/deactivated by the key cardholder, using a card swipe followed by a special code entered via the reader's keypad.

38. Serial Device Interface
    a. The software shall allow the definition of ASCII commands to be sent out over a computer serial port (physical or virtual) or through the RS-232 interface of the DBU. These serial commands shall be available through the user interface as well as in the conditional logic described herein.
39. Automatic Holiday Override
    a. The software shall be programmed by the operator to recognize special or holiday dates, which in turn can be linked to operational changes in how the site is to be managed on these specific days. This feature shall notify a system operator of individual holiday dates up to seven days prior provides a useful check on the date's current validity. Multiple types of holiday dates shall also be provided so that partial days or early closing requirements on specific dates can be accommodated.
    b. The SMS shall provide a calendar function to enable scheduling of events up to five (5) years into the future.
    c. The SMS shall provide the ability to schedule one-time events for up to five (5) years into the future.
40. System Partitioning
    a. The access point readers, monitor points, and auxiliary outputs shall be managed on a partition basis by simply defining which devices are to be included in a partition.
    b. The SMS shall support an unrestricted number of partitions.
    c. Multiple private or public entities shall be able to share the system with database segregation for card records and ownership of readers, monitor point inputs and switching outputs dependent upon the operator's assigned permissions. Each company partition shall allow for autonomous system administration, allowing partitioned card administration, reports, and alarms.
    d. Operator permissions shall be created and assigned globally or by the owning company. When created and assigned globally an Operator's password shall be associated with one or more companies.
    e. Alarm reporting shall be routed to a client located at the company owning the monitor point or reader and can be automatically redirected to a different PC at pre-programmed times and selective days of the week.
    f. Common areas, such as the main entrance, shall have the ability to be shared so that all companies may access these doors, even when different card customer/site codes have been configured.
41. Alarm Management
    a. Alarm handling shall be efficiently managed with up to 99 priority levels and user definable instruction messages to ensure the operator monitoring the site takes appropriate responses. The facility shall have the ability to customize audible alerts for each type of alarm is provided

using standard or custom generated multimedia wave files. Each alarm type shall also be presented in a user-defined color.

b. To provide additional information when reviewing alarm signals, the operator shall either enter custom comments or simply select from a predefined pick list to provide a time-stamped record of all the actions taken throughout the incident. Predefined manual commands shall be uniquely assigned for each alarm, and readily activated by the operator via a command button provided on the alarm acknowledgement screen. Additionally automatic conditional commands shall be configured to automatically operate in response to any given alarm condition.

c. The SMS shall be optionally configured to require operator comments when acknowledging alarms.

d. The SMS shall support the ability to selectively choose alarms to acknowledge and/or clear.

e. Each alarm shall be configurable to have a specified color and sound.

f. Each alarm shall be capable of linking video from digital video recorders (if applicable) for incident playback.

g. The Alarm Monitor screen shall provide an indication that cardholder information is available for a specific alarm. A “Card” button shall be available that when pressed will display the cardholder badge image.

h. Alarm monitor screen shall support the display of alarm statistics, shall provide up to ten alarm filters to be displayed in different tabs on the alarm screen, and shall provide the ability to sort based on each different column.

i. Each alarm shall be time-stamped in the local time zone (not the server time zone), and the system shall support the additional display of labels associated with different geographical time zones such as PST, EST, GMT, etc. The labels for time zones shall be customizable.

j. The system shall permit the routing and display of real time activity at any standard client machine. Activity shall be shown in a dedicated activity window that is updated automatically when new transactions occur. This option shall not be limited to routing transactions to one location and shall support the simultaneous routing and display of real time activity at multiple locations.

k. Alarms shall be capable of being routed to specific client machines by time of day or day of week.

l. Unacknowledged alarms shall be capable of being routed to alternate client (or Email – see Software Options below) based on age and priority of alarm.

m. The display of reader door alarms shall be automatically enabled or disabled by the use of timed commands, either by reader or by a group of readers.

n. The system shall support a generic ASCII input capability that allows the system administrator to define specific ASCII input strings as alarms to be displayed in the alarm monitoring window as well as on the graphical map interface if so configured.

42. Graphical Site Maps (Provide as Alternate)

a. To further enhance the presentation to the operator, the system shall have the ability to import and use graphical maps. Maps shall be linked together using a tiered tree structure. To speed the location of an incident, each map level shall contain a clearly visible indicator as to which sub map the operator should select next to find the device that is in alarm.

b. Maps shall also have the ability to be configured to appear automatically on presentation of a new alarm, providing the operator with prompt visual indication that an alarm has occurred.
c. The status of readers, doors, monitor points and auxiliary outputs shall be requested from any map by simply selecting the icon representing the device and its current state will be displayed.
d. The icons on the graphic map shall dynamically indicate the status of the device they represent. For example, a door icon shall change to show the door open when the door position sensor indicates such, and shall change to the original icon when the door is again secure. Additionally, monitor points shall also change to show their current state.
e. Should the operator wish to change the current setting, simply pressing the right mouse button shall cause the appropriate command options list to appear for selection.
f. Having selected a command, confirmation shall be provided by reflecting the change in status on the display.
g. Maps shall be created using standard office tools such as Paint® or drawing packages such as AutoCAD®. It shall be possible to import drawings in the following formats: JPEG, Bitmap, Windows metafile or DXF.
h. Icons representing access points, monitoring points, switching outputs, alarm inputs, CCTV cameras or intercom call stations shall be placed on any map at the required location in a drag and drop manner.
i. It shall be possible to define on the map the location of readers, access doors, and alarm monitored points, output switching relays, IP CCTV cameras, Digital Video Recorder Cameras, Intercom call stations and alarm panel devices. The map display shall allow the operator to switch the video display of any defined IP CCTV camera to any defined IP CCTV monitor. The map display shall allow the display of stored and live Digital Video Clips.
j. It shall also be possible to change the status of readers, reader groups, and floor groups, alarm monitored points or output switching relays and confirm the successful execution of such commands from the map display. This functionality shall be capable of being restricted per device based on operator permission.
k. The map display shall include the option to display a group of similar devices as a single icon. Once devices are grouped it shall be possible to change their status. For example, it shall be possible to unlock all entrance doors by executing a single command from the map display.

43. Manual and Automatic Commands
a. Operators shall be provided with a wide choice of manual commands embracing the control of readers, monitor points, output switching relays and door locking devices. Also the operator shall have the ability to check the status of single, or multiple devices. This shall ensure the operator is always able to check the operational status of the system and make any adjustments as requirements change. When graphical maps are utilized, status requests shall be simply initiated by “clicking” on the device icon within the map. This functionality shall be capable of being restricted per device based on operator permission.
b. Automatic commands shall be included and may operate on a timed or event basis.

c. Scheduled commands shall easily be defined linking complimentary commands to occur at the start and stop times of any chosen timecode.
d. Event triggered commands shall provide an extremely powerful means of creating IF/THEN/WHEN associations encompassing a wide selection of IF conditions to the automatic execution of THEN commands subject to a WHEN timecode being active. A minimum of 10 THEN actions shall be available per trigger command.
e. Devices shall be managed on a partition basis by grouping readers, monitor points and auxiliary outputs. This feature shall allow multiple devices to be actioned by a single command when using manual, timed and conditional commands. This functionality shall be capable of being restricted per device based on operator permission.
f. The SMS shall support an unrestricted number of automatic (scheduled and trigger) and manual commands. These commands shall be capable of spanning across multiple field controllers.

44. Card Initiated Commands
    a. The software shall allow authorized cardholders to initiate powerful trigger commands manually from selected reader locations when certain models of readers are used in conjunction with the field panels.
    b. Up to 99 predefined commands shall be invoked by an authorized card allowing, for example, a patrolling guard to switch on outputs, disable monitor points, lock doors, providing remote management of the system during a patrol of the site.
    c. The system shall only permit assigned users to enter command codes at keypad readers. Such assigned users shall not be restricted as to when or where they can enter a command code – such restrictions may be placed on the commands themselves.
    d. User Code Mode
        1) The SMS shall support the ability to put a keypad-equipped reader into User Code Mode. This feature shall allow a cardholder to gain access by entering a valid card's number at a reader keypad, therefore not requiring the holder to carry a card.
        2) User code mode shall be enabled on a per reader basis.
        3) This mode shall support card number only, or card number and its assigned PIN code.
45. Device Configuration
    a. The system shall support a notes field to be associated with each device configured on the system. The notes field shall be free-form text, and shall support a minimum of 256 characters. The notes field may be used for detailed device descriptions or for maintenance history. The notes field shall also allow files to be associated.
    b. The system shall provide a hierarchical tree view of the system configuration supporting expansion and collapse of any and all branches.
46. Windows Daylight Saving Auto Adjustment
    a. The system shall support Windows Time Server or Windows time management.
47. History Archive and System Back up
    a. The system shall allow on line archiving of history logs, along with database back up of system configuration and cardholder details. To further ease the burden of remembering to back up your system's database, this function shall be able to be automated to occur without intervention at a pre-set time.

b. The system backup and history archive shall be to a magnetic tape drive at the database machine, or the system may be configured with a destination drive and path located on a different PC accessible to the Database machine via the network.

48. Anti-Passback
    a. The system shall support both "hard" Anti-Passback and "soft" Anti-Passback alarm reporting modes.
    b. If the cardholder has access rights at a reader, but creates an Anti-Passback alarm, if the reader configured as hard anti pass-back sends an Anti-Passback alarm and denies access to the door/portal.
    c. Soft anti pass-back sends an Anti-Passback alarm, but still allows access through the door/portal.
    d. The system shall support timed anti-pass back. The principle of timed anti pass-back is simple: once a card has been used at a timed anti pass-back reader, the card causes an Anti-Passback violation if it is used again at the same or another timed anti pass-back reader within a predefined period of time. The exception to this rule is when the Anti-Passback reader has been defined to be for an exit route. In this case, the card can be used at any time without causing an alarm or event. This allows for situations where a person enters an Anti-Passback protected area, then wishes to exit the area immediately, perhaps, for example, because he or she forgotten something.
    e. The use of an exit anti-pass back reader also causes the time delay for reuse of the card to be zeroed, so in the example, the person can re-enter the anti-pass back-protected area immediately, without having to wait. The delay can also be zeroed from the Card Holders screen or by means of an anti-pass back command. Sending a command may be useful if, for example, people have passed through an exit during a fire drill and the delay is long.
49. Provide Manufacturer:
    a. RS2 Enterprise
        1) Access Panel: Intelligent Controller
        2) Model #: As required by the owner; EP1502 with Enclosure
        3) <u>RS2 Enterprise</u>

C. Furnish & Install all ancillary devices which shall be compatible with the specified Access Control System and Intrusion Alarm/Central Station Monitoring or the approved equal. All devices and finishes shall be coordinated and approved by the architect prior to installation. Provide the following components:

1. Card Readers HID/ASSA ABLOY
    a. Manufacturer: ASSA ABLOY/HID
    b. Part #: RP-40 (HID Multi-Class)
    Or approved equivalent
2. Dual Reader Interface
    a. Manufacturer: RS2 Mercury
    b. Part #: MR52

3. Single Reader Interface
    a. Manufacturer: RS2 Mercury
    b. Part #: MR50

4. Panic/Duress Button
   a. Manufacturer: HONEYWELL
   b. Part # 269R Series Panic Switch
      Or approved equivalent
5. Door Contacts (Recessed)
   a. Manufacturer: GE
   b. Part # 1076W (wide 1 inch gap)
      Or approved equivalent
6. Request to Exit Push button
   a. Manufacturer: Schlage
   b. Part #: 620 Series
      Or approved equivalent
7. Request to Exit Sensor (PIR)
   a. Manufacturer: Bosch
   b. Part #: DS-150i with Trim plate TP 160
      Or approved equivalent
8. Intrusion Alarm Panel (Central Station Communicator)
   a. Manufacturer: Honeywell
   b. Part #: Vista Series with Wireless Receiver
      Or approved equivalent
9. I/0 CONTROLLERS
   a. Manufacturer: RS2 Enterprise
   b. Part #: MR16IN & MR16OUT INPUT/OUTPUT MODULES
10. Local Alarm (Audible)
   a. Manufacturer: DSI
   b. Part #: ES-411 (with auto-reset audible timeout)
      Or approved equivalent
11. Electrified Mortise Lock
   a. Manufacturer: ASSA ABLOY
   b. Part #: L9080 WITH REQUEST TO EXIT FUNCTION
      Or approved equivalent
12. Power Supply (Locks)
   a. Manufacturer: Altronix
   b. Part #: AL600ULXD- 6 Amp 12-24vdc with Battery Backup (7amp Battery) or approved equivalent
13. Access Control Power Supply
   a. Manufacturer: ~~Software House~~ ALTRONIX
   ~~b.~~ Part #: ~~APS w/Enclosure with Battery Backup~~ AL600ULX (7amp Battery) Or approved equivalent
14. Card Reader Cabling (Composite-Plenum)
   a. Manufacturer: CSC Cable, West Penn, Windy City Wire
   b. Part #: CSC P/N:112110 (Plenum)
   c. Part #: West Pen P/N:AC251822 (Plenum)
   d. Part #: Windy City P/N: 4461095-S (Smart Wire-4 Plenum)

D. Miscellaneous Materials. Provide all cabling, connectors, mounting hardware, interface modules, software, manuals, instructions and miscellaneous items necessary for a complete, fully installed and functional system, ready for the Owner's

use. ALL MECHANICAL DOOR HARDWARE SHALL BE FURNISHED BY OTHERS (electric locks, magnetic door strike, strikes, etc.). Security contractor responsible for final terminations.

E. Labeling and documentation of all cables, boxes, devices, and hardware installed under this contract.

F. Testing and test documentation as described below.

G. Ancillary Devices. Key pads, PIR detectors, panic buttons, door contacts, glass break detectors (audio type) etc. shall be compatible with specified the alarm panel or the approved equal. All devices and finishes shall be coordinated and approved by the architect prior to installation.

H. Miscellaneous Materials. Provide all cabling, connectors, mounting hardware, interface modules, software, manuals, instructions and miscellaneous items necessary for a complete, fully installed and functional system, ready for the Owner's use.

I. Labeling and documentation of all cables, boxes, devices, and hardware installed under this contract.

J. Testing and test documentation as described below.

2.3 VIDEO MANAGEMENT SYSTEM (VMS) (Existing) ONSSI Enterprise

A. Furnish & Install all IP CCTV hardware as depicted on drawings, or approved equal, complete with all hardware necessary for a complete and functional system. The system shall have ample capacity to accommodate future growth. Provide the following components:
   1. Performance Requirements
      a. Complete IP CCTV video recording management solution in a compact design.
      b. Capable of high resolution H.264 video compression.
      c. Provide system wide recording, monitoring, and management of fixed and PTZ cameras.
      d. Simultaneous live display, recording, playback, network transmission, and back-up.
      e. Stable embedded operating system.
      f. Rack mountable.
   2. Field replaceable hard drives, accessible via the front without uninstalling the unit from the application.
   3. The VMS shall have flexible, open architecture built on accepted industry standards that facilitate integration with IT infrastructures.
      a. Flexible and scalable IP CCTV management system in an easy to use versatile design.
      b. View, record, control cameras, handle alarms and check device status through one interface.
      c. Real-time digital recording and playback at 25/30 IPS in CIF, 2CIF and 4CIF resolution on all channels simultaneously.
      d. Real-time live display at 25/30 IPS in 4CIF resolution for greater detail as needed (independent of recording settings).
      e. Multiple control options via USB mouse, front panel and joystick keyboard.

f. Remote configuration and management of devices on surveillance system.
g. Powerful search and playback functions.
h. Hybrid recording of 8 or 16 analog cameras and up to 16 H.264 IP channels with a variety of hard drive capacities.
i. Internal storage up to 8 TB on four front-accessible hard drives.
j. Lip-Synchronous audio/video.
k. Video player with image authentication (watermarking).
l. NTSC and PAL selectable video format (auto detected).

4. Field replaceable hard drives, accessible via the front without uninstalling the unit from the application.
5. The VMS shall have a distributed fault-tolerant, failover database architecture. The distributed server architecture allows for each subsystem to operate in an independent mode, without affecting video recording or live viewing.
6. The database video storage shall provide minimum of 20 days of high quality at 7.5 fps 2 CIFF resolution quality. The overall storage shall be based on real time recording and motion detection no less that 50 percent of motion activity and H.264 compression scheme.
7. The VMS shall possess an internal watchdog to detect and recover from the unlikely occurrence of system lockup.
8. The VMS shall provide support for IP (network) cameras from multiple third party manufacturers.
9. The VMS shall not use multiplexing or timed division technology for analog video recording. All analog camera sources shall be digitally recorded.
10. The VMS shall be able to support video motion detection natively. This operation can be executed by the edge device or the IP Camera. Enabling motion detection shall be performed either:
    a. On a continuous basis
    b. Scheduled for particular times, dates, days, months, etc.
    c. Defined areas of interest through an easy-to-use user interface using simple editing tools
    d. At a defined level of sensitivity
11. The VMS shall support local language translation, including languages that do not support the European character set, such as Chinese.
12. All text displayed in the user interface shall be stored in a database to allow for easy translation to another language.
13. The VMS shall support both single and multi-site deployments.
14. The VMS shall be designed to work with cameras that generate a standard NTSC or PAL composite video signal.
15. The VMS shall support a variety of video matrix switcher devices, code generators, and PTZ cameras from different manufacturers.
16. The recorders will use a standard Ethernet connection for video input via TCP/UDP/IP.
17. The VMS shall be capable of supporting large organizations with systems at multiple site locations linked via LAN / WAN connections.
18. Provide the following components:

    a. Helipad - Full 360 Degrees PTZ Network Camera
        1) Manufacturer: AXIS Comm. (PTZ Control Camera)
        2) Part # AXIS Q6000-E Mk II PTZ Four 2-MP Sensors and wall mount kit or approved equivalent

b. Helipad - Outdoor PTZ Dome Network Camera
   1) Manufacturer: AXIS Comm. (PTZ Dome Control Camera)
   2) Part # AXIS Q6042-E PTZ HDTV 1080P & 32x Optical Zoom
      And wall mount kit or approved equivalent

c. Med Room – Fixed Dome Network Camera
   1) Manufacturer: AXIS Comm. (PTZ Dome Camera)
   2) Part # AXIS P3225-LVE Mk II HDTV 1080p Video Quality Streamlined and wall mount kit or approved equivalent

d. Flexible Multi-Sensor Network Camera
   1) Manufacturer: AXIS Comm. (Flex., 360 Degree Multi Sensor)
      Part # AXIS P3707-PE 8MP and 360 Degree, Multi-Sensor Camera and ceiling mount kit or approved equivalent.
      Fixed Dome, Multi-Sensor, Multi-Megapixel Network Camera

   2) Manufacturer: AXIS Comm. (Fixed Dome Camera)
      Part # AXIS Q3709-PVE 180 Degree Overview, 3x4K at 33MP resolution and wall mount kit or approved equivalent.

e. Door Entry and Gate Control
   1) Manufacturer: TALKAPHONE Grand Stream PBX System
   2) Part # AVM-1 (Grand stream GXV3275)
      IP Video Attendant Phone
      Wall mountable. Integrated stand with two (2) adjustable angles.

f. Door Entry and Gate Control
   1) Manufacturer: TALKAPHONE Compact IP Call System
   2) Part # VOIP-200C (Flush mount configuration)
      VOIP-201C (Surface mount configuration)

g. Power Supplies and battery backup
   1) Manufacturer: Altronix
   2) Part # R2432UL (Rack Mount)
      Or approved equivalent

h. UPS
   1) Manufacturer: Tripp
   2) Part # 3KVA Smart Pro tower and rack Mount
      Or approved equivalent

i. Cabling (Coaxial and Power)
   1) Manufacturer: CommScope
   2) Part # 2054K/2054V
      Or approved equivalent

j. Video Network Recorder/VMS (Existing)

1) Manufacturer: ONSSI
2) Part # IP Licenses as required

k. Encoders for analog cameras (Elevator)

l. Video Transceivers
1) Manufacturer: NVT
2) Part #: NV-214A-M
3) Part #: 8-channel Video Transceiver Hub Model NV-813S Or approved equivalent

m. POE Network Switch
1) Manufacturer: Interlogix
2) Part # 24 Port Switch Giga bit Ethernet Managed switch POE on all 24 Ports 15.5 watts/port, 2 x 1 GB backbone 4 x SFP ports copper.

n. CCTV Monitors
1) Manufacturer: Bosh
2) Part #: LCD 26" High Definition Monitor Model # UML-262-90

19. Ancillary Devices such as cameras, lenses, camera mounts, camera enclosures, recorders, switch gear, etc. shall be compatible with the overall system design intent. All devices and finishes shall be coordinated and approved by the architect prior to installation.
20. Miscellaneous Materials. Provide all cabling, connectors, mounting hardware, interface modules, software, manuals, instructions and miscellaneous items necessary for a complete, fully installed and functional system, ready for the Owner's use.
21. Labeling and documentation of all cables, boxes, devices, and hardware installed under this contract.
22. Testing and test documentation as described below.

2.4 RELATED WORK NOT INCLUDED IN THIS SECTION AND SPECIFIED ELSEWHERE, UNLESS OTHERWISE NOTED.

A. Electrical outlets.

B. Standard electrical boxes with ¾-in conduit stub ups to ceiling.

C. Cutting, patching, and painting.

2.5 WARRANTY

A. Warranty all portions of the work against faulty and improper material and workmanship for a minimum period of one (2) year from date of final acceptance by the Owner. Where warranty for a longer term is offered through a manufacturer/installer certification program, such longer term shall apply.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine pathway elements intended for cables. Check raceways, cable trays, and other elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting installation.

B. Examine roughing-in for cable conduit systems to PCs, Controllers, card readers, and other cable-connected devices to verify actual locations of conduit and back boxes before device installation.

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

3.2 GROUNDING

A. Comply with Division 16 Section "Grounding and Bonding."

B. Comply with IEEE 1100, "Power and Grounding Sensitive Electronic Equipment."

C. Ground cable shields, drain conductors, cabinets and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.

D. Bond shields and drains conductors to ground at only one point in each circuit.

3.3 LABELING/IDENTIFICATION

A. In addition to requirements in this Article, comply with applicable requirements in Division 16 Section "Electrical Identification" and with TIA/EIA-606.

B. Label each terminal strip and screw terminal in each cabinet, rack, or panel.
   1. All wiring conductors connected to terminal strips shall be individually numbered, and each cable or wiring group being extended from a panel or cabinet to a building-mounted device shall be identified with the name and number of the particular device as shown.
   2. Each wire connected to building-mounted devices is not required to be numbered at the device if the color of the wire is consistent with the associated wire connected and numbered within the panel or cabinet.

C. At completion, cable and asset management software shall reflect as-built conditions.

3.4 FIRE STOPPING

A. Seal all penetrations through fire rated walls, floors and walls created by or made on the behalf of the contractor so that the original fire rating of the floor or wall is maintained as required by Article 300-21 of the National Electric Code.

B. Use sealant material that has passed fire exposure testing in accordance with standard time-temperature curve in the standard, UL, ASTM E 119, and NFPA 251 and the hose stream test in accordance with UL 1OB.

3.5 TESTING

A. Test all components installed under the contract.

B. Pre-installation Inspection

1. Visually inspect items and shipping cartons for damage. Return visibly damaged items to the manufacturer.
2. Prior to testing, submit for review and approval copies of test report forms proposed for use. Forms shall, at minimum, contain: Project name; Contractor's name; Date of test; Type and description of test, and test criteria for acceptance.

C. Post Installation Testing
1. Submit Test and Acceptance Plan to owner for approval prior to testing.
2. Test only completed systems. Partial testing is not acceptable.
3. The Consultant reserves the right to observe the conduct of any or all portions of the testing process and to conduct, and to require the Contractor, using the Contractor's equipment and labor, a random re-test.
4. Document all test results and corrective procedures and submit to the Consultant within ten (10) working days of test completion.

3.6 TRAINING

A. User Training.
1. Provide up to 8 hours of system and software training in at least two separate sessions for 2 to 5 members of the owner's staff. Provide an additional follow-up training session of up to two hours within 6 week of final acceptance.
2. All training shall be on the Owner's premises using the installed system.
3. Provide telephone technical support to the Owner for a minimum of one year after acceptance of the system.

B. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain security access system.
1. Develop separate training modules for the following:
   a. Computer system administration personnel to manage and repair the system and databases and to update and maintain software.
   b. Operators who prepare and input credentials to man the control station and workstations and to enroll personnel.
   c. Security personnel.
   d. Hardware maintenance personnel.
   e. Corporate management.

3.7 SYSTEM SOFTWARE

A. Develop, install, configure and test software and databases for the complete and proper operation of systems involved. Assign software license to Owner.

3.8 ACCEPTANCE

A. Once the testing has been completed, as-built and testing documentation delivered to the Owner and the Owner is satisfied that all work is in accordance with the contract documents, the Owner will notify the contractor in writing of the acceptance of the work performed. The date of this acceptance shall constitute the commencement of the warranty period.

3.9 STARTUP SERVICE

A. Engage a factory-authorized service representative to supervise and assist with startup service. Complete installation and startup checks according to approved procedures that were developed in "Preparation" Article and with manufacturer's written instructions.
   1. Prepare and issue access cards and finalized database for Owner's operators, management, and security personnel.
   2. Train security personnel.

END OF SECTION

SECTION 28 31 11

FIRE ALARM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

A. This specification describes an Addressable Voice Fire Detection and Evacuation System capable of networking with the existing MMC Campus system. Provide evacuation alarm tone signaling or pre-recorded messages using sounding devices to sound the alarm evacuation, and strobe lights, including firemen's HVAC override control panel. The system shall be analog addressable, low voltage and modular, with digital communication techniques, in full compliance with all applicable codes and standards.

B. Install, program, test, and deliver to the Owner in fully operational condition including all required hardware, software, raceways and interconnecting wiring as required. The system shall consist of, but not be limited to, the following:

1. Fire Alarm Control Panel (FACP)
2. Fire Alarm System Printers.
3. Addressable Manual Dual Action Fire Alarm Pull Stations.
4. Addressable Analog Duct Smoke Detectors
5. Addressable Area Heat Detectors
6. Addressable Interface and Control Modules.
7. Linear Beam Smoke Detection.
8. Audible and Visual Notification Devices.
9. Hand On-Off-Auto Control Switches for HVAC and/or Purge Systems.
10. Interface Monitoring and/or Control of Fixed Fire Suppression Systems.
11. Magnetic Hold Open Door Release.
12. Security Interface

C. Non-addressable alarm initiating, supervisory and status monitored devices shall be integrated into the fire alarm system, as applicable, via the addressable interface module:

1. Sprinkler water flow alarm (alarm initiating)
2. Sprinkler standpipe water flow (alarm initiating)
3. Sprinkler valve tamper switch (supervisory)
4. Preaction sprinkler system (alarm initiating)
5. Preaction sprinkler system supervisory air - valve tamper alarm (supervisory - two monitoring points)
6. Fire pump status contacts (supervisory), minimum of three monitoring points

7. Emergency generator status contacts (supervisory), minimum of three monitoring points
8. HVAC systems "AUTO-OFF" status (status monitoring).
9. HVAC systems "PURGE ON-AUTO-OFF" (status monitoring), and fire/smoke dampers closure (status monitoring).
10. Magnetic Hold Open Door Release.
11. Security interface.
12. Audible / visual signaling devices and communicating devices to be controlled by the Fire Alarm Control Panel (FACP) and/or Remote System Panels (RSP, transponder panels):
    a. Speakers
    b. Strobe Lights
    c. Combination Speaker-Strobe
    d. Horns
13. Devices to be controlled by the Fire Alarm Control Panel (FACP) and/or Remote System Panels (RSP), programmable relays, and/or addressable interface module relays:
    a. Connections to the appropriate Receiving Agency for manual station alarm, sprinkler alarm, smoke alarm, interfaced suppression system alarm, supervisory and system trouble conditions.
    b. Magnetic door holders release control.
    c. Magnetic door lock release control.
    d. Air handling fan systems alarm shutdown operations.
    e. Special air handling system return fans or exhaust fans used for smoke purge.
    f. Fire/smoke dampers operations.
    g. Elevator controls for elevator recall.
    h. Elevator shaft smoke hatch/vent release control.

D. Prior to the commencement of work, obtain all permits necessary for installation of the work. All permit costs and inspections fees shall be included as part of the required work. After completion of work, notify all authorities having jurisdiction.

E. Local requirements shall be adhered to with regard to submitting specifications, wiring diagrams, shop drawings and plans. Responsibility for furnishing the quantities of copies on mylar and/or paper, as directed by such requirements, shall be included as part of the work of this Section.

F. Submit a letter of approval of the installation, from the local code authority, before requesting final acceptance of the system.

G. Related Sections include the following:

1. Division 8 Section "Hardware" for door closers/holders/smoke detectors, electric door locks, and release devices that interface with fire alarm systems.
2. Wire and Cable.
3. Raceways.

H. Coordinate with the mechanical contractor for installation of duct mounted smoke detectors and interface with motor controls.

I. Coordinate with fire protection contractor for interface with fire protection devices and coordinate with elevator contractor for interface with terminal recall relay.

J. Coordinate with the Architect for final locations and appearance of devices.

K. Electronic component models must have been commercially available for at least one year prior to bid.

1.3 SUBMITTALS

A. Prior to the start of work, provide a complete and comprehensive submittal for review. Describe the proposed system and its equipment. Failure to provide a complete submittal shall be grounds for rejection of submission. Submittal shall include, but not be limited to, all of the following material:

1. Battery capacity: Minimum of 125% of the operating requirement.
2. Power requirements for all equipment: Minimum 25% spare capacity.

B. Shop Drawings: Show details of graphic annunciator.

1. Drawing or catalog page showing actual dimensions of system components.
2. Single line riser diagram showing all equipment, all connections and number and size of all conductors and conduits.
3. Wiring Diagrams: Detail wiring, differentiate between manufacturer-installed and field-installed wiring.
4. Provide samples when so requested by the Engineer.
5. Floor Plans: Indicate final outlet locations and raceway routing.
6. Device Address List: Coordinate with final system programming.
7. System Operation Description: Detailed description for this specific Project, including method of operation and supervision of each type of circuit and sequence of operations for manually and automatically initiated system inputs and outputs. Manufacturer's standard descriptions for generic systems are not acceptable.

C. Product Certificates: Signed by manufacturers of system components certifying that products furnished comply with requirements.

D. Field Test Reports: Comply with NFPA 72.

E. Maintenance Data: Comply with NFPA 72.

F. Submissions to Authorities Having Jurisdiction: In addition to distribution requirements for Submittals specified in Division 1 Section "Submittals," make an identical submission to authorities having jurisdiction. Include copies of annotated Contract Drawings to depict component locations to facilitate review. On receipt of comments from authorities having jurisdiction, submit them to Architect for review.

G. Certificate of Completion: Comply with NFPA 72.

H. Provide the address, telephone number, and contact person(s) of the manufacturer's local service facility for normal and off hour warranty issues.

I. Provide a fire alarm system input output function matrix. Matrix shall illustrate alarm output events in association with initiating devices input events. Include any and all departures, exceptions, variances or substitutions from these specifications and/or project drawings at the time of bid.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: A firm experienced in manufacturing systems similar to those indicated for this Project and with a record of successful in-service performance.

B. Installer Qualifications: An experienced installer who is an authorized representative of the manufacturer for both installation and maintenance of units required for this Project.

C. Source Limitations: Obtain fire alarm system components through one source from a single manufacturer.

D. Comply with applicable building code, local ordinances and regulations, and requirements of authorities having jurisdiction.

E. Comply with NFPA 72 and NFPA 70 Article 760.

F. Comply with NFPA 90A, Air Conditioning and Ventilation Systems.

G. Fire alarm system shall be UL listed.

H. Submit three copies of all required Licenses and Bonds.

1.5 SEQUENCING AND SCHEDULING

A. Existing Fire Alarm Equipment: Maintain fully operational until new equipment has been tested and accepted. As new equipment is installed, label it "NOT IN SERVICE" until it is accepted. Remove labels from new equipment when put into service and label existing fire alarm equipment "NOT IN SERVICE" until removed from the building.

B. Equipment Removal: After acceptance of the new fire alarm system, remove existing fire alarm equipment and restore damaged surfaces.

1. Package operational and label fire alarm and detection equipment that has been removed and deliver to Owner.
2. Remove from site and legally dispose of existing material not designated for other disposition.

1.6 EXTRA MATERIALS

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

1. Lamps for Remote Indicating Lamp Units: Quantity equal to 10 percent of amount installed, but not less than one unit.
2. Lamps for Strobe Units: Quantity equal to 10 percent of amount installed, but not less than one unit.

3. Smoke Detectors, Fire Detectors, and Flame Detectors: Quantity equal to 10 percent of amount of each type installed, but not less than one unit of each type.
4. Detector Bases: Quantity equal to 2 percent of amount of each type installed, but not less than one unit of each type.
5. Printer Ribbons: Six spares.
6. Keys and Tools: One extra set for access to locked and tamperproofed components.

1.7 COORDINATION

A. Coordinate work in this Section with all related trades.

B. Air handling system, smoke exhaust fan and smoke damper control circuits shall be wired and connected to the fire alarm system.

C. Sprinkler water flow alarm and valve tamper switches shall be wired and connected to the fire alarm system.

D. Elevator recall control equipment shall be wired and connected to the fire alarm system.

E. Elevator shaft smoke hatch/vent control equipment shall be wired and connected to the fire alarm system.

F. Fire watch responsibilities: Fire watch responsibilities shall be coordinated with the owner.

1.8 PERMITS AND FEES

A. The Contractor shall give necessary notice, file drawings and specifications with the department having jurisdiction, obtain permits or licenses necessary to carry out this work and pay all fees therefor. The Contractor shall arrange for inspection and tests of any or all parts of the work if so required by authorities and pay all charges for same. The Contractor shall pay all costs for, and furnish to the Owner before final billing, all certificates necessary as evidence that the work installed conforms with all regulations where they apply to this work.

B. This contractor shall prepare or hire the necessary consultants to prepare and file all plans, calculation, forms, etc.. required for filing with all agencies required for this work. including but not limited to the Portland Fire Dept, etc

1.9 INSPECTIONS / TESTING

A. Independent testing and inspections shall be provided by this contractor who shall hire the inspector or testing agency

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work included, but are not limited to, the following:

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

1. Siemens (Fire Finder XLSV).
2. Edwards Systems Technology; Unit of General Signal (ETS-3).
3. Honeywell, Inc. (XLS 1000).
4. Notifier; Div. of Pittway Corp. (NFS 3030).

2.2 STANDARDS AND CODES

A. All equipment shall be installed and complied with the current adopted provisions of the applicable electrical and building codes, and following codes and standards listed in 2.06.B (below).

B. All equipment shall be UL listed for its intended use, as a minimum, the following standards shall apply:

1. Underwriters Laboratories Standards
   a. UL 228 - Door Holders for Fire Protective Signaling Systems.
   b. UL 268 and 268A-Smoke Detectors for Fire Protective Signaling Systems-Duct Application.
   c. UL 346 - Waterflow Indicators for Fire Protective Signaling Systems.
   d. UL 464 - Audible Signaling Appliances.
   e. UL 864 - Control Units for Fire Protective Signaling Systems.
   f. UL 1480 - Speakers for Fire Protective Signaling Systems.
   g. UL 1481 - Power Supplies for Fire Protective Signaling Systems.
   h. UL 1971 - Signaling Devices for the Hearing Impaired.
   i. UUKL – Smoke Control.
2. National Fire Protection Association Standards.
   a. NFPA No. 13 - Sprinkler Alarm and Supervision.
   b. NFPA No. 20 - Fire Pump Supervision.
   c. NFPA No. 70 - National Electrical Code.
   d. NFPA No. 72 – National Fire Alarm Code.
   e. NFPA No. 90A - Installation of Air Conditioning & Ventilating Systems.
   f. NFPA No. 101 - Life Safety Code

C. All devices being reused, where permitted, shall be UL cross listed with the fire alarm system; otherwise, new devices are required. Submit approval documents.

D. The fire alarm system and its installation shall comply with all other local codes and authorities having jurisdiction, including but not limited to, owners engineering design guidelines.

E. The fire alarm system and its installation shall comply with all applicable requirements of the Americans With Disabilities Act (ADA), in areas of new work.

2.3 FUNCTIONAL DESCRIPTION OF SYSTEM

A. Basic System Equipment, Circuiting, Addressing and Operating Capabilities

1. The Fire Command Station, remote control modulation panels shall communicate via a RS-485, Multiple Access Protocol: Carrier Sense, Multiple Access, Collision Detect, also known as CSMA/CD an ETHERNET type protocol network. System modulation panels shall be connected as network "nodes". Network data communication wiring shall be NFPA Standard 72 Class A, Style 7, two-circuit system, wherein a single open, single ground or wire-to-wire short shall not degrade the network operation.
2. FACP shall provide NFPA 72, Class B, Style 4. Connect no more than 80% of the maximum number of devices allowed on any addressable loop.
3. System power supplies, including necessary transformers rectifiers, regulators, filters and surge protection required for system operation, with the capacity to power the system in a worst case condition with all devices in alarm and all local indicating appliances active without exceeding the listed ratings. All system devices shall display normal and alarm conditions consistently whether operating from normal power or reserve (standby) power.
4. System primary power: Primary power for the FACP and the secondary power battery chargers shall be obtained from dedicated emergency power circuits. Fuse cut-outs shall protect each circuit. Each cut-out shall be two (2) pole with a solid neutral. Each circuit used for fire alarm purposes shall be permanently labeled for function.
5. Secondary power supply: Provide sealed gelled electrolyte batteries as the secondary power supply for all fire alarm functions. The battery supply shall be calculated to operate loads in a supervisory mode for twenty four (24) hours for proprietary and central station systems, sixty (60) hours for municipal or remote supervisory systems, with no primary power applied, and after that time, operate in alarm mode for fifteen (15) minutes.
6. Provide battery charging circuitry for each standby battery bank.
7. Total system response time shall not exceed 2.5 seconds on a system configured to maximum capacity. All system processors shall be supervised by individual watchdog circuitry furnishing automatic restart after loss of activity. Systems with single watchdog circuits for all processors shall not be acceptable. Provide digital communication capabilities for the control panel to communicate with remote annunciators, input/output drivers and displays.
8. Where multiple visual signals are visible from any location, circuitry shall be incorporated for the synchronization of flash rate. Maintain a minimum of 40% spare capacity in each strobe circuit. Include one (1) additional circuit per floor, plus one (1) additional circuit per stack area as spare.
9. System shall be configured to provide the following types of alarm sounding and communicating devices with NFPA 72, Class A, supervised, alarm indicating appliance (signal) and/or communicating circuits, as follows:
    a. General floor audible notification appliance circuits shall consist of two (2) circuits. Circuits shall be installed in an alternate style, so that 50% of the audible devices installed would be operationally functional should one circuit fail.
    b. Two separate notification circuits, alternating, shall be provided on both sides of floor smoke partitions intended to be utilized for horizontal egress.
    c. In no case shall audible or visual circuits serve more than one floor area.

10. System shall provide support for Firefighter Smoke Control Panel status indicators and control switches for the following functions:
    a. Smoke control fans.
    b. Status indicators for sprinkling system water flow and valve supervisory devices.
    c. Any additional status or control functions as indicated on the drawings, including but not limited to, emergency generator functions, fire pump functions, door unlocking and security with bypass capabilities.
    d. Purge fan units by floor and/or fire area.
    e. Fire and/or smoke dampers.
11. HVAC supply-exhaust units, purge units, fire and smoke dampers shall be provided with a "HAND OFF-ON-AUTO" switch module with LED indicators. LED indication shall be red for “OFF”, green for “ON” and amber for monitoring circuit integrity.
12. Smoke detectors shall alarm at their programmed sensitivity settings.
13. Software and Firmware Control:
    a. All software and firmware provided with a fire alarm system shall be listed for use with the fire alarm control unit.
    b. A record of installed software and firmware version numbers shall be maintained at the location of the fire alarm control unit.
    c. All software and firmware shall be protected from unauthorized changes through the use of "access levels."

B. System Alarm Operation – Private Mode of Operation

1. Activation of any addressable activation or interface device shall cause the following functions and indications:
    a. Activate “ALARM” notification to the FACP (CD, remote annunciators) computer terminal display indicating device address, type, location, time and date. Activate red flashing device symbol on the CRT terminals.
    b. Activate “ALARM” notification to the appropriate receiving agency and/or on site location as shown on the drawings.
    c. The pre-signal alert tone shall sound. Tone shall be a 900 Hz tone pulsed to produce one round of code 4 at approximately one second intervals. All audible and visual notification alarms on all floors throughout the building will be activated. Alarms shall be heard clearly by all occupants throughout building, including elevators. All visual signals shall flash throughout the building in a synchronized fashion.
    d. A pre-recorded message shall activate regarding the evacuation procedure. The message shall be a female voice and contain the following:
    e. “Attention please. The signal tone you have just heard indicated a report of an emergency in this building in zone XY. If your floor evacuation signal sounds after this message, walk to the nearest stairway and leave the floor. While the report is being verified, occupants on other floor should wait further instructions”. NOTE: (X is the floor and Y is the zone of a floor).
    f. This message shall repeat three times.
    g. Activate the evacuation signal on the floor of incident, floor below floor of incident and the floor above incident.
    h. Activate smoke control systems. (manual pull stations shall not active smoke control).

i. Activate fire emergency HVAC operational shutdowns and/or purge requirements.
j. Annunciate alarm notification on remote annunciators.
k. Record all events at the system alarm printer.
l. Release all magnetically held doors.
m. Unlock all magnetically locked doors.
n. Record event to the system historical log.
o. Activate the associated device alarm LED alarm indicator.
p. Actuation shall also cause an additional visual and audible annunciation in the elevator cab and required annunciators to alert all building occupants, fire fighters, and other emergency personnel that the elevators are no longer safe to use.

2. Elevator lobby smoke detectors shall sound an alarm on the floor of activation and the floor above the floor of activation. All elevator lobbies shall have one smoke detector utilizing alarm verification.
   a. Upon first activation of the smoke detector, an alarm condition shall be noted on the fire alarm control panel and at any remote annunciation panels, no system audible indication.
   b. Upon the re-activation of the smoke detector, an alarm shall be sounded on the floor of activation and the floor above activation and all elevators shall be recalled to a designated floor.
3. Elevator machine room smoke detectors shall sound an alarm on the floor of activation and if there is no other floor above the floor of the elevator machine room, then the floor below the elevator machine room shall also sound an alarm. All elevator machine rooms shall utilize smoke detectors with alarm verification similar to the Elevator lobby operation above.
4. Alarm activation of an elevator lobby smoke detector, elevator machine room smoke detector or any single elevator shaft smoke detector shall automatically:
   a. Provide those automatic alarm functions as described above.
   b. Shall cause the recall of that bank of elevators to the terminal floor and the lockout of controls. In the event of recall initiation by detector(s) in the first floor lobby, the recall shall be to the alternate floor.
   c. Elevator recall activation shall also cause activation of all required hoist-way vents to open and mechanical ventilation fans to operate in fire emergency smoke evacuation mode.
5. Alarm activation of any heat detector/sensor in the elevator shaft or machine room shall, after field settable timed delay, activate shunt-trip device to disconnect power from elevator and elevator cab lighting.

C. System Supervisory Functions:

1. Activation of any supervisory circuit shall cause the following actions and indications:
   a. Activate “SUPERVISORY ALARM” notification to the FACP computer terminal display indicating device address, device type, device location, time and date. Activate yellow flashing device symbol on the graphic terminal.
   b. Activate “SUPERVISORY ALARM” notification to the appropriate receiving agency and/or on site location as shown on the drawings.
   c. Annunciate alarm notification on system remote annunciators.

d. Audible signals shall be silence able from the control panel by an acknowledge switch.
e. Record within system history, the occurrence of the event, the time of occurrence and the device initiating the event.
f. Record all events at the system alarm printer.

D. System Trouble Functions

1. Receipt of a system trouble alarm, shall cause the following actions and indications similar to "System Supervisory Functions" above.
2. The fire alarm system wiring (except control wiring to fans, dampers, 120Vac door holders) shall be electrically supervised to automatically detect and report trouble conditions to the FACP.
   a. Any opens or grounds shall initiate a system trouble condition.
   b. System addressable devices shall be supervised for placement and normal operation. Removal of an addressable device or the failure of its internal electronic circuitry shall initiate a system trouble condition.
   c. The following FACP and/or remote transponder control panels shall initiate a system trouble condition when the following occurs:
      1) Primary 120/220 VAC power loss.

      2) Battery disconnect.

      3) Battery low voltage.

      4) FACP remote transponder or graphic LCD annunciator panel power loss.

      5) FACP primary alarm printer power loss.

   d. Operating a central station agency alarm disconnect switch, or any manual control commands that alter the system from its normal programmed standby configuration shall initiate a trouble condition.
   e. Trouble conditions shall automatically activate an audible signal and flash the general system trouble LED indicator at the FACP. Pressing the trouble acknowledge key on the FACP shall silence the audible signal and continuously light the LED indicator, until the trouble condition is repaired. Subsequent trouble conditions shall resound the audible signal and again flash the LED. Each trouble condition must be individually acknowledged.
   f. Removal of or failure of internal electronic circuitry of any addressable device shall initiate a system trouble condition.
3. One-Way Voice Communication
   a. The fire alarm tone signal, alert tone signal and live voice announcements shall be capable of being manually transmitted from the FACP to any speaker circuit (including elevators), selected speaker circuits or all speaker circuits by manual selection of the associated speaker circuit control switches.
   b. Manual override, for live voice announcements, via the hand-held microphone and speaker circuit control switches shall take priority over any and all alarm tone signals or alert tone signals, including all stack area bells and horns.

c. Alarm speaker amplification equipment shall be sized to provide two (2) watts of input power to each speaker shown on the Drawings, with the allowance of fifty percent (50%) spare capacity in the system to permit the addition of future alarm speakers.
d. One (1) back-up alarm speaker amplifier shall be provided for the system or at each distributed amplifier location. If any primary alarm speaker amplifier fails, its function shall be taken over by the backup amplifier.

4. System Supervision For Trouble Conditions
   a. The fire alarm system wiring (except control wiring to fans, door holders, etc.) shall be electrically supervised to automatically detect and report trouble conditions to the FACP.
   b. Any opens or grounds on Monitor Addressable Module alarm initiating or supervisory circuit wiring and any opens, grounds or shorts across MAPNET addressable data communications, remote annunciator panel data communications, alarm signal, alarm speaker, Warden telephone or alarm strobe light circuit wiring shall initiate a system trouble condition.
5. Fire Alarm Control Panel (FACP) relays, system transponder panel relays and Control Zone Addressable Module relays shall be provided to connect to and provide fire alarm system control of associated equipment such as central station transmitter connections and door holders. Assignment of individual relays for control operation shall be accomplished during the programming of the FACP central processing unit (CPU) software. Each of the following types of remote equipment shall be provided with a control relay typically as follows or indicated on plans:
   a. Central station agency connections: Provide five (5) contacts (manual station alarm condition, sprinkler alarm condition, smoke alarm condition, system supervisory off-normal condition and system trouble condition) for connection to the central station agency transmitter.
   b. Magnetic door holders: Provide one (1) release control contact for magnetic door holders.
   c. Duct smoke sensor addressable relays and addressable relays shall be provided to connect to and provide fire alarm system control of remote equipment such as air handling systems, elevator controls, etc. Each relay shall be individually addressable and provide double-pole, double-throw (DPDT) contacts fused at two Amperes (2.0 A.) @ 120 VAC or 28 VDC (Non-inductive). Assignment of individual relays for control operation shall be accomplished during the programming of the FACP central processing unit (CPU) software.
6. The FACP shall provide each of the following types of equipment and circuits associated with the fire alarm system with a manual control switch, as required by the functional requirements of these Specifications, which shall be typically as follows:
   a. Central station alarm disconnect: Provide one (1) switch with one (1) green, "ACTIVATED" status LED indicator to disable the central station alarm transmission function.
   b. Central station alarm transmit: Provide one (1) switch with one (1) green, "ACTIVATED" status LED indicator to initiate the transmission of an alarm signal to the central station agency.

c. Alarm speaker circuits: Provide one (1) control switch for each floor and stack area.
d. Warden telephone circuits: Provide one (1) control switch for each Warden telephone circuit.

E. Conductors

1. Each conductor shall be identified with wire markers at terminal points. Attach permanent VISIBLE wire markers within 2 inches of the wire termination.
2. All wiring shall be code compliant and in conduit.
3. Vertical conductors shall be within fire rated chases or be UL listed two hour fire rated cable installed per manufacturer's requirements.
4. Wiring for analog loop circuits, conventional detection circuits and telephone circuits shall be per fire alarm manufacturer's wiring requirements, but shall not be smaller then #14 AWG.
5. Conductor size shall be increased as required so as to limit voltage drop to a maximum of 2.5%.
6. Splices are not permitted except at termination devices and then shall be made with UL listed mechanical connectors.
7. Crimp-on type spade lugs shall be used for terminations of stranded conductors. Spade lugs shall have upset legs and insulation sleeves sized for the conductors.
8. Wire nuts or other solder-less splicing devices shall not be used.
9. Provide a consistent color code for fire alarm system conductors. Submit for approval prior to installation of wire, a proposed color code for system conductors.
10. Color coding of all system wiring shall be in accordance with state and local codes.
11. All nominal voltage branch circuit power feeds (120/208 VAC) shall be identified "labeled" at both ends of the circuit indicate its source and purpose.
12. Wiring within system control panels shall be arranged and routed to allow accessibility to equipment for adjustment and maintenance and to isolate nominal voltage wiring from system low voltage wiring.
13. Splices in electrical conductors in vertical risers are prohibited except when the length of conductors exceeds 150 feet in vertical risers, in which case terminal cabinet shall be used.

2.4 MANUAL PULL STATIONS

A. Description: Fabricated of metal and finished in red with molded, raised-letter operating instructions of contrasting color.

1. Single-action mechanism initiates an alarm.
2. Double-action mechanism requires two actions, such as a push and a pull, to initiate an alarm.
3. Station Reset: Key or wrench operated; double pole, double throw; switch rated for the voltage and current at which it operates.
4. Indoor Protective Shield: Factory-fabricated clear plastic enclosure, hinged at the top to permit lifting for access to initiate an alarm. Lifting the cover actuates an integral battery-powered audible horn intended to discourage false alarm operation.

5. Weatherproof Protective Shield: Factory-fabricated clear plastic enclosure, hinged at the top to permit lifting for access to initiate an alarm.
6. Integral Addressable Module: Arranged to communicate manual-station status (normal, alarm, or trouble) to the FACP.

2.5 SMOKE DETECTORS

A. General: Include the following features:

1. Operating Voltage: 24-V dc, nominal.
2. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
3. Plug-in Arrangement: Detector and associated electronic components are mounted in a module that connects in a tamper-resistant manner to a fixed base with a twist-locking plug connection. Terminals in the fixed base accept building wiring.
4. Integral Visual-Indicating Light: LED type. Indicates detector has operated.
5. Sensitivity: Can be tested and adjusted in-place after installation.
6. Remote Controllability: Unless otherwise indicated, detectors are analog-addressable type, individually monitored at the FACP for calibration, sensitivity, and alarm condition, and individually adjustable for sensitivity from the FACP.

B. Photoelectric Smoke Detectors: Include the following features:

1. Sensor: LED or infrared light source with matching silicon-cell receiver.
2. Detector Sensitivity: Between 2.5 and 3.5 percent/foot smoke obscuration when tested according to UL 268A.
3. Integral Thermal Detector: Fixed-temperature type with 135 deg F setting.

C. Ionization Detector: Include the following features:

1. Responsive to both visible and invisible products of combustion.
2. Self-compensating for changes in environmental conditions.

D. Beam-Type Smoke Detector: Each detector consists of a separate transmitter and receiver with the following features:

1. Adjustable Sensitivity: More than a six-level range, minimum.
2. Linear Range of Coverage: 600 feet, minimum.
3. Tamper Switch: Initiates trouble signal at the central FACP when either transmitter or receiver is disturbed.
4. Separate Color-Coded LEDs: Indicate normal, alarm, and trouble status. Any detector trouble, including power loss, is reported to the central FACP as a composite "TROUBLE" signal.

E. Duct Smoke Detector: Photo-Electric.

1. Sampling Tube: Design and dimensions as recommended by the manufacturer for the specific duct size, air velocity, and installation conditions where applied.
2. Relay Fan Shutdown: Rated to interrupt fan motor-control circuit.

2.6 OTHER DETECTORS

A. Heat Detector, Combination Type: Actuated by either a fixed temperature of 135 deg F or rate of rise of temperature that exceeds 15 deg F per minute, unless otherwise indicated.

1. Mounting: Adapter plate for outlet box mounting.
2. Mounting: Plug-in base, interchangeable with smoke detector bases.
3. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the FACP.

B. Heat Detector, Fixed-Temperature Type: Actuated by temperature that exceeds a fixed temperature of 190 deg F.

1. Mounting: Adapter plate for outlet box mounting.
2. Mounting: Plug-in base, interchangeable with smoke detector bases.
3. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to the FACP.

2.7 NOTIFICATION APPLIANCES

A. Description: Equip for mounting as indicated and have screw terminals for system connections.

1. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly.

B. Visible Alarm Devices: Xenon strobe lights listed under UL 1971 with clear or nominal white polycarbonate lens. Mount lens on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch- high letters on the lens.

1. Strobes shall produce a flash rate of one flash per second minimum per the listed input voltage (20 VDC – 31 VDC) range.
2. Rated Light Output: 75 candela.
3. Rated Light Output: 110 candela.
4. Strobe Leads: Factory connected to screw terminals.

C. Voice/Tone Speakers:

1. High-Range Units: Rated 2 to 15 W.
2. Low-Range Units: Rated 1 to 2 W.
3. Mounting: Flush, semirecessed, surface, or surface-mounted; bidirectional as indicated.
4. Matching Transformers: Tap range matched to the acoustical environment of the speaker location.

2.8 REMOTE DEVICE LOCATION-INDICATING LIGHTS AND IDENTIFICATION PLATES

A. Description: LED indicating light near each smoke detector that may not be readily visible, and each sprinkler water-flow switch and valve-tamper switch. Light is connected to flash when the associated device is in an alarm or trouble mode. Lamp is flush mounted in a single gang wall plate. A red, laminated, phenolic-resin identification plate at the indicating light identifies, in engraved white letters, device initiating the signal and room where the smoke detector or valve is located. For water-flow switches, the identification plate also designates protected spaces downstream from the water-flow switch.

2.9 MAGNETIC DOOR HOLDERS

A. Description: Units are equipped for wall or floor mounting as indicated and are complete with matching door plate.

1. Electromagnet: Requires no more than 3 W to develop 25-lbf holding force.
2. Wall-Mounted Units: Flush mounted, unless otherwise indicated.
3. Rating: 120-V ac.

B. Material and Finish: Match door hardware.

2.10 CENTRAL FACP

A. Cabinet: Lockable steel enclosure. Arrange interior components so operations required for testing or for normal maintenance of the system are performed from the front of the enclosure. If more than one unit is required to form a complete control panel, fabricate with matching modular unit enclosure to accommodate components and to allow ample gutter space for field wiring and interconnecting panels.

1. Identify each enclosure with an engraved, red, laminated, phenolic-resin nameplate with lettering not less than 1 inch high. Identify individual components and modules within cabinets with permanent labels.
2. Mounting: Flush.
3. Mounting: Surface.

B. Alarm and Supervisory Systems: Separate and independent in the FACP. Alarm-initiating zone boards consist of plug-in cards. Construction requiring removal of field wiring for module replacement is unacceptable.

C. Control Modules: Include types and capacities required to perform all functions of fire alarm systems.

D. Indications: Local, visible, and audible signals announce alarm, supervisory, and trouble conditions. Each type of audible alarm has a different sound.

E. Indicating Lights and System Controls: Individual LED devices identify zones transmitting signals. Zone lights distinguish between alarm and trouble signals, and indicate the type of device originating the signal. Manual switches and push-to-test buttons do not require a key to operate. Controls include the following:

1. Alarm acknowledge switch.
2. Alarm silence switch.
3. System reset switch.
4. LED test switch.

F. Resetting Controls: Prevent the resetting of alarm, supervisory, or trouble signals while the alarm or trouble condition still exists.

G. Alphanumeric Display and System Controls: Arranged for interface between human operator at the FACP and addressable system components, including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.

1. Display: Liquid-crystal type, 40 characters, minimum.

2. Keypad: Arranged to permit entry and execution of programming, display, and control commands.

H. Alphanumeric Display and System Controls: Arranged for interface between human operator at the FACP and addressable system components, including annunciation, supervision, and control.

1. Display: A minimum of 80 characters; alarm, supervisory, and component status messages; and indicate control commands to be entered into the system for control of smoke detector sensitivity and other parameters.
2. Keypad: Arranged to permit entry and execution of programming, display, and control commands.

I. Voice Alarm: An emergency communication system, includes central voice alarm system components complete with microphones, preamplifiers, amplifiers, and tone generators. Features include the following:

1. Two alarm channels permit simultaneous transmission of different announcements to different zones or floors automatically or by using the central control microphone. All announcements are made over dedicated, supervised communication lines.
2. Status annunciator indicates the status of various voice alarm speaker zones and the status of firefighters' two-way telephone communication zones.

J. Instructions: Printed 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.

2.11 REMOTE ANNUNCIATOR

A. Description: Duplicate annunciator functions of the FACP for alarm, supervisory, and trouble indications. Also duplicate manual switching functions of the FACP, including acknowledging, silencing, reset, and test.

1. Mounting: Flush cabinet, NEMA 250, Class 1.
2. Mounting: Surface cabinet, NEMA 250, Class 1.

B. Display Type and Functional Performance: Individual LED for each type of alarm and supervisory device, and LEDs to indicate "NORMAL POWER" and "TROUBLE."

1. An alarm or supervisory signal causes the illumination of a zone light, floor light, and device light.
2. System trouble causes the illumination of all lights above and also the trouble light.
3. Additional LEDs indicate normal and emergency power modes for the system.
4. A test switch tests LEDs mounted on the panel. Switch does not require key operation.

C. Display Type and Functional Performance: Alphanumeric display same as the FACP. Controls with associated LEDs permit acknowledging, silencing, resetting, and testing functions for alarm, supervisory, and trouble signals identical to those in the FACP.

D. Graphic Display Panel for Remote Annunciator: Wall-mounted engraved panel indicating the building floor plan with a "YOU ARE HERE" designation. Engrave zone, area, and floor designations on the face of the panel.

1. Materials: Satin-finished stainless steel or brushed aluminum.
2. Floor Plan and Zone Boundary Lines: Engraved in the surface and filled with colored paint. Floor plan lines are black and 1/4 inch wide; zone boundaries are red and 1/8 inch wide.
3. Engraved Legends: 1/4-inch- high minimum, in letters filled with red paint.
4. Mounting: Integral with lamp-type annunciator. Locate zone lamps in the floor plan zones they represent.
5. Mounting: Adjacent to remote annunciator.

2.12 EMERGENCY POWER SUPPLY

A. General: Components include valve-regulated, recombinant lead acid battery; charger; and an automatic transfer switch.

1. Battery Nominal Life Expectancy: 10 years, minimum.

B. Battery Capacity: Comply with NFPA 72.

1. Magnetic door holders are not served by emergency power. Magnetic door holders are released when normal power fails.

C. Battery Charger: Solid-state, fully automatic, variable-charging-rate type. Provide capacity for 150 percent of the connected system load while maintaining batteries at full charge. If batteries are fully discharged, the charger recharges them completely within four hours. Charger output is supervised as part of system power supply supervision.

D. Integral Automatic Transfer Switch: Transfers the load to the battery without loss of signals or status indications when normal power fails.

2.13 ADDRESSABLE INTERFACE DEVICE

A. Description: Microelectronic monitor module listed for use in providing a multiplex system address for listed fire and sprinkler alarm-initiating devices with normally open contacts.

B. Integral Relay: Capable of providing a direct signal to the elevator controller to initiate elevator recall or to a circuit-breaker shunt trip for power shutdown.

2.14 DIGITAL ALARM COMMUNICATOR TRANSMITTER

A. Listed and labeled under UL 864 and NFPA 72.

B. Functional Performance: Unit receives an alarm, supervisory, or trouble signal from the FACP panel, and automatically captures one or two telephone lines and dials a preset number for a remote central station. When contact is made with the central station(s), the signal is transmitted. The unit supervises up to two telephone lines. Where supervising two lines, if service on either line is interrupted for longer than 45 seconds, the unit initiates a local trouble signal and transmits a

signal indicating loss of telephone line to the remote alarm receiving station over the remaining line. When telephone service is restored, unit automatically reports that event to the central station. If service is lost on both telephone lines, the local trouble signal is initiated.

C. Secondary Power: Integral rechargeable battery and automatic charger. Battery capacity is adequate to comply with NFPA 72 requirements.

D. Self Test: Conducted automatically every 24 hours with report transmitted to central station.

2.15 NETWORK INTERFACE

A. Provide a network interface card to allow full network capability with the existing campus system.

2.16 SYSTEM PRINTER

A. Description: Listed and labeled as an integral part of the fire alarm system.

2.17 FIRE FIRGHTERS OVERRIDE PANEL

A. Description

1. The Fire Fighters Override Panel (FFOP) shall be located in the fire command center and shall allow fire department personnel to monitor and manually control the automatic smoke control system provided for the building.
2. The FFOP shall conform to the requirements of the Applicable Building Code and the latest edition of NFPA 92A "Smoke Control Systems".
3. The FFOP shall have the highest priority control over all smoke control systems and equipment. Where manual controls are also provided at other building locations for control of smoke control systems, the control mode selected from the FFOP shall prevail. FFOP control shall override or bypass other building controls such as the hand and auto positions of Hand-Off-Auto, and Start/Stop switches located on fan motor controllers, freeze detection devices, and duct smoke detectors. FFOP control shall not override or bypass devices and controls intended to protect against electrical overloads, provide for personnel safety, and prevent major system damage. These include overcurrent protection devices and electrical disconnect switches, high limit static pressure switches, and combination fire/smoke damper closure control that would preclude that response to heat beyond the required UL 33, Standard for Heat Responsive Links for Fire Protection Services, heat responsive link, for UL 555S, Standard for Leakage Rated Dampers for Use in Smoke control Systems, operator/actuator degradation temperature classifications.
4. The FFOP fan control capability shall not bypass switches located on motor controllers of non-dedicated smoke control system fans..
5. The fire fighters' override panel shall contain a building diagram provided by Mechanical Engineering and Design that clearly indicates the type and location

of all smoke control equipment (fans, dampers, etc.). The building areas affected by the equipment shall also be clearly indicated

6. A real time status of the systems and equipment that are activated or are capable of activation for smoke control shall be clearly indicated at the fire fighters' smoke control station.
7. Status indication shall include on and off status of each individual fan used for smoke control. "ON" status shall be sensed by pressure difference or proof of amp draw of a motor under load (adjusted for a drive belt failure).
8. Status indication of open, closed, opening and closing shall be provided for each damper involved in smoke control.
9. The FFOP shall be supplied with UL listed factory interface driver cards mounted internal to the FFOP to form a single UL listed assembly for processing and logic utilizing defined factory programmable logic and parameters. Systems that employ 3rd party logic controllers or PLC drivers and interface to the FACP via Monitor and Relay points shall not be permitted or be provided with certification of UL listed of use in unison and documentation showing required interfaces and hardware for consideration of use prior to submission.
10. The FFOP shall be GL8 Series by Space-Age Electronics.

B. Physical Arrangement

1. The FFOP shall be designed to depict graphically the physical building arrangement, smoke control systems and equipment, and the areas served by the equipment.
2. Following is a summary of the status indicators and smoke control capability applicable to the FFOP smoke control graphic(s).
   a. Status indicators shall be provided for all smoke control equipment by pilot lamp-type indicators as follows:
      i. Smoke control fans and other critical operating equipment in the confirmed operating status shall be green, red, shall indicate off.
      ii. Smoke control equipment and other critical equipment that may have two or more states or positions, such as dampers shall be green (i.e., open) and red (i.e., closed), flashing green (i.e., opening), and flashing red (i.e. closing).
      iii. Smoke control system or equipment faults shall be yellow.
      iv. Normal status (no fault, HOA in auto) shall be indicated by a white lamp.
   b. The position of each piece of equipment shall be indicated by lamps and appropriate legends.
   c. Provisions for testing the pilot lamps on the FFOP smoke control panel(s) by means of one "LAMP TEST" momentary push button or other self-restoring means shall be included.

C. Smoke Control Capability

1. The FFOP shall provide control capability over all smoke controls system equipment within the building as follows:

   a. ON-AUTO-OFF control over each individual piece of operating smoke control equipment that can also be controlled from other sources within the building. This includes smoke exhaust fans; HVAC supply, return, and exhaust fans, elevator shaft fans; atrium supply and exhaust fans; and any other operating equipment used or intended for smoke control

purposes shown on the smoke control matrix and/or sequences of operation.

b. ON-OFF or OPEN-CLOSE control over all smoke control and other critical equipment associated with a fire or smoke emergency and that can only be controlled from the FFOP.

c. OPEN-AUTO-CLOSE control over all individual dampers relating to smoke control and that are also controlled from other sources within the building.

d. HVAC terminal units, such as VAV boxes that are all located within and serve one designated smoke control zone, shall be controlled collectively in lieu of individually.

D. Control Action and Priorities

1. The FFOP control action shall be as follows:

a. ON-OFF, OPEN-CLOSE - These control actions have the highest priority of any control point within the building. Once issued from the FFOP, no automatic or manual control from any other control point within the building shall override the FFOP control action.

b. Where automatic means is provided to interrupt normal non-emergency equipment operation or produce a specific result to safeguard the building or equipment (i.e., duct freezestats, duct smoke detectors, cutouts, and similar devices), such means shall be capable of being overridden by the FFOP control action and the last control action indicated by each FFOP switch position shall prevail.

c. AUTO - Only the AUTO position of each 3-position FFOP control shall allow automatic or manual control action from other control points within the building. The AUTO position shall be the normal, non-emergency, building control position. When an FFOP control is in the AUTO position,the actual status of the device (on, off, open, closed, normal, fault) shall continue to be indicated by the status indicator(s) described.

d. FFOP Response Time: For purposes of smoke control, the FFOP response time shall be the same as for automatic or manual smoke control action initiated from any other building control point.

e. FFOP pilot lamp indication of the actual status of each piece of equipment shall not exceed 15 seconds after operation of the respective feedback device.

f. Graphic Depiction: The location of all smoke control systems and equipment within the building should be indicated by symbols within the overall FFOP smoke control building graphic panel. All major ducts and dampers within the building that are part of the smoke control system, as well as the building areas served by the smoke control systems, should be shown on the FFOP smoke control building graphic panel. Fans and dampers used for smoke control should be shown on the building graphic panel, and where appropriate, should be shown connected to their respective ducts, with a clear indication of the direction of airflow.

E. Location and Access

1. An FFOP shall be located in the fire command room or as shown on the drawings.

F. Knowledge of System

1. Use of the FFOP shall not require any knowledge of the BCS nor its smoke control logic.

2.18 WIRE

A. Non-Power-Limited Circuits: Solid-copper conductors with 600-V rated, 75 deg C, color-coded insulation.

1. Low-Voltage Circuits: No. 16 AWG, minimum.
2. Line-Voltage Circuits: No. 12 AWG, minimum.

B. Power-Limited Circuits: NFPA 70, Types FPL, FPLR, or FPLP, as recommended by manufacturer.

PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION

A. Connect the FACP with a disconnect switch with lockable handle or cover.

B. Manual Pull Stations: Mount semiflush in recessed back boxes.

C. Water-Flow Detectors and Valve Supervisory Switches: Connect for each sprinkler valve station required to be supervised.

D. Ceiling-Mounted Smoke Detectors: Not less than 4 inches from a side wall to the near edge. For exposed solid-joist construction, mount detectors on the bottom of joists. On smooth ceilings, install not more than 30 feet apart in any direction.

E. Wall-Mounted Smoke Detectors: At least 4 inches, but not more than 12 inches, below the ceiling.

F. Smoke Detectors near Air Registers: Install no closer than 60 inches.

G. Duct Smoke Detectors: Comply with manufacturer's written instructions.

1. Verify that each unit is listed for the complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
2. Install sampling tubes so they extend the full width of the duct.

H. Heat Detectors in Elevator Shafts: Coordinate temperature rating and location with sprinkler rating and location.

I. 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. Combine audible and visible alarms at the same location into a single unit.

J. Visible Alarm-Indicating Devices: Install adjacent to each alarm bell or alarm horn and at least 6 inches below the ceiling.

K. Device Location-Indicating Lights: Locate in public space near the device they monitor.

L. FACP: Surface mount with tops of cabinets not more than 72 inches above the finished floor.

M. Annunciator: Install with the top of the panel not more than 72 inches above the finished floor.

N. Antenna for Radio Alarm Transmitter: Mount to building structure where indicated. Use mounting arrangement and substrate connection that will resist 100-mph wind load with a 1.3 gust factor without damage.

3.2 WIRING INSTALLATION

A. Wiring Method: Install wiring in metal raceway. Conceal raceway except in unfinished spaces and as indicated. Raceway shall be Red in color.

B. Wiring within Enclosures: Separate power-limited and non-power-limited conductors as recommended by the manufacturer. Install conductors parallel with or at right angles to sides and back of the enclosure. Bundle, lace, and train conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with the fire alarm system to terminal blocks. Mark each terminal according to the system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

C. Cable Taps: Use numbered terminal strips in junction, pull and outlet boxes, cabinets, or equipment enclosures where circuit connections are made.

D. Color-Coding: Color-code fire alarm conductors differently from the normal building power wiring. Use one color-code for alarm circuit wiring and a different color-code for supervisory circuits. Color-code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visible alarm-indicating devices. Paint fire alarm system junction boxes and covers red.

E. Risers: Install at least two vertical cable risers to serve the fire alarm system. Separate risers in close proximity to each other with a minimum one-hour-rated wall, so the loss of one riser does not prevent the receipt or transmission of signal from other floors or zones.

F. Wiring to Remote Alarm Transmitting Device: 1-inch conduit between the FACP and the transmitter. Install number of conductors and electrical supervision for connecting wiring as needed to suit monitoring function.

3.3 IDENTIFICATION

A. Identify all system components, wiring, cabling, and terminals.

B. Identify all system components, wiring, cabling, and terminals.

C. Install instructions frame in a location visible from the FACP.

D. Paint power-supply disconnect switch red and label "FIRE ALARM."

3.4 GROUNDING

A. Ground cable shields and equipment according to system manufacturer's written instructions to eliminate shock hazard and to minimize, to the greatest extent possible, ground loops, common-mode returns, noise pickup, cross talk, and other impairments.

B. Signal Ground Terminal: Locate at main equipment rack or cabinet. Isolate from power system and equipment grounding.

C. Install grounding electrodes of type, size, location, and quantity as indicated.

D. Ground equipment and conductor and cable shields. For audio circuits, minimize, to the greatest extent possible, ground loops, common-mode returns, noise pickup, cross talk, and other impairments. Provide 5-ohm ground at main equipment location. Measure, record, and report ground resistance.

E. Ground radio alarm transmitter system and equipment as recommended by the manufacturer.

3.5 FIELD QUALITY CONTROL

A. Certificate of Compliance

1. Complete and submit to the Project Engineer in accordance with NFPA 72, paragraph 1.7.2. and Local Building Code.
2. As required by the installation and phasing. The contractor shall include pre-testing and fire department testing in phases.

B. Field - Testing General

1. All equipment shall be pre-tested by the contractor and witnessed by the Owner’s representative prior to testing.
2. As required by the installation and phasing. The contractor shall include pre-testing and fire department testing in phases.
3. NFPA 72 -1996, 5-3.6.1.3 Detectors shall not be installed until after the construction cleanup of all trades is complete and final. Exception: Where required by the authority having jurisdiction for protection during construction. Detectors that have been installed prior to final cleanup by all trades shall be cleaned or replaced in accordance with Chapter 7 -NFPA 72 - 1996.
4. Each addressable analog smoke detector shall be individually field tested prior to installing the device at it’s designated location to ensure reliability after shipment and storage conditions. A dated log indicating correct address, type of device, sensitivity and initials of the technician performing test using test equipment specifically designed for that purpose shall be prepared and kept for final acceptance documentation. After testing, the detection devices and

base shall be labeled with the system address, date and initials of installing technician. Labeling shall not be visible after installation is complete.

5. Wiring runs shall be tested for continuity, short circuits and grounds before system is energized. Resistance, current and voltage readings shall be made as work progresses.
   a. A systematic record shall be maintained of all readings using schedules or charts of tests and measurements. Areas shall be provided on the logging form for readings, dates and witnesses.
6. The acceptance inspector shall be notified before the start of any required tests. All items found at variance with the drawings or this specification during testing or inspection by the acceptance inspector, shall be corrected.
7. Test reports shall be delivered to the acceptance inspector as completed.
8. All test equipment, instruments, tools, and labor required to conduct the system tests shall be made available by the installing contractor. The following equipment shall be a minimum for conducting the tests:
   a. Ladders and scaffolds as required to access all installed equipment.
   b. Multimeter for reading voltage, current, and resistance.
   c. Intelligent device programmer-tester.
   d. Laptop computer with programming software for any required program revisions.
   e. Two way radios, flashlights, smoke generation devices and supplies.
   f. Spare printer paper. (If required)
   g. An approved device for measuring air flow through air duct smoke detector sampling assemblies.
   h. Decibel meter.
   i. Testing documentation.
9. In addition to the testing specified to be performed by the installing contractor, the installation shall be subject to test by the acceptance fire and building department inspectors.

C. Final Acceptance Testing

1. An acceptance test of the fire alarm system shall be conducted by the contractor and the fire alarm equipment vendor as directed by the owner after the fire alarm equipment vendor has performed a 100% test of the system.
2. A written “Acceptance Test Procedure” (ATP) for testing the fire alarm system components and installation will be prepared by the contractor, for approval by the engineer in accordance with NFPA 72 and this Specification. The contractor shall be responsible for the performance of the ATP, demonstrating the function of the system and verifying the correct operation of all system components, circuits and programming.
3. A final "As-Built Function Matrix" shall be prepared by the installing contractor referencing each alarm input to every output function affected as a result of an alarm, trouble or supervisory condition on that input. In the case of outputs programmed using more complex logic functions involving "any", "or", "not", "count", "time", and "timer" statements; the complete output equation shall be referenced in the matrix.
4. A complete listing of all device labels for alpha-numeric annunciator displays and logging printers shall be prepared by the installing contractor prior to the ATP.

5. The acceptance inspector shall use the system record drawings in combination with the specified documents during the testing procedure to verify operation as programmed. In conducting the ATP, the acceptance inspector shall request demonstration of any or all input and output functions. The items tested shall include but not be limited to the following:
   a. System wiring shall be tested to demonstrate correct system response and correct subsequent system operation in the event of:
      1) Open, shorted and grounded intelligent analog signaling circuit.

      2) Open, shorted and grounded network signaling circuit.

      3) Open, shorted and grounded conventional zone circuits.

      4) Open, shorted and grounded speaker, telephone circuits.

      5) Intelligent device removal.

      6) Primary power or battery disconnected.

      7) Incorrect device at address.

      8) Printer trouble, off line or out of paper.

      9) Loss of data communications between system control panels.

      10) Loss of data communications between system annunciators.

6. System evacuation alarm indicating appliances shall be demonstrated as follows:
   a. All alarm notification appliances actuate as programmed.
   b. Audibility and visibility at required levels.
   c. System indications shall be demonstrated as follows:
      1) Correct message display for each alarm input at the control panel, each remote alpha-numeric LCD display and graphic display.

      2) Correct annunciator light for each alarm input, at each annunciator and color graphic terminal.

      3) Correct printer logging for all system activity.

   d. System on-site and/or off-site reporting functions shall be demonstrated as follows:
      1) Correct alarm custom message display, address, device type, date and time transmitted for each alarm input.

      2) Correct trouble custom message display, address, device type, date and time transmitted for each alarm input.

      3) Trouble signals received for disconnect.

   e. Secondary power capabilities shall be demonstrated as follows:

1) System primary power shall be disconnected for a period of time as specified herein. At the end of that period, an alarm condition shall be created and the system shall perform as specified for a period as specified.

2) System primary power shall be restored for forty eight hours and system charging current shall be normal trickle charge for a fully charged battery bank.

3) System battery voltages and charging currents shall be checked at the fire alarm control panel using the test codes and displayed on the LCD display.

7. In the event of system failure to perform as specified and programmed during the ATP procedure, at the discretion of the acceptance inspector, the test shall be terminated.
   a. The installing contractor shall retest the system, correcting all deficiencies and providing test documentation to the acceptance inspector.
   b. In the event that software changes are required during the ATP, a utility program shall be furnished by the system manufacturer to compare the edited program with the original. This utility shall yield a printed list of the changes and all system functions, inputs and outputs effected by the changes. The items listed by this program shall be the minimum acceptable to be retested before calling for resumption of the ATP. The printed list and the printer log of the retesting shall be submitted before scheduling of the ATP. The acceptance inspector may elect to require the complete ATP to be performed again if, in his opinion, modifications to the system hardware or software warrant complete retesting.

D. Documentation

1. System documentation shall be furnished to the owner and shall include but not be limited to the following:
   a. System record drawings and wiring details including one set of reproducible masters and drawings on 3 1/2 inch floppy disks in a DXF format suitable for use in a CAD drafting program.
   b. System operation, installation and maintenance manuals.
   c. Written documentation for all logic modules as programmed for system operation with a matrix showing interaction of all input signals with output commands.
   d. Documentation of system voltage, current and resistance readings taken during the installation, testing and ATP phases of the system installation.
   e. System program “hard copy” showing system functions, controls and labeling of equipment and devices. Also provide a 3.5" floppy diskette with system file.
   f. All specified documentation as required under submittals of the sections of the specifications.

E. Test Equipment

1. The contractor shall furnish to the owner all test equipment as required to program the field analog devices, specifically an intelligent device programmer-tester or a calibrated smoke generator with power source.

F. Warranty/Services

1. The contractor shall submit three manufacturer's certified service companies that are in a 50 mile radius of the project. The Owner shall have the ability to utilize any of these firms for service, maintenance, and warranty work if the present company fails to comply with the stated guarantee and warranty conditions.
2. The contractor shall warrant and maintain the entire system against system hardware and electrical defects including programming software defects, bi-yearly maintenance and complete system testing as per New York City Building code requirement, for the two year warranty period. This period shall begin upon satisfactory completion and certification of final acceptance testing by the "authority having jurisdiction" of the system and sign acceptance of Engineer. Contractor shall provide to owner a letter stating the owner accepted start-date and end-date of warranty period.
3. The fire alarm vendor shall provide pricing for the next three years after the two year warranty period, (third, fourth, and fifth year) after the expiration of the two year warranty period. The pricing shall be separated into two categories; parts and labor and bi-yearly maintenance and testing required.
4. Provide complete hardware and software unit pricing which shall be in effect for the two year warranty period for purchase by the Owner or Owner' s representative.
5. The contractor responsible for the system, must also additionally provide an updated list of name(s) and phone number(s) for normal and off hours contacts necessary to respond to warranty issues. Response to warranty notification shall require a field reply within 24 hours of initial contact.
6. The manufacturer shall allow for three complete reprogrammings of the fire alarm system after successful completion of final acceptance test, at no expense to the Owner.
7. The Fire Alarm Vendor shall guarantee that a copy of the software programming of the fire alarm system is given to the client upon successful completion of acceptance testing. The Fire Alarm Vendor shall also guarantee a new copy of the software will be provided to the Owner upon incorporating any new changes into the system.
8. The Fire Alarm Vendor shall guarantee a copy of the most up-to-date software programming to any other maintenance company, anytime, at no charge to the Owner. This will insure that the Owner is not dependent upon the Fire Alarm Manufacturer, or limited to one maintenance company.

G. Training

1. The fire alarm contractor shall furnish an onsite video taped training session as follows for a minimum of four employees of the system user.
   a. Training in the receipt, handling and acknowledgment of alarms.
   b. Training on system operation including manual control of output functions from the FACP.
   c. Training in the testing of the system including logging of detector sensitivity, field test of devices and response to common troubles.

d. The total training shall be a minimum of eight (8) hours, but shall be sufficient to cover all items specified.

2. The manufacturer shall provide a written schedule of training dates for factory training of two (2) Owner's representatives and include all costs associated with travel, room and board.
   a. The total training requirement shall be factory certification for full utilization of the complete fire alarm system. A factory certificate shall be issued upon completion of the training.
   b. The total training requirement shall be three (3) days or more.

3.6 CLEANING AND ADJUSTING

A. Cleaning: Remove paint splatters and other spots, dirt, and debris. Touch up scratches and marred finish to match original finish. Clean unit internally using methods and materials recommended by manufacturer.

3.7 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel as specified below:

1. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, adjusting, and maintaining equipment and schedules. Provide a minimum of 8 hours' training.
2. Training Aid: Use the approved final version of the operation and maintenance manual as a training aid.
3. Schedule training with Owner, through Architect, with at least seven days' advance notice.

3.8 ON-SITE ASSISTANCE

A. Occupancy Adjustments: When requested within one year of date of Substantial Completion, provide on-site assistance in adjusting sound levels, controls, and sensitivities to suit actual occupied conditions. Provide up to three requested visits to Project site for this purpose.

END OF SECTION

SECTION 28 31 11.11

BI-DIRECTIONAL ANTENNA SYSTEM

PART 1 - GENERAL

1.1 REFERENCES

A. This Section covers a firefighter's two way communications system referred to in this section as a Bi-Directional Antenna System (BDA).

B. Refer to SECTION 260000 for other general requirements.

1.2 SCOPE

A. Provide testing of the existing space to be renovated to ensure sufficient radio communications. If found to be necessary, provide labor, materials, equipment, services and transportation necessary for complete and operational BDA system as indicated on Contract Drawings and specified herein.

B. All final connections, testing and adjusting of the system shall be done under the direct supervision of the system supplier and the Building Owner's Testing and Service company. After completion of the installation, a trained technician employed by the system supplier shall demonstrate the system to be satisfaction of the Owner's Representative and local authorities and shall make all additional adjustments to the system operation as required by the Owner's Representative or local authority as a result of this demonstration. Pay cost for all services to be provided by Owner's Testing and Service company.

C. Installation and Testing company shall be certified by UL and approved by the local fire department.

1.3 SUBMITTALS

A. Submit for review shop drawings on following:
1. Bi-directional radio amplifier
2. Radiating coaxial cable (if required)
3. Coaxial cable
4. Antennas (if required)
5. Terminators
6. T-taps (if required)
7. Other components and interconnecting circuitry as required
8. UPS Power systems
9. Detailed one line schematic wiring diagrams of the system and its interconnecting wiring. Typical wiring diagram will not be accepted. All data submitted shall be complete for all equipment and shall apply only to this specific project.
10. Shop drawings that are submitted for review without all of this information will not be considered and will be rejected.

PART 2 - PRODUCTS

2.1 BI-DIRECTIONAL ANTENNA SYSTEM

A. Provide a Bi-Directional Antenna System meeting all the requirements of the Local Fire Department.

B. The Local Fire Department radio test shall check the signal reception at several locations on the floor area. Signal strength shall be as required for clear reception throughout the building utilizing the type of hand held radio unit that is used by the Local Fire Department. Quantity of test locations shall be determined and conducted by the local fire department representative. The owner's project manager shall be present during said test. A minimum of test point locations shall be determined by the following equation: Number of equally spaced test points = [(floor square footage) /(25000)]*2 specific test locations may need to be considered in areas containing special wall constructions or large quantities of electromechanical building system equipment.

C. Required Signal Levels
   1. Signal strength shall be as required for clear reception throughout the building utilizing hand held radio units of the type(s), which are used by the Local Fire Department.
   2. A minimum signal strength of –95 dBm (DAQ4) shall be available on over 95% of the floor area requiring coverage when transmitted from the fire department.
   3. A minimum signal strength of –95 dBm (DAQ4) shall be received at the fire department system from over 95% of the floor area requiring coverage.

D. Required Broadcasting Frequencies
   1. Typical downlink frequency range for Local Fire Department shall be as required to be compatible with Local Fire Department equipment.
      Note: The building owner will be responsible for keeping the operational frequencies of the BDA compatible with the Local Fire Department radio system.

E. The bi-directional antenna type system shall consist of the following components:
   1. Bi-directional radio amplifier
   2. Radiating coaxial cable (if required)
   3. Coaxial cable
   4. Antennas (if required)
   5. Terminators
   6. T-taps (if required)
   7. Other components and interconnecting circuitry as required
   8. UPS Power systems

F. It is the intent of these specifications that where a BDA system is required, a complete fully functioning system will be designed, approved and tested before an Occupancy Permit is issued.

G. The selected vendor/electrical contractor will complete a Fire Alarm Permit Application acquired from the Fire Prevention Division stating a "BDA" installation. Plan Review: Provide one line, schematic and detail drawings of the proposed

system architecture. Indicate proposed locations for system components. Provide specifications for procurement and installation of a complete system, including operating frequencies, for review by the Local Fire Department, and all other agencies and authorities having jurisdiction.

H. Testing and Commissioning: Coordinate the completion date of the Fire Department radio signal repeater system to allow a Certificate of Occupancy to be obtained in a timely manner, in accordance with a schedule established by the owner's project manager. The entire system shall meet with the approval of the Local Fire Department, and all other agencies and authorities having jurisdiction, before a Certificate of Occupancy will be issued.

I. Design Data: Include signal calculations.

J. Test Reports: Indicate measured signal levels pre-installation and post installation.

K. Filings: The design engineer shall provide all necessary documents required by the contractor for submitting to the Local Fire Department, Local ISD, and any other agencies having jurisdiction. Necessary documents shall include but not be limited to the required quantities of floor plans, system narrative, system specifications, wiring diagrams, shop drawings and any aforementioned documents requiring the engineer's signature.

L. Permits: Permits necessary for installation of the work shall be obtained prior to beginning work. All filing fees, permit costs, and inspection fees shall be included as part of the required work.

M. The system shall be completed with all components and wiring required for compliance with all applicable codes and regulations, and for its operation as described hereinafter. No exclusion from or limitation in the symbolism used on the drawings or the language used in these specifications shall be interpreted as a reason for omitting any appurtenances or accessories required to enable the system to perform the specified functions.

N. Upon completion of the installation, the work shall include making all arrangements with the owner's project manager and providing any assistance necessary for inspection and test as required for approval by the Local Fire Department. Modifications, adjustments and/or corrective work necessary to obtain approval along with subsequent inspection and test resulting from the issuance of a "Notice of Defect" shall precede any consideration of formal acceptance by the building owner. In conjunction with the above, training as deemed necessary to instruct authorized building personnel in the proper operation of the system shall also form a part of the required work.

O. The central equipment shall be supplied with an emergency power unit including batteries and battery charging equipment that maintains this equipment, and all outlying equipment that requires power operation, without any change in status for a minimum period of twenty-four (24) hours. Optionally, emergency power may be supplied by an emergency generator. The emergency power units(s) shall be sized to meet the following minimum requirements: operating in normal (supervisory) mode, twenty-four (24) hours, followed by twelve (12) hours of emergency operation. Batteries shall be of the sealed maintenance free type.

P. System design shall be such that neither the failure of the normal power source, the transfer to an emergency source, nor the transfer back to the normal source shall cause a change in system status.

Q. Battery low voltage alarm contacts shall activate "trouble" indication at the Fire Alarm Annunciator to read "BDA Back up Power Trouble."

R. Loss of A.C. input power or failure of the UPS power system shall provide an Indication at the Fire Alarm Annunciator to read "BDA Power Failure."

S. Amplifier failure shall provide an indication at the Fire Alarm Annunciator to read "BDA System Failure."

T. Alarms from the amplifier and power systems shall be of a contact closure type with demarcation on a punch-block. Normally open and normally closed points shall be clearly identified so appropriate status can be visualized at the central equipment. The contractor shall be responsible for wiring the alarms to the punch-block but not to the fire control central equipment, which will be done by others.

U. Secured Space
   1. The bi-directional radio amplifiers shall not be located in electric closets. They shall be located in a suitable non-finished space as approved by the engineer and/or where specifically shown on the drawings. The entrance to the secured space shall clearly identify the space as having the "Local Fire Department" radio signal repeater equipment, by the use of an attached engraved nameplate.

V. Unsecured Space
   1. The bi-directional amplifiers shall be provided with NEMA 1 enclosures, hinged lockable doors, electric supervision against unauthorized access and the removal of any components, and shall each have an attached engraved nameplate identifying the unit.

W. The bi-directional amplifier shall be supplied with cavity style filtering in order to minimize unwanted frequencies from entering the amplifier. Cavities shall be tuned to the frequencies from Section 1 Item D. above. Cavity filters will be housed to allow access by technicians, but will be protected from tampering, or accidental damage.

X. Units as approved by Local Fire Department shall manufacture the bidirectional radio amplifier.

Y. The bi-directional amplifier shall contain automatic limiting control circuitry to avoid producing overdriven outputs from the amplifier.

Z. The firefighter's communication bi-directional radio amplifier system shall be by a competent installer with a minimum of five years service in in-building RF solutions.

AA. Components indicated on the drawings shall be located where shown. Components which are required for proper operation, but which are not indicated on the drawings shall be located in mechanical rooms, at accessible locations within suspended ceilings, or at locations for which express permission of the owner's project manager has been obtained.

BB. Note the following circuitry requirements:
   1. Conduit intended for use with the firefighter's communication bidirectional radio amplifier system shall be steel electrical metallic tubing (EMT), except as follows:
      a. It shall be galvanized steel intermediate conduit where mounted within 8'-0" of the floor in mechanical spaces or otherwise exposed to mechanical damage, or where intended for embedment in concrete.

b. It shall be galvanized steel intermediate conduit if local authorities prohibit use of EMT.
c. It shall be rigid galvanized steel conduit for the power supply to the central equipment and to all outlying equipment cabinets requiring a 120-volt or 120/208-volt supply

2. Where wires and cables are permitted to be run without conduit, they shall be independently supported from the building structure or ceiling suspension systems at intervals not exceeding four feet on center, utilizing cable supports specifically approved for the purpose. Wires and cables shall not rest on or depend on support from suspended ceiling media (tiles, lath, plaster, as well as splines, runners or bars in the plane of the ceiling), nor shall they be supported from pipes, ducts or conduits. Bundling and/or supporting ties shall be of a type suitable for use in a ceiling air handling plenum regardless of whether or not installed in a plenum.
3. Cables shall be tagged or labeled at each termination point and in each intermediate junction box, pull box or cabinet through which they pass, as well as intervals not exceeding 50 feet on centers where cables are run without conduit.
4. Comply with applicable building and electrical code requirements for locating and routing circuitry, for installing circuitry, and for fire stopping.
5. The covers of all dedicated junction, pull boxes shall be painted red and labeled "Fire Dept. Radio System". Junction and pull boxes will not be shared with other systems.
6. Cables other than radiating coaxial cables shall be run in conduit where indicated by the Engineer. Where not indicated, cable shall be installed per manufacturer's recommendation. Conduit shall be electrical metallic tubing or threaded conduit subject to the restrictions specified elsewhere for light and power circuitry.
7. Radiating coaxial cables shall be run without conduit. Where installed in a plenum type ceiling cable insulation shall be of a fire resistant low-smoke producing type, with a minimum rating of CATVR. This classification shall be clearly marked on the outer surface of the cable at regular intervals.

CC. Submit certification that system is compatible with Local Fire Department radio systems prior to installation.

DD. Verify proper operation of system by means of field tests in accordance with Local Fire Department requirements, and include all adjustments and modifications to the system required for proper operation. Coverage of each floor of the building to a minimum of 95% is required for acceptance. Testing shall be performed and signed by a qualified radio technician with a minimum of 10 years RF experience whose qualifications are acceptable to Local Fire Department.
1. No activation or power up of any RF equipment is permitted without first obtaining permission of the Local Fire Department. This includes any testing or calibration.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Installation shall be in accordance with the Electric Code, NFPA 72, local and state codes, as indicated on the Drawings, and as recommended by the system manufacturer.

B. All conduit, junction boxes, conduit supports and hangers shall be concealed in finished areas and may be exposed in unfinished areas.

C. Provide in accordance with manufacturer's instructions, all wiring, conduit and outlet boxes required for the installation of the complete system as specified and described herein and as indicated on the Drawings.

D. Fire Department Requirements:
   1. Coordinate with and provide all items required by the local Fire Department. Pay all costs.
   2. Confirm operations and testing with local fire department and pay all back charges.

E. Provide complete wiring and conduit between all equipment. All devices shall be mounted upon and terminations made in listed boxes.

F. Use 14 AWG minimum size solid conductors for circuit conductors unless otherwise required by the manufacturer.

G. Terminate conductors using ring type compression connectors on labeled and numbered terminal blocks. Do not splice conductors. Label conductors at all terminations with terminal number and system number.

H. Junction boxes, pull boxes, terminal boxes, outlet boxes and covers in the fire alarm raceway system shall be painted red.

3.2 EXTRA MATERIALS

A. Provide extra materials as indicated below:
   1. Three of each automatic smoke and heat detector (without base).

3.3 MANUFACTURER'S FIELD SERVICES

A. Provide manufacturer certified and trained technicians and representatives for demonstration testing, supervision and assistance in the installation of the fire alarm system. Connections and terminations shall be made under the direct supervision of the fire alarm manufacturer. Equipment manufacturer shall be responsible for demonstration tests, programming, adjustment and calibration of the equipment.

3.4 ACCEPTANCE TESTING

A. Pre-test the entire system and all functions to verify complete operation. After correct operation is verified, notify the Fire Department, local authorities, Owner and the Architect that system is complete and ready for acceptance testing. Provide testing at a time mutually agreeable to all parties. Provide a minimum one week notice.

B. Testing shall be as required by the Fire Department, Local Authorities, the Owner and the Architect. At a minimum, operate every building fire alarm device to ensure proper operation, correct annunciation at each remote annunciator and

control panel. One-half of all tests shall be performed on standby power. Where applying heat would destroy any detector, they may be manually operated.

C. Tests shall be performed in the presence of the Project Foreman, the Owner's representative, fire authority of the fire jurisdiction and the representative of the fire alarm system manufacturer.

D. Provide the service of a competent, factory-trained engineer or technician authorized by the manufacturer of the fire alarm equipment to technically supervise and participate during all of the adjustments and tests for the system. All testing shall be in accordance with NFPA 72. Provide type written reports of results and system information as required by forms in NFPA 72.

E. The entire system shall be marked per device circuit to indicate function and operation from manufacturer's point-to-point wiring diagrams. Drawings shall be signed by the Installer, Manufacturer and UL certified Testing Company and the Fire Department's Representative.

F. Upon completion of testing, co-signed drawings and reports shall be forwarded to the Architect for record purposes for final acceptance. Testing and reports shall comply with NFPA 72 standard requirements.

G. Pay all costs for certification, testing and fire department approvals.

H. Leave the fire alarm system in proper working condition.

I. Provide copies of testing reports and UL certification in the O&M manuals.

3.5 FINAL INSPECTION

A. At the final inspection a factory trained representative of the manufacturer of the major equipment shall demonstrate that the systems function properly in every respect.

3.6 INSTRUCTION

A. Provide instruction as required for operating the system. Hands-on demonstrations of the operation of all system components and the entire system including program changes and functions shall be provided.

B. Provide a type written "Sequence of Operation" to the owner.

END OF SECTION

This page is intentionally left blank.

SECTION 28 41 11

AREA OF RESCUE ASSISTANCE INTERCOM SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. The specification describes an addressable microprocessor based area of rescue assistance intercom system. The system shall be an analog addressable, low voltage and modular, with digital communication techniques, in full compliance with all applicable codes and standards.

B. Install, program, test, and deliver to the Owner in fully operational condition including all required hardware, software, raceways and interconnecting wiring as required. The system shall consist of, but not be limited to, the following:

1. Main Control Unit with enclosure and battery back-up.
2. Master Console.
3. PBX Telephone Interface
4. Remote Call Station.

C. Prior to the commencement of work, obtain all permits necessary for installation of the work. All permit costs and inspections fees shall be included as part of the required work. After completion of work, notify all authorities having jurisdiction.

D. Related sections include the following:

1. Low-Voltage Electrical Power Conductors and Cable.
2. Raceways and Boxes for Electrical Systems.

E. Coordinate with the Architect for final locations and appearance of devices.

1.3 SUBMITTALS

A. Prior to the start of work, provide a complete and comprehensive submittal for review. Describe the proposed system and its equipment. Failure to provide a complete submittal shall be grounds for rejection of submission. Submittal shall include, but not be limited to, all of the following material:

1. Battery capacity: Minimum of 125% of the operating requirement.
2. Power requirements for all equipment: Minimum 25% spare capacity.

B. Shop Drawings:

1. Drawing or catalog page showing actual dimensions of system components.
2. Single line riser diagram showing all equipment, all connections and number and size of all conductors and conduits.
3. Wiring Diagrams: Detail wiring, differentiate between manufacturer-installed and field-installed wiring.
4. Provide samples when so requested by the Architect/Engineer.

C. Provide the address, telephone number, and contact person(s) of the manufacturer's local service facility for normal and off hour warranty issues.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: A firm experienced in manufacturing systems similar to those indicated for this Project and with a record of successful in-service performance.

B. Installer Qualifications: An experienced installer who is an authorized representative of the manufacturer for both installation and maintenance of units required for this Project.

C. Source Limitations: Obtain area of rescue assistance intercom system components through one source from a single manufacturer.

D. Comply with applicable building code, local ordinances and regulations, and requirements of authorities having jurisdiction.

E. Comply with National Electric Code (NEC).

F. Comply with Massachusetts State Building Code.

G. Comply with all applicable UL Standards.

H. Comply with Americans with Disabilities Act (ADA).

1.5 COORDINATION

A. Coordinate work in this Section with all related trades.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Manufactuers: Subject to compliance with requirement, provide products b one of the following

1. Jeron Electronic Systems, Inc.
2. TekTone Sound and Signaling, Inc.
3. Alpha Communications.

2.2 FUNCTIONAL DESCRIPTION OF SYSTEM

A. Basic System Equipment, Circuiting, Addressing and Operating Capabilities

1. Main Control Unit shall be a Jeron Electronic System, Inc. #4851 with #5288 enclosure. Unit shall support up to 128 remote call stations without modification. Unit shall provide power, voice amplification, signal tones, and multiplex control logic for Master Console and Remote Call Stations. Unit shall have a self-charging battery backup that maintains full system function during line power outages. Non-volatile program memory shall eliminate the need to reprogram the system if power is disconnected. Unit shall continually test system for master and remote call station response. Diagnostic messages shall be reported to master console.
2. Master Console shall be a Jeron Electronic System, Inc. #4875 with #6269 wall jack for desk mounted console. Console shall provide alphanumeric display of remote station number and location. Console shall be provided with Jeron Electronic System, Inc. #4890 Administration Program Software. Communication for console shall be handset privacy or hands-free. Console shall display multiple calls simultaneously.
3. PBX Telephone Interface shall be a Jeron Electronic System, Inc. #4862. Interface shall “call forward” to an outside phone via Auto-Dial all calls from remote stations to an unstaffed Master Console. Interface shall have diagnostic indicators to continuously verify operation and a disconnect switch for manual override of the PBX loop connection.
4. Remote Call Stations shall be a Jeron Electronic System, Inc. #4888. Communications shall be hands-free. Canceling a call from a remote station shall only be possible after acknowledging the call at the Master Console. Remote Stations shall have the ability to interface with a PBX Telephone system to allow calls from Remote Stations to be forwarded to outside telephones. Systems not capable of forwarding calls to outside phones shall not be acceptable. Remote Station shall have a 3″ square loud speaker/microphone and a momentary push button switch for placing a call on the system.

B. System Operation

1. Placing calls from remote call stations.
2. Calls shall be placed on the system by momentarily pressing the call button on the Remote Call Station. This action shall cause the following to occur:

a. The Remote Call Station's green call placed LED indicator shall light steadily.
b. An alert tone shall pulse once at the Remote Call Station to verify call placement on the system.
c. The LCD display at the master console shall show the location of the calling station by name and number and an alert tone shall sound.
d. The Master Console shall have the capability to display multiple calls simultaneously.

3. Acknowledging/Answering Calls At The Master Console

a. The attendant shall acknowledge the call by either pressing the Push-to-Talk button or by lifting the handset.
b. When the call is acknowledged at the Master Console, the red Monitor LED on the Remote Call Station shall light steadily and an alert tone shall pulse once.
c. The LCD display on the Master Console shall show the name and number of the selected station and "CONNECTED", indicating that voice communication between the Master Console and the Remote Station exists.
d. Hands-free, two-way communication may be conducted with the Master Console using the Remote Call Station's built-in loudspeaker.
e. After the call is acknowledged, the Remote Call Station indicator shall flash slowly and a pulse tone shall be emitted every two seconds.

4. Canceling Calls

a. A call shall only be canceled from the Master Console after it has been acknowledged. After the call has been canceled, the LED indicator extinguishes and communication is terminated.

5. Originating Calls At The Master Console

a. The Master Console shall be capable of initiating audio communication with a Remote Call Station at any time by dialing the station number on its keypad. The Master shall also be capable of paging a group of up to 10 Remote Call Stations to broadcast evacuation information.

6. PBX Telephone Interface

a. The System shall function as described above regardless of whether the Telephone Interface is, or is not utilized. When the Telephone Interface is employed, calls placed from Remote Stations to an unstaffed Master Console shall be forwarded to outside telephones.
b. Each Interface Unit shall connect to a dedicated, analog extension port on the local telephone switch equipment having the capability to provide calling party release. A disconnect pushbutton shall be provided to override the release function of the telephone switch. The Telephone Interface Unit shall be equipped with three diagnostic LEDs to indicate status of the unit.
c. The system shall have the ability to perform the following function:

1) Have a call from a remote station to an unstaffed Master Console forwarded to an outside phone via auto-dial.

7. Supervision

a. In the event of circuit trouble with any Remote Call Station, the Master Console shall display the name and number of the station and "TROUBLE."

PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION

A. Locate Master Control Unit as shown on plans. Top of enclosure shall be 6′-0″ A.F.F.

B. Locate PBX telephone Interface next to Master Control Unit as directed by equipment manufacturer.

C. Locate Master Console recessed in wall. Exact location as directed by Architect/Engineer.

D. Locate Remote Call Station as shown on plans and/or as directed by Architect/Engineer. Units shall be 44″ A.F.F.

3.2 WIRING INSTALLATION

A. Wiring shall be Category-5 type cable to interconnect system components.

B. System shall employ multiplexed data transmission requiring no more than six (6) common conductors, with no unique or "home run" conductors.

C. System wiring shall not require a shielded cable.

D. All system wiring shall be in conduit. Minimum size conduit shall be 3/4″.

E. All Category-5 wire terminations shall be connectorized according to ANSI Standard T568A.

3.3 FIELD QUALITY CONTROL

A. Testing

1. A complete test of the system shall be conducted and shall include, but not necessarily limited to the following:

a. All remote call stations transmit a signal to the master console and two-way communication is confirmed.
b. All remote call stations call an outside phone and two-way communication is confirmed.
c. All system components shall be tested and proper operation confirmed.
d. Manufacturer of system shall submit letter stating system has been tested and is 100% operational.

B. Warranty/Services

1. The contractor shall submit three manufacturer's certified service companies that are in a 50 mile radius of the project. The Owner shall have the ability to utilize any of these firms for service, maintenance, and warranty work if the present company fails to comply with the stated guarantee and warranty conditions.
2. The contractor shall warrantee the complete system for one (1) year from date of final acceptance.

C. Training

1. The owner shall be thoroughly instructed in the use of the Area of Rescue Assistance Intercom System by an authorized distributor of the manufacturer.
2. The system supplier shall provide instruction to the staff by means of a portable demonstration system, which shall be set up in a conference room or auditorium to give the staff hands-on experience without disrupting normal duties.
3. The demonstration system shall include representative components as utilized in the installation. The instructor shall demonstrate the functions of the system with all indicators and tones operational.

END OF SECTION

SECTION 28 41 14

GPS WIRELESS CLOCK SYSTEMS/ELAPSED TIMER

PART 1 - GENERAL

1.1 GENERAL

A. Furnish and install a complete new GPS wireless clock system using Primex Wireless Inc. GPS wireless system. All bids shall be based on the hospital selected equipment as specified herein, and as distributed by Signet Electronic Systems, Inc. HCC Group, Norwell, MA (781) 871-5888, fax: (781) 871 4757

1.2 SECTION INCLUDES

A. Transmission Systems GPS Receiver Primary Transmitter

B. Satellite Transmitter

C. Clocks

D. Analog

E. Digital Elapsed Timers-Rauland

F. Nurse Call Integration

1.3 RELATED SECTIONS

A. Division 26 – Electrical (120 volt grounded outlet required for transmitter).

1.4 REFERENCES

A. This Technical Specification and Associated Drawings

B. Primex Wireless GPS Satellite Time System User Manual.

1.5 DEFINITIONS

A. GPS: Global Positioning System, a worldwide system that employs 24 satellites in an integrated network to determine geographic location anywhere in the world, and which employs and transmits Universal Coordinated Time, the world's most accurate and reliable time.

B. UTC: Universal Coordinated Time

1.6 SYSTEM DESCRIPTION

A. GPS wireless clock system shall continually synchronize clocks throughout the facility, and shall be capable of clock readouts in multiple time zones where desired.

B. The system shall provide wireless time using GPS and be synchronized to UTC. The system shall not require hard wiring. Clocks shall automatically adjust for Daylight Saving Time

C. Analog Clocks shall be synchronized to within 10 milliseconds 6 times per day, and the system shall have an internal oscillator that maintains plus or minus one second per day between synchronizations, so that clock accuracy shall not exceed plus or minus 0.2 seconds.

D. The system shall include an internal clock reference so that failure of the GPS signal shall not cause the clocks to fail in indicating time.

E. The system shall incorporate a “fail-safe” design so that failure of any component shall not cause failure of the system. Upon restoration of power or repair of failed component, the system shall resume normal

F. Operation without the need to reset the system or any component thereof.

G. Clock locations shall be as indicated, and clocks shall be fully portable, capable of being relocated at any time.

H. The system must operate in accordance with a “Radio Station Authorization” , Form

I. FCC 601 – LM, granted by the Federal Communications Commission (FCC). This license will be issued to and held by the end user.

1.7 REGULATORY REQUIREMENTS

A. Equipment and components furnished shall be of manufacturer’s latest model.

B. The end user will hold a license, known as a “Radio Station Authorization” granted by the FCC.

C. This license grants the end user protected use for wireless transmission at the designated frequency.

D. This license will designate a unique “call sign” for each end user.

E. Transmitter and receiver shall comply with Part 90 of FCC rules as follows:

F. This device may not cause harmful interference, and

G. This device must accept interference received, including interference that may cause undesired operation.

H. Transmitter frequency shall be governed by FCC Part 90.35.

I. Transmitter output power shall be governed by FCC Part 90 257 (b)

J. System shall be installed in compliance with local and state authorities having jurisdiction.

1.8 SUBMITTALS

A. Product Data: Submit complete catalog data for each component, describing physical characteristics and method of installation. Submit brochure showing available colors and finishes of clocks.

B. Operating License: Submit evidence of application for FCC Radio Station Authorization prior to installing equipment. Furnish the license or a copy of the application for the license, to the Owner/End User prior to operating the equipment. The original license must be delivered to the Owner/End User.

C. Samples: Submit one clock for approval. Approved sample shall be tagged and shall be installed in the work at location directed.

D. Manufacturer's Instructions: Submit complete installation, set-up and maintenance instructions.

E. Floor plans indicating the location of system transmitter(s), approved by manufacturer, will be submitted to owner prior to installation.

1.9 SUBSTITUTIONS

A. Proposed substitutions, to be considered, shall be manufactured of equivalent materials that meet or exceed specified requirements of this Section.

B. Proposed substitutions shall be identified not less than 10 days prior to bid date.

C. Other systems requiring wiring and/or conduit between master and clocks will not be accepted.

D. Other systems using wireless technology in an unlicensed frequency range will not be accepted.

E. Other systems using wireless technology where the license is held by any party other than the end user will not be accepted.

1.10 QUALITY ASSURANCE

A. Qualifications:
   1. Manufacturer: Company specializing in manufacturing commercial time system products with a minimum of 30 continuous years of documented experience including
   2. 4 years experience producing GPS wireless time systems.
   3. Installer: Company with documented experience in the installation of commercial time systems.
   4. Prior to installation, a site survey must be performed to determine proper transmitter placement.

1.11 DELIVERY STORAGE AND HANDLING

A. Deliver all components to the site in the manufacturer's original packaging. Packaging shall contain manufacturer's name and address, product identification number, and other related information.

B. Store equipment in finished building, unopened containers until ready for installation.

1.12 PROJECT SITE CONDITIONS

A. Clocks shall not be installed until painting and other finish work in each room is complete.

B. Coordinate installation of GPS receiver for access to the roof or exterior side wall so that the bracket and related fasteners are watertight.

1.13 SYSTEM STARTUP

A. At completion of installation and prior to final acceptance, turn on the equipment; ensure that all equipment is operating properly, and that all clocks are functioning.

1.14 WARRANTY

A. Manufacturer will provide a 1 year warranty on GPS receiver, transmitter, and satellite transmitter. Manufacturer will offer an optional 4 year extended warranty Primex Wireless Part Number14998. All other components will have a 1 year warranty.

PART 2 - PRODUCTS

2.1 MANUFACTURER

A. GPS wireless clock system shall be manufactured by Primex Wireless, Inc., N3211 County Road H, Lake Geneva WI 53147 and as distributed by Signet Electronic Systems, Inc. Norwell, MA

2.2 SEQUENCE OF OPERATION

A. Transmitter Operation: When power is first applied to the transmitter, it checks for and displays the software version. It then checks the position of the switches and stores their position in memory. The transmitter looks for the GPS time signal. Once the transmitter has received the GPS time, it sets its internal clock to that time. The transmitter then starts to transmit its internal time once every second. The transmitter updates its internal clock every time it receives valid time data from the GPS.

B. Analog Clock Operation:
   1. Apply power or insert batteries. Follow set up procedures detailed in manufacturer's instructions.
   2. After initial setup, the clock will shut off the receiver. Six times each day, the microprocessor will activate the receiver and starting with the stored channel, it will again look for a valid time signal. If necessary, the clocks will resynchronize to the correct time.
   3. If the clock has not decoded a valid time signal for a pre-determined number of days, it will go to a step mode. Non signal reception can be caused by low battery voltage. If this occurs, replace the batteries.

2.3 EQUIPMENT

A. General: The clock system shall include a transmitter, a roof or window mounted GPS receiver, indicating clocks, and all accessories for complete operation.

B. GPS Receiver: GPS roof mounted, with 10 foot cable (3m) attached (additional Primex Wireless extension cable available: 50ft (15.25m), 100 ft (30.5m), and 200 ft (61m).

C. The GPS Receiver shall be a complete GPS receiver including antenna in a waterproof case, designed for roof or outdoor mounting. Provide mounting bracket for attachment to roof structure.

D. The GPS Receiver cable must be plenum rated where required by local code.

E. Transmitter: Primex Wireless Model 14400, consisting of wireless transmitter with GPS receiver, a surge suppressor/battery backup, and a mounting shelf. Unit shall obtain current atomic time from satellite. The clock system shall transmit time continuously to all clocks in the system.

F. Transmission:
   1. Frequency Range: 72.100 to 72.400 MHz.
   2. Transmission Power: 1 watt (30dBm) maximum
   3. Radio technology: narrowband FM
   4. Number of channels: 16
   5. Channel bandwidth: 20 kHz maximum
   6. Transition mode: one-way communication
   7. Data rate: 2 KBps
   8. Operating range: 32 degree F to 158 degrees F (0 degrees C. to 70 degrees C).

G. Transmitter:
   1. Transmitter output power: +26 to +30 dBm
   2. Frequency deviation: +/- 4 kHz
   3. Transmitter power requirements: 120 VAC 60 Hz
   4. Internal power requirements: 5 VDC
   5. Carrier frequency stability: +/- 20 ppm

H. Transmitter shall have 16 selectable channels to assure interference-free reception.

I. Transmitter shall have the following switches:
   1. Time zone adjustment switches for all time zones in the world. Includes: Eastern, Central, Mountain, Pacific, Alaska, and Hawaii.

J. Daylight Saving Time bypass switch.

K. 12-hour or 24-hour display.

L. Transmitter housing shall be black metal case, 16-3/4 inches (424.4mm) by 12 inches (304.8mm) by 1-7/8 inches (46.4mm) in size.

M. Antenna shall be 46 inches (1168mm) high, commercial type, mounted on top center of transmitter housing. Antenna gain shall be < 2.2 dB. Antenna polarization shall be vertical.

N. Transmitter housing shall incorporate a display which shall include the following:
   1. Time readout
   2. AM and PM indicator if 12-hour time display is set
   3. Day and date readout
   4. Indicator for daylight savings or standard time
   5. LED which shall flash red in event of reception problem
   6. GPS reception indicator

O. Transmitter shall contain an internal clock such that failure of reception from the GPS will not disable the operation of the clocks.

P. Power supply (included)
   Input: 120 volt AC 50/60 Hz, 0.4 amps.
   Output: 9 volt DC, 1.5 amps.

Q. Surge Protector/Battery Backup (included).
   Input: 120 volt AC 60 Hz +/- 1 Hz.
   Output: 120 volt AC, 500VA, 300 watts
   Surge Energy Rating: 365 joules

R. Satellite Transmitters Primex Wireless Model 14401: Satellite Transmitters shall receive the signal from the Wireless Receiver Switches and transmit the signal to the devices in its vicinity, which are out of the range from the Master Transmitter. The unit shall include the following:
   1. Antenna mounted on top of the housing, 46 inches (1168mm) long.

2. Traditional analog clocks (7 year lithium battery): Analog clocks shall be wall mounted. Clocks shall have polycarbonate frame and polycarbonate lens. Face shall be white. Hour and minute hands shall be black-24 hr dial format.
3. This project shall utilize Primex Platinum Series 13.75" round hospital grade,7 year lithium sealed battery analog clock model #14512, with 24hr markings.
4. Additional colors, finishes, and dial faces are available from manufacturer.
5. Analog clocks shall be battery-operated, fitted with a 7 year Sealed Package Primex Lithium Battery. Standard alkaline batteries are subject to leakage, and shall not be acceptable.
6. Analog clocks shall be capable of automatically adjusting for Daylight Saving Time. An on-off switch located on the transmitter shall disable this function If desired.
7. Time shall be automatically updated from the transmitter 6 times per day.
8. Analog clocks shall remember the time during changing of batteries.
9. 9 inch (228.6mm) and 12.5 inch (317.5mm) analog clocks shall have a tamper proof/theft resistant clock lock mounting slots.

S. Analog clock receivers shall be as follows:
Receiver sensitivity: >-110 dBm
Receiver power: two batteries
Antenna type: internal
Antenna gain: -7 dBd

T. If the transmitter stops transmitting valid time signals due to power failure, the clocks will continue to function as accurate quartz clocks until a valid time signal is decoded. If signal transmission is not restored after 96 hours, the second hand will "five step" as a visual indicator that the signal has been lost. Should the clocks lose power and signal, the clocks will not function.

U. Elapsed Timers shall be Rauland Borg #2521 Digital, with matching #2423 Elapsed Timer Controller. It shall integrate with the adjacent Rauland #R4KCB12 code 99 nurses call device in a procedure room as shown on plans.

V. Low Voltage Timer Power Supply shall be Rauland #2515.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that construction is complete in spaces to receive equipment and that rooms are clean and dry.

B. Verify that 120 volt electrical outlet is located within 6 feet (1.83m) of location of transmitter and the outlet is operational and properly grounded.

3.2 INSTALLATION

A. Provide all equipment necessary for a complete and operable system.

B. GPS Unit: Install on roof in location indicated, in clear view of the sky. Install unit in location free from standing water, and above accumulations of leaves or debris. Seal cable connection to GPS with cable connection sealant. Any added cable lengths must be protected from outside elements.

C. Transmitter:
   1. Locate transmitter where indicated, a minimum of 2 to 3 feet (.6 to 1 meter) above the floor, away from large metal objects such as filing cabinets, lockers or metal framed walls. Transmitter(s) will be placed at locations indicated below:
      a. Attach receiver to transmitter using cable.
      b. Connect antenna to transmitter, using care not to strip threads.
      c. Connect power supply to the transmitter.
      d. Set the channel number on the display to correspond to the FCC license.
      e. Plug power supply into electrical outlet.
      f. Analog clocks perform the following operations with each clock:
      g. Set clock to correct time in accordance with manufacturer's instructions.
      h. Observe analog clock until valid signals are received and analog clock adjusts itself to correct time.
      i. Install the analog clock on the wall in the indicated location, plumb, level and tight against the wall. If using 12-1/2 inch (317.5mm) clock, attach using clock-lock hanging method and suitable fasteners as approved by clock manufacturer.
      j. Analog clocks (AC): Perform the following operations with each clock:
      k. Observe clock until valid time signals are received and analog clock adjusts itself to correct time.
      l. Install the analog clock on the wall in the indicated location, plumb, level, and tight against the wall. Attach using clock-lock hanging method and suitable fsteners as approved by clock manufacturer.

3.3 ADJUSTING

A. Prior to final acceptance, inspect each clock, adjust as required, and replace parts which are found defective.

3.4 CLEANING

A. Prior to final acceptance, clean exposed surfaces of clocks, using cleaning methods recommended by clock manufacturer. Remove temporary labels from clock faces. Do not remove labels from backs of clocks.

3.5 DEMONSTRATION

A. Provide training to Owner's representative on setting and adjusting clocks, replacing batteries and routine maintenance.

3.6 PROTECTION

A. Protect finished installation until final acceptance of the project.

3.7 TESTING

A. All devices must be tested at their operational location under normal operational conditions to assure reception of signal. The system shall be sold, tested, warranted and implemented by a factory authorized Primx/Rauland Borg outlet.

END OF SECTION

This page is intentionally left blank.

SECTION 31 10 00

SITE CLEARING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Protecting existing vegetation to remain.
2. Removing existing vegetation.
3. Clearing and grubbing.
4. Stripping and stockpiling topsoil.
5. Removing above- and below-grade site improvements.
6. Disconnecting, capping, or sealing site utilities.
7. Temporary erosion and sedimentation control.

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 MATERIAL OWNERSHIP

A. Except for materials indicated to be stockpiled or otherwise remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site.
   1. Granite curb and sidewalk brick removed from within the public right of way is the property of the City of Portland. Curb that is to be reset in a future construction package is to be stacked and transported to a location as directed by the construction manager. Curb that is not to be reset shall be stacked and transported off site to the City of Portland’s designated stockyard .

1.4 FIELD CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.

   1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
   2. Provide alternate routes around closed or obstructed trafficways if required by Owner or authorities having jurisdiction.

B. Salvageable Improvements: Carefully remove items indicated to be salvaged and store on Owner's premises where indicated.

C. Utility Locator Service: Notify utility locator service for area where Project is located before site clearing.

D. Do not commence site clearing operations until temporary erosion- and sedimentation-control measures are in place.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Satisfactory Soil Material: Requirements for satisfactory soil material are specified in Section 312000 "Earth Moving."

1. Obtain approved borrow soil material off-site when satisfactory soil material is not available on-site.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect and maintain benchmarks and survey control points from disturbance during construction.

B. Protect existing site improvements to remain from damage during construction.

1. Restore damaged improvements to their original condition, as acceptable to Owner.

3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL

A. Provide temporary erosion- and sedimentation-control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to erosion- and sedimentation-control Drawings and requirements of authorities having jurisdiction.

B. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.

C. Inspect, maintain, and repair erosion- and sedimentation-control measures during construction until permanent vegetation has been established.

D. Remove erosion and sedimentation controls, and restore and stabilize areas disturbed during removal.

3.3 EXISTING UTILITIES

A. Locate, identify, disconnect, and seal or cap utilities indicated to be removed or abandoned in place.

1. Arrange with utility companies to shut off indicated utilities.

B. Interrupting Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others, unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify Owner and Architect not less than seven days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Architect's written permission.

C. Removal of underground utilities is included in earthwork sections; in applicable fire suppression, plumbing, HVAC, electrical, communications, electronic safety and security, and utilities sections; and in Section 024116 "Structure Demolition" and Section 024119 "Selective Demolition."

3.4 CLEARING AND GRUBBING

A. Remove obstructions, trees, shrubs, and other vegetation to permit installation of new construction.

1. Grind down stumps and remove roots larger than 3 inches in diameter, obstructions, and debris to a depth of 18 inches below exposed subgrade.
2. Use only hand methods or air spade for grubbing within protection zones.

B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.

1. Place fill material in horizontal layers not exceeding a loose depth of 8 inches, and compact each layer to a density equal to adjacent original ground.

3.5 TOPSOIL STRIPPING

A. Remove sod and grass before stripping topsoil.

B. Strip topsoil to depth of 6 inches in a manner to prevent intermingling with underlying subsoil or other waste materials.

C. Stockpile topsoil away from edge of excavations without intermixing with subsoil or other materials. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust and erosion by water.

3.6 SITE IMPROVEMENTS

A. Remove existing above- and below-grade improvements as indicated and necessary to facilitate new construction.

3.7 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Owner's property.

END OF SECTION 311000

SECTION 31 20 00

EARTH MOVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

B. The structural plans indicate estimated areas of the building excavation where subgrade soils do net reach adequate bearing strata on dense or very dense glacial till. Over excavation or soil improvements are required. Soil improvement if employed is a delegated design item. Refer to the structural plans for requirements.

1.2 SUMMARY

A. This Section includes the following:
1. Preparing subgrades for [slabs-on-grade] walks pavements lawns and grasses and exterior plants.
2. Excavating and backfilling for buildings[, site walls] and structures.
3. Drainage course for slabs-on-grade.
4. Subbase and base course for concrete walks and pavements.
5. Subbase and base course for asphalt paving.
6. Subsurface drainage backfill for walls and trenches.
7. Excavating and backfilling for utility trenches within the building excavation limits.
8. Excavating and backfilling for site utility trenches.
9. Excavating and backfilling trenches for buried mechanical and electrical utilities and pits for buried utility structures.
10. Excavation and off-site disposal of all unsuitable and excess materials and stockpiling of all suitable onsite materials required for reuse.
11. Provision, transportation and placement of all required fill and backfill materials.

B. Related Sections include the following:
1. Division 01 Section "Unit Prices" for unit-price rock excavation and authorized additional excavation provisions.
2. Division 01 Section "Construction Progress Documentation] for recording preexcavation and earthwork progress.
3. Division 01 Section "Temporary Facilities and Controls" for temporary controls, utilities, and support facilities.
4. Division 03 Section "Cast-in-Place Concrete" and Architectural Concrete.

5. Divisions 21, 22, 23, 26, 27, and 28 Sections for installing underground mechanical and electrical utilities and buried mechanical and electrical structures.
6. Division 02 Section "Clearing" for site stripping, grubbing, stripping and stockpiling topsoil, and removal of above- and below-grade improvements and utilities.
7. Division 31 Section "Erosion Control" for temporary erosion and sedimentation control measures. ,
8. Division 31 Section "Dewatering" for lowering and disposing of ground water during construction.
9. Structural plans for soil improvement requirements.

1.3 SOIL IMPROVEMENT

A. The structural plans indicate estimated areas of the building excavation where subgrade soils do net reach adequate bearing strata on dense or very dense glacial till. Overexcavation or soil improvements are required. Soil improvement may be employed is a delegated design item.

B. If employed Design, furnish and install soil improvements in areas where subgrade soils do not reach adequate bearing strata.
   1. Delegated Design: Design soil improvements including comprehensive engineering analysis by a qualified professional engineer licensed in the State of Maine, using performance requirements and design criteria indicated.
   2. Provide specialty contractor and professional engineering service needed to assume engineering responsibility including preparation of Drawings and a comprehensive engineering analysis.
   3. Soil improvement may consist of Rigid Inclusions, Rammed Aggregate Piers, or other methods that can adequately achieve the performance criteria listed below.
      a. Allowable soil bearing pressure must achieve a minimum of 5,000 psf and a modulus of sub-grade reaction of at least 125 pci.
      b. Settlement of improved soil cannot exceed ½" when subjected to 5,000 psf proof load.
      c. The specialty contractor shall design the soil improvement and submit drawings and calculations for the Structural Engineer of Record to review.
      d. The specialty Contractor shall submit the names of three (3) previous projects within the last 5 years that demonstrate successful execution of the proposed methods and satisfy their respective performance requirements.

1.4 UNIT PRICES

A. Unit prices for earthwork are included in Division 01 Section "Unit Prices."

B. Rock Measurement: Volume of rock actually removed, measured in original position. See Article "Excavation, General" for rock pay limits..

1.5 DEFINITIONS

A. Backfill: Soil material or controlled low-strength material used to fill an excavation.
   1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
   2. Final Backfill: Backfill placed over initial backfill to fill a trench.

B. Base Course: Aggregate layer placed between the subbase course and hot-mix asphalt paving.

C. Bedding Course: Aggregate layer placed over the excavated subgrade in a trench before laying pipe.

D. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.

E. Drainage Course: Course supporting the slab-on-grade that also minimizes upward capillary flow of pore water.

F. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.
   1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Architect. Authorized additional excavation and replacement material will be paid for according to Contract provisions for unit prices or changes in the Work.
   2. Bulk Excavation: Excavation more than 10 feet in width.
   3. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Architect. Unauthorized excavation, as well as remedial work directed by Architect, shall be without additional compensation.

G. Fill: Soil materials used to raise existing grades.

H. Rock: Rock material in beds, ledges, unstratified masses, conglomerate deposits, and boulders of rock material that exceed 2 cu. yd. for bulk excavation or 1 cu. yd. for footing, trench, and pit excavation that cannot be removed by rock excavating equipment equivalent to the following in size and performance ratings, without systematic drilling, ram hammering, ripping, or blasting, when permitted:
   1. Excavation of Footings, Trenches, and Pits: Late-model, track-mounted hydraulic excavator; equipped with a 42-inch- wide, maximum, short-tip-radius rock bucket; rated at not less than 138-hp flywheel power with bucket-curling force of not less than 28,090 lbf and stick-crowd force of not less than 18,650 lbf; measured according to SAE J-1179.
   2. Bulk Excavation: Late-model, track-mounted loader; rated at not less than 210-hp flywheel power and developing a minimum of 48,510-lbf breakout force with a general-purpose bare bucket; measured according to SAE J-732.

I. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.

J. Subbase Course: Aggregate layer placed between the subgrade and base course.

K. Subgrade: Uppermost surface or elevation remaining after completing excavation, or top surface of a fill or backfill immediately below subbase, drainage fill, or topsoil materials.

L. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

1.6 SUBMITTALS

A. Delegated Design Submittal: For Soil Improvements indicated to comply with performance requirements and design criteria including analysis data and plans signed and sealed by the qualified professional engineer responsible for their preparation.
   1. Design Drawings signed and sealed by the professional engineer responsible for their preparation showing the location, layout, materials and construction, details of soil improvement.
   2. Written data and calculations and design assumptions.

B. Product Data: For the following:
   1. Each type of plastic warning tape.
   2. Geotextile fabrics.
   3. Controlled low-strength material, including design mixture.

C. Material Test Reports: From a qualified testing agency indicating and interpreting test results for compliance of the following with requirements indicated:
   1. Classification according to ASTM D 2487 of each borrow soil material proposed for fill and backfill.
   2. Laboratory compaction curve according to ASTM D 1557 for each borrow soil material proposed for fill and backfill.

D. Preexcavation Photographs or Videotape: Show existing conditions of adjoining construction and site improvements, including finish surfaces, that might be misconstrued as damage caused by earthwork operations. Submit before earthwork begins.

E. Earth Material Samples: Contractor shall be responsible for obtaining samples (50 lb. minimum) of earthwork materials proposed to be used and transporting them to the site seven calendar days in advance of the time planned for incorporating them into the work. Use of proposed materials by the Contractor prior to testing and approval or rejection shall be at the Contractor's risk. The following information shall be submitted with the samples.
   1. Location of borrow source site.
   2. Present and past usage of the source site and material.
   3. Any previously existing report(s) associated with an assessment of the source site, as relates to the presence of oil or hazardous material.
   4. Location within the source site from which the material will be obtained.

F. Up to three test series (gradation and laboratory compaction) will be completed by the geotechnical engineer or owner's agent for off-site borrow sources for each category of earth materials defined in Part 2 of this Section at the cost. Testing of

additional samples or sources shall be at the Contractor's cost. Retesting of failed results as noted above shall be at the Contractor's cost.

1. Sieve analysis to be based on washed sieve analysis in accordance with appropriate ASTM Standard.

G. Material Test Reports: For each on-site and borrow soil material proposed for fill and backfill as follows:
   1. Classification according to ASTM D 2487.
   2. Laboratory compaction curve according to ASTM D 1557.
   3. Report of actual unconfined compressive strength and/or results of bearing tests of each stratum tested.

H. Flowable Fill Mix Design: Submit mix design with admixture information for review and approval a minimum of 15 days prior to start of Work.

1.7 QUALITY ASSURANCE

A. Pre-excavation Conference: Conduct conference at Project site.
   1. Before commencing earthwork, meet with representatives of the governing authorities, owner, architect, engineer, consultants, independent testing agency, and other concerned entities. Review earthwork procedures and responsibilities including testing and inspection procedures and requirements. Notify participants at least three working days prior to convening conference. Record discussions and agreements and furnish a copy to each participant.

1.8 PROJECT CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during earth moving operations.
   1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
   2. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.

B. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted in writing by Architect and then only after arranging to provide temporary utility services according to requirements indicated.
   1. Notify Architect not less than seven days in advance of proposed utility interruptions.
   2. Do not proceed with utility interruptions without Architect's written permission.
   3. Contact utility-locator service for area where Project is located before excavating.

C. Existing Utilities:
   1. Notify utility locator service for area where project is located before site clearing or excavating. Contact Dig Safe not less than 3 business days before starting the work. Dig Safe requirements are in addition to local and/or State DOT street opening permit requirements

2. Hire private utility markout service for areas not marked by utility companies. See the "General Conditions" of the construction contract.
3. Before starting excavation, establish location and extent of any underground utilities occurring in work area. Make arrangements with appropriate utility company for removal and relocation of lines which are in the way of excavation. If utilities are to remain in place, provide adequate means of support and protection during earthwork operations.
4. Should uncharted or incorrectly charted piping or other utilities be encountered during excavation, consult utility owner immediately for direction. Cooperate with owner, owner's agent, Architect and utility companies in keeping respective services and facilities in operation. Repair damaged utilities to satisfaction of utility owner.
5. Inactive or abandoned utilities encountered during construction operations shall be removed, plugged or capped. The location of such utilities shall be noted on record drawings and reported in writing to Architect Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies for shutoff services if lines are active.
6. Do not interrupt existing utilities serving facilities occupied and used by owner or others, during occupied hours, except when permitted in writing by owner's agency and then only after arranging to provided acceptable temporary utility services. Provide minimum of seven days notice to Architect and receive written notice to proceed before interrupting any utility. Do not proceed with utility interruptions without owner's written permission.
7. When in the course of the work it is necessary to connect a utility to a main in a public way, all the requirements of both the authorities governing the utility and those governing the public way shall be met. Pavement shall be temporarily and permanently replaced as directed by these authorities at no additional cost to the owner.

D. Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies to shut off services if lines are active.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS - GENERAL

A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.

B. Satisfactory Soils: ASTM D 2487 Soil Classification Groups GW, GP, GM, SW, SP, and SM, or a combination of these groups; free of rock or gravel larger than 3 inches in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.

C. Unsatisfactory Soils: Soil Classification Groups GC, SC, CL, ML, OL, CH, MH, OH, and PT according to ASTM D 2487, or a combination of these groups.

1. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.
2. Unsuitable Materials also include material containing excessive plastic clay, vegetation, organic matter, debris, pavement, stones or boulders over 6 inches in greatest dimension, and frozen material. Material which, in the opinion of the Geotechnical Engineer, will not provide a suitable foundation or subgrade.

D. On-Site Material: Any suitable material from on-site excavation.

E. Common Borrow: Inorganic mineral soil suitable for embankment construction free from frozen material, perishable rubble, peat and other unsuitable material.

F. Backfill and Fill: Satisfactory soil materials.

G. Unless indicated otherwise, materials shall conform to the "Standard Specification for Highways and Bridges" revision of November 2014, Maine Department of Transportation (abbreviated as MDOT "Standard Specification").

H. Granular Borrow: Granular borrow shall be obtained from suitable excavated onsite soil or offsite borrow sources for use as fill and backfill below and interior to building areas except where other materials are specified or detailed, and as detailed on the drawings. Granular fill shall consist of non-plastic naturally or artificially graded mixture of sound coarse and fine aggregates free of debris, waste, frozen materials and organics and conforming to the following gradation:

Sieve Designation	Percent by Weight Passing Square Mesh Sieve
3-Inch	100
No. 4	30-90
No. 40	10-50
No. 200	0-8

I. Crushed Stone for use around underdrains and as the working mat at pile cap and grade beam locations shall meet the requirements of Maine Department of Transportation Standard Specifications Section 703.22, Underdrain Backfill, Type C.

J. 3/4 Inch Crushed Stone: Crushed stone shall be a quarry product 3/4 inch or washed gravel stone obtained from offsite sources for use as detailed on the drawings. Crushed stone shall consist of durable crushed rock or gravel stone essentially free of silt, clay, loam or other deleterious materials and shall conform to the following gradation requirements for the nominal size indicated.

Sieve Designation	Percent by Weight Passing Square Mesh Sieve
1-Inch	100
¾-Inch	90-100
½_Inch	20-55
3/8 Inch	0-15
No.4	0-5

K. 1-1/2 Inch Crushed Stone: Crushed stone shall be a quarry product or washed gravel stone obtained from offsite sources for use as detailed on the drawings. Crushed stone shall consist of durable crushed rock or gravel stone essentially free of silt, clay, loam or other deleterious materials and shall conform to the following gradation requirements for the nominal size indicated.

Sieve Designation	Percent by Weight Passing Square Mesh Sieve
2-Inch	100
1 ½ Inch	95-100
¾ Inch	35-70
3/8 Inch	10-30
No.4	0-5

L. Sand: Sieve analysis by weight:

Sieve Designation	Percent by Weight Passing Square Mesh Sieve
3/8 Inch	100
No.4	95-100
No. 16	50-85
No. 100	2-10

M. Impervious Fill: Clayey gravel and sand mixture capable of compacting to a dense state.

2.2 SOIL MATERIALS FOR ROADWAYS AND PARKING LOTS

A. Aggregate Subbase Material: Shall meet the requirements of Maine Department of Transportation Standard Specifications Section 703.06(c), Type D.

B. Aggregate Base Materials: Shall meet the requirements of MDOT Standard Specifications Section 703.06(a), Type A or Section 703.06(a), Type B as noted on the plans

2.3 SOIL MATERIALS FOR STRUCTURES

A. Structural Fill: Backfill under concrete slabs, entrance slabs, exterior slabs, in depression left from the removal of existing foundations and adjacent to the foundations and site walls. Hard, durable sand and gravel meeting the following gradation requirements:

Sieve Designation	Percent by Weight Passing Square Mesh Sieve
4-inch	100
3 Inch	90-100
No. 4	25-90
No. 40	0-30
No. 200	0-5

2.4 GEOTEXTILES

A. Subsurface Drainage Geotextile: Nonwoven needle-punched geotextile, manufactured for subsurface drainage applications, made from polyolefins or polyesters; with elongation greater than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:
1. Basis-of-Design Product: Mirafi 180N by Mirafi Inc., P.O. Box 240697, Charlotte, North Carolina 28224.
2. Survivability: Class 2; AASHTO M 288.

B. Separation Geotextile: Woven geotextile fabric, manufactured for separation applications, made from polyolefins or polyesters; with elongation less than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:
1. Basis-of-Design Product: Mirafi 600X by Mirafi Inc., P.O. Box 240697, Charlotte, North Carolina 28224.
2. Survivability: Class 2; AASHTO M 288.

2.5 FLOWABLE FILL MATERIAL

A. Flowable Fill: Mixture of cement, GranCem, sand, water and admixtures to produce a flowable fill with a 100 psi minimum, 28 day minimum compressive strength.

2.6 RIGID INSULATION

A. Extruded closed – cell rigid foamed polystyrene, 2 inch thickness, width of trench, Styrofoam HI-60 by Dow Chemical, or approved equal.

2.7 ACCESSORIES

A. Detectable Warning Tape: Acid- and alkali-resistant polyethylene 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 the 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 as follows:
   1. Red: Electric.
   2. Yellow: Gas, oil, steam, and dangerous materials.
   3. Orange: Telephone and other communications.
   4. Blue: Water systems.
   5. Green: Sewer systems.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.

B. Preparation of subgrade for earthwork operations including removal of vegetation, topsoil, debris, obstructions, and deleterious materials from ground surface is specified in Division 31 Section "Site Clearing."

C. Protect and maintain erosion and sedimentation controls, which are specified on the plans and in Division 31 Section " Site Clearing," during earthwork operations.

D. Provide protective insulating materials to protect subgrades and foundation soils against freezing temperatures or frost.

E. Provide protective construction fence around all landscaping in work area to remain.

F. Paved surfaces: Do not operate equipment on paved surfaces that will damage surface.

G. Preparation of Building Area for Foundations:
   1. The Contractor’s bid is to include the costs to excavate and legally dispose of from the site all materials within the building footprint to the subgrade elevations indicated on the drawings, including stripping of topsoil. The Contractor’s bid is also to include all excavation of the area of proposed footings plus 2 feet horizontally (minimum) beyond the area of all footings, 4.5 feet horizontally (minimum) from building entrances, as well as excavation of necessary transitional slopes per OSHA requirements, and backfill with compacted granular fill. The Contractor’s bid is to include the removal of all previous construction including foundations, walls, slabs and abandoned utilities from within the limits of the proposed building.

Additionally the Contractor's bid is to include the costs to furnish and place compacted granular fill and base materials to the slab subgrade elevations indicated on the drawings.

2. Excavation of Unsuitable Material within the Influence of the Building Foundations: Additional excavation to remove existing fill or other unsuitable material from within the areas of influence of the foundations and below slabs-on-grade shall be conducted when so directed by the Architect or Geotechnical Engineer. The horizontal limits of excavation below footing level shall be one foot beyond the outside perimeter of the footing plus an additional one foot for every foot of depth below the footing, unless otherwise directed by the engineer.
3. The structural plans indicate estimated areas of the building excavation where subgrade soils do net reach adequate bearing strata on dense or very dense glacial till. Overexcavation or soil improvements are required. Soil improvement if employed is a delegated design item. Refer to the structural plans for requirements.

3.2 DEWATERING

A. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.

B. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.
   1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches. The Contractor shall grade and ditch the site as necessary to direct surface runoff away from open excavations.
   2. Install a dewatering system, specified in Division 31 Section "Dewatering," to keep subgrades dry and convey ground water away from excavations. Maintain until dewatering is no longer required.
   3. The Contractor shall provide, at his own expense, adequate pumping and drainage facilities to keep all excavations and work sufficiently dry from groundwater and/or surface runoff so as not to adversely affect construction product or procedures nor cause excessive disturbance of underlying natural ground or footing and slab subgrades. Contractor shall similarly control water entering the excavation as a result of construction operations, such as washing of concrete equipment and tools and the like.
   4. Water from trenches and excavations shall be disposed of in such a manner as will not cause injury to public health, nor damage to public or private property, existing work, or work in progress, nor to the surface of roads, walks and streets, nor cause any undue interference with the use of the same by the public. The Contractor shall comply with all applicable environmental protection and/or sediment/erosion control regulations.
   5. Under no circumstances place concrete or fill, or lay piping or install appurtenances in excavations containing free water. Keep utility trenches free from water until pipe joint material has hardened.

3.3 SHEETING, SHORING AND BRACING

A. Refer to Section 315000 "Excavation Support and Protection."

3.4 EXPLOSIVES

A. Explosives: Do not use explosives.

3.5 EXCAVATION, GENERAL

A. Stability of Excavations:
   1. Slope sides of excavations to comply with OSHA regulations and local codes. Shore and brace where sloping is not possible because of space restrictions or stability to material excavated.
   2. Maintain sides and slopes of excavations in a safe condition until completion of backfilling.

B. Classified Excavation: Excavate to subgrade elevations. Material to be excavated will be classified as earth and rock. Do not excavate rock until it has been classified and cross sectioned by Architect. The Contract Sum will be adjusted for rock excavation according to unit prices included in the Contract Documents. Changes in the Contract time may be authorized for rock excavation.
   1. Earth excavation includes excavating pavements and obstructions visible on surface; underground structures, utilities, and other items indicated to be removed; together with soil, boulders, and other materials not classified as rock or unauthorized excavation.
      a. Intermittent drilling; blasting, if permitted; ram hammering; or ripping of material not classified as rock excavation is earth excavation.
   2. Rock excavation includes removal and disposal of rock. Remove rock to lines and subgrade elevations indicated to permit installation of permanent construction without exceeding the following dimensions:
      a. 24 inches (600 mm) outside of concrete forms other than at footings.
      b. 12 inches (300 mm) outside of concrete forms at footings.
      c. 6 inches (150 mm) outside of minimum required dimensions of concrete cast against grade.
      d. Outside dimensions of concrete walls indicated to be cast against rock without forms or exterior waterproofing treatments.
      e. 6 inches (150 mm) beneath bottom of concrete slabs on grade.
      f. 6 inches (150 mm) beneath pipe in trenches, and the greater of 24 inches (600 mm) wider than pipe or 42 inches (1065 mm) wide.

3.6 EXCAVATION FOR STRUCTURES

A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch. If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.

1. Pile Foundations: Stop excavations 6 to 12 inches (150 to 300 mm) above bottom of pile cap before piles are placed. After piles have been driven, remove loose and displaced material. Excavate to final grade, leaving solid base to receive concrete pile caps.
2. Excavation for Underground Tanks, Basins, and Mechanical or Electrical Utility Structures: Excavate to elevations and dimensions indicated within a tolerance of plus or minus 1 inch. Do not disturb bottom of excavations intended as bearing surfaces.

B. Matt Footing and Wall Footing Subgrades:
1. Portions of the excavation do not reach suitable bearing strata at the foundation subgrade elevation. Over excavate to suitable bearing strata as determined by the Geotechnical Engineer or design, furnish and install ground improvements as a delegated design item.
2. The subgrades will be sensitive to disturbance from construction activity. Contractor shall take every precaution to minimize the disturbance of excavated subgrades in the natural soils and fill encountered in the excavation. Such precautions shall include, but not be limited to, using excavation buckets without teeth and/or accomplishing excavation to final subgrade with hand tools. All materials disturbed during excavation shall be removed to undisturbed natural soils or re-compacted as directed by the geotechnical engineer.
3. Footing foundations shall bear on a minimum of 12 inches of crushed stone wrapped in non-woven geotextile filter fabric or compacted granular fill overlying natural inorganic soils or improved soils. . The crushed stone shall extend at least one foot horizontally beyond the limits of the footing.
4. Footing subgrades shall be prepared by excavating all existing material to the specified bottom of the footing elevation, 5 feet below existing grades, or as indicated on the Contract Documents, whichever is lower. Allow the geotechnical engineer and Architect to view the excavated subgrade at this level. The geotechnical engineer and Architect shall determine whether authorized additional excavation is required to remove unsuitable material. Remove and replace such unsuitable material in accordance with paragraph 3.05 B.2 of this section or as otherwise directed by the engineer.
5. Refill excavation to the specified bottom of the footing elevation with structural fill or improved soils placed and compacted in accordance with the requirements of this Section.
6. Proof compact the final footing subgrade with at least two passes of a vibratory plate compactor immediately prior to placing forms and reinforcing.

C. Subgrade for Slabs-on-Grade:

D. Slabs-on-grade shall be supported on crushed stone or subbase/base course(s) as indicated on the drawings.

E. Remove and replace excessively wet, disturbed or unstable material and proof compact the subgrade for the slab subbase/base course with at least six passes of a vibratory plate or vibratory roller compactor immediately prior to placement of slab base course material unless otherwise directed.

F. The final surface of the subgrade for the moisture retarder membrane and/or slabs-on-grade shall be proof rolled with at least four passes of an approved vibratory plate or vibratory drum compactor immediately prior to placing the membrane, reinforcing or concrete (as may be applicable).

G. EXCAVATION FOR WALKS AND PAVEMENTS

H. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

I. Saw cut pavement prior to excavation to provide a clean, uniform edge. Minimize disturbance of remaining pavement. Cut and remove the minimum amount of pavement required to do the work.

J. Use shoring and bracing where sides of excavation will not stand without undermining pavement.

3.7 EXCAVATION FOR UTILITY TRENCHES

A. Excavate trenches to indicated gradients, lines, depths, and elevations.
   1. Beyond building perimeter, excavate trenches to allow installation of top of pipe below frost line.

B. Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches higher than top of pipe or conduit, unless otherwise indicated.
   1. Clearance: 12 inches each side of pipe or conduit.

C. Trench Bottoms: Excavate trenches 4 inches (100 mm) deeper than bottom of pipe elevation to allow for bedding course. Hand excavate for bell of pipe.
   1. Excavate trenches 6 inches (150 mm) deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.

3.8 SUBGRADE INSPECTION

A. Notify Geotechnical Engineer and Architect when excavations have reached required subgrade.

B. If Geotechnical Engineer or Architect determines that unsatisfactory soil is present, continue excavation and replace with compacted backfill or fill material as directed.and in accordance with Article “Excavation for Structures” of this sectio.

C. Proof-roll subgrade as directed by the Geotechnical Engineer and /or Architect.

D. Proof-roll subgrade below the building slabs pavers and and pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.

1. Completely proof-roll subgrade in one direction[, repeating proof-rolling in direction perpendicular to first direction]. Limit vehicle speed to 3 mph (5 km/h).
2. Proof-roll with a loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons (13.6 tonnes).
3. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Geotechnical Engineer or Architect, and replace with compacted backfill or fill as directed.

E. Authorized Additional Excavation: In the case that unsuitable materials, as determined by the Geotechnical Engineer or Architect, are encountered at the specified subgrade elevation, the Geotechnical Engineer or Architect may direct the removal of the unsuitable material and refill with structural fill placed and compacted in accordance with the requirements of this Section. This work will be paid for according to Contract provisions for changes in the Work.

F. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Architect, without additional compensation.

3.9 UNAUTHORIZED EXCAVATION

A. Unauthorized Excavation: Unauthorized excavation consists of removal of materials beyond indicated subgrade elevations or dimensions without specific direction of the Architect. Unauthorized excavation, as well as remedial work specified by the Architect, shall be at the Contractor's expense.
1. In areas below structures, pavements and walks, backfill unauthorized excavation with structural fill placed and compacted in accordance with this Section, unless otherwise directed by the engineer.
2. Elsewhere, backfill and compact unauthorized excavations with granular fill, compacted to the requirements of this Section.
3. Where the excavation of otherwise suitable materials is required due to these materials being rendered unsuitable due to disturbance, construction activity, freezing or lack of protection from the elements, the Contractor shall excavate these materials and provide remedial work as specified above at no additional cost to the owner.

B. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill, with 28-day compressive strength of 2500 psi, may be used when approved by Architect.
1. Fill unauthorized excavations under other construction or utility pipe as directed by Architect.

3.10 STORAGE OF SOIL MATERIALS

A. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.

1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.11 BACKFILL

A. Backfilling Prior to Acceptance of Work Installed:
   1. Do not allow or cause the work performed or installed to be covered up or enclosed by work of this Section prior to all required inspections, tests and acceptances.
   2. Should any of the work be so enclosed or covered up before it has been accepted, uncover all such work at no additional cost to the owner.
   3. After the work has been completed, tested, inspected and accepted, make all repairs and replacements necessary to restore the work to the condition in which it was found at the time of uncovering, all at no additional cost to the owner.

B. Place and compact backfill in excavations promptly, but not before completing the following:
   1. Construction below finish grade including, where applicable, subdrainage, dampproofing, waterproofing, and perimeter insulation.
   2. Surveying locations of underground utilities for Record Documents.
   3. Testing and inspecting underground utilities.
   4. Removing concrete formwork.
   5. Removing trash and debris.
   6. Removing temporary shoring and bracing, and sheeting.

C. Place backfill on subgrades free of mud, frost, snow, or ice.

D. Unless otherwise specified or indicated on the drawings, the products specified in Part 2 of this Section shall be employed in the various fill and backfill applications indicated in that part. Place and compact fill material in layers to required elevations as follows:
   1. Under steps and ramps, use structural fill material.
   2. Under building slabs-on-grade, crushed stone. See Contract Documents for additional information.
   3. Under footings and foundations, use crushed stone.
   4. Against the interior face of foundation walls, use structural fill material. Use structural fill material to 3'-0" beyond the outside face of foundation walls. Use general fill beyond the 3 feet of granular fill.
   5. Against the interior face (retained soil side) of site retaining walls use crushed stone or structural fill material. Under utilities, use either bedding material or crushed stone (see drawings).
   6. Under equipment pads, use crushed stone.
   7. Under grass and planted areas, use general fill
   8. Under walks and pavements, use base and subbase material

E. All vegetation, peat, organic topsoil or subsoil, trash, debris, roots, stumps, and any compressible or otherwise deleterious materials shall be stripped from the

existing ground surface and removed from excavations prior to placement of fill or backfill.

F. Crushed stone fill under foundations is to be placed on non woven geotextile. Woven geotextile (Mirafi 600X or equal in areas requiring over excavation and for silty clay subgrades beneath floor areas.

G. All fill and backfill materials shall be placed in horizontal layers. Each layer shall be spread evenly and thoroughly mixed during spreading to ensure uniformity of material in each layer. Layer thickness shall not exceed that specified.

H. Where horizontal fill layers meet a natural or excavated slope, the layer shall be keyed into the slope by cutting a bench. The surface of benches shall be compacted to the same requirements as apply to the area being filled.

I. In no instance place fill over materials that were permitted to freeze prior to compaction or over ice or snow. Removal of such materials will be required as directed by the engineer. In no case will frozen material be allowed for use in fill or backfill.

J. No fill shall be placed or compacted during unfavorable weather conditions. When work is interrupted by heavy rains or snow, fill operations shall not be resumed until the moisture content and density of previously placed fill are as specified hereinafter.

3.12 UTILITY TRENCH BACKFILL

A. Place backfill on subgrades free of mud, frost, snow, or ice.

B. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.

C. Backfill trenches excavated under footings and within 18 inches of bottom of footings with satisfactory soil; fill with concrete to elevation of bottom of footings. Concrete is specified in Division 03 Section "Cast-in-Place Concrete."

D. Backfill under all existing utility pipes crossed during construction operations with ¾-inch crushed stone. Crushed stone backfill shall extend continuously from the bedding of new utility pipes to the utility pipe crossed, including a 6-inch thick envelope of crushed stone all around the existing utility pipes. Crushed stone backfill shall stand at its own angle of repose. No “haunching” or “forming” with common fill will be allowed.

E. Provide 4-inch- thick, concrete-base slab support for piping or conduit less than 30 inches below surface of roadways. After installing and testing, completely encase piping or conduit in a minimum of 4 inches of concrete before backfilling or placing roadway subbase.

F. Place and compact initial backfill of bedding material or ¾" crushed stone to a height of 12 inches over the utility pipe or conduit.
   1. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of utility piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.

G. Electrical and Telecommunications Conduit:
   1. Electrical Conduits: Bury beneath finish grade a minimum of 30 inches to top of conduit, or as required by the National Electrical Code or local utility company, whichever is deeper. Surround conduits by a minimum of 6 inches of sand or bedding material.
   2. Telephone and Communication Conduits: Bury beneath finish grade a minimum of 30 inches to top of conduit, or as required by the local utility company, whichever is deeper. Surround conduits by a minimum of 6 inches of sand or bedding material.

H. Controlled Low-Strength Material: Place initial backfill of controlled low-strength material to a height of 12 inches over the utility pipe or conduit.

I. Backfill voids with satisfactory soil while installing and removing shoring and bracing.

J. Place and compact final backfill of satisfactory soil to final subgrade elevation.

K. Controlled Low-Strength Material: Place final backfill of controlled low-strength material to final subgrade elevation.

L. Install warning tape directly above utilities, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

M. Coordinate backfilling with utilities testing.

3.13 SOIL FILL

A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.

B. Place and compact fill material in layers to required elevations as follows:
   1. Under grass and planted areas, use satisfactory soil material.
   2. Under walks and pavements, use satisfactory soil material.
   3. Under steps and ramps, use structural fill.
   4. Under building slabs, use structural fill.
   5. Under footings and foundations, use structural fill.

C. Place soil fill on subgrades free of mud, frost, snow, or ice.

3.14 SOIL MOISTURE CONTROL

A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content.
   1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.
   2. Remove and replace, or scarify and air dry otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

B. Moisture Control:
   1. Water shall be added to fill material which does not contain sufficient moisture to be compacted to the specified densities. Fill and backfill material containing excess moisture shall be required to dry prior to or during compaction to a moisture content not greater than two percentage points above optimum except that material which displays pronounced elasticity or deformation underfoot or under load shall be required to dry to optimum moisture content before it is placed and compacted, if that is required to achieve specified compaction. At the Contractor's option, material which is too wet may be removed and replaced with satisfactory material at no additional cost to the owner.
   2. The Contractor is alerted to the potential silty nature of the onsite soil which renders them sensitive to moisture. Onsite silty soils are difficult to handle and compact and are easily disturbed when wet. The Contractor shall plan and conduct his excavation and filling operations considering the nature of the onsite materials.

3.15 COMPACTION OF SOIL BACKFILLS AND FILLS

A. Place backfill and fill soil materials in layers not more than 12 inches in loose depth for material compacted by heavy compaction equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.

B. Place backfill and fill soil materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.

C. Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D 1557:

D. Allow the Geotechnical Engineer and Architect sufficient time to make necessary observations and tests. The degree of compaction shall be based on a maximum dry density as determined by ASTM Standard D1557 or AASHTO Standard T180. All fill and backfill placed in various areas shall be compacted in individual layers to minimum dry densities as follows:
   1. Under Structures, within Building Foundation Backfill Limits, Equipment Pads, Building Slabs, Steps and Pavements: 95 percent.
   2. Beside site retaining walls or tank walls: 95 percent
   3. Top 2 feet under pavement: 95 percent
   4. Below top 2 feet under pavement: 92 percent
   5. Trenches through paved areas, top 2 feet:: 95 percent

6. Trenches through paved areas, below top 2 feet: 92 percent
7. Trenches through unpaved areas: 92 percent
8. Embankments: 92 percent
9. Pipe Bedding: 92 percent
10. Under pipes through structural fills: 92 percent
11. Underdrain filter sand: 92 percent
12. Sand bedding for conduit: 95 percent
13. Grass and mulch areas: 90 percent
14. Uniformly graded crushed stone materials which are not suited to field density testing shall be compacted in accordance with the minimum compactive effort indicated in paragraph 3.10 L of this Section.

E. The term "under," as applied to building, structures and paved areas, shall be construed to include all materials immediately below the plan area of the building, as well as those materials within a line sloping at one vertical to one horizontal drawn downward and outward from the exterior of building foundation, structure foundation or paved area.

F. Compaction shall be by mechanical means designed specifically for compaction and approved by the engineer or Architect. The engineer or Architect reserves the right to disapprove any device or inadequate capacity or of type unsuited to the character of the material being compacted. In areas which are too restricted to permit the use of mechanical compactors, fill may be placed in 3 inch layers and compacted by hand rammer or pneumatic tools.

G. Where the geotechnical engineer determines that fill or backfill does not conform to the compacted density specified, or did not receive the minimum compactive effort specified, such fill shall be removed and replaced with conforming materials at the Contractor’s own cost.

H. Backfilling of Walls:
1. Do not backfill against walls until completion of slabs-on-grade, structural framing and suspended slabs which provide lateral support to these walls. In placing backfill, take special care to prevent any wedge action, eccentric loading or overloading by equipment used in backfilling and compaction. See Contract Documents for additional requirements.
2. Do not use equipment weighing more than 5,000 lbs. within 10 feet of all walls. Equipment weighing more than 5,000 lbs. shall not be used adjacent to walls, except as expressly approved by the engineer.
3. Backfill shall be placed concurrently on all sides of shafts, tunnel, and freestanding walls, each lift being compacted on all sides before successive lifts are placed. See Contract Documents for additional requirements.
4. Prevent damage to wall waterproofing or dampproofing when backfilling.

3.16 GRADING

A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.

1. Provide a smooth transition between adjacent existing grades and new grades.
2. Cut out soft spots, fill low spots, and trim high spots to comply with required surface tolerances.

B. Site Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:
1. Lawn or Unpaved Areas: Plus or minus 1 inch.
2. Walks: Plus or minus 1/2 inch.
3. Pavements: Plus or minus 1/2 inch.

C. Grading inside Building Lines: Finish subgrade to a tolerance of 1/2 inch when tested with a 10-foot straightedge.

D. Maintenance:
1. Protection of Graded Areas: Protect newly graded areas from traffic and erosion. Keep free of trash and debris.
2. Reconditioning Compacted Areas: Where completed compacted areas are disturbed by subsequent construction operations or adverse weather, scarify surface, re-shape, and compact to required density prior to further construction.

3.17 SUBSURFACE DRAINAGE

A. Subdrainage Pipe: Specified in Division 33 Section "Subdrainage."

B. Subsurface Drain: Place subsurface drainage geotextile around perimeter of subdrainage trench. Place a 6-inch course of filter material on subsurface drainage geotextile to support subdrainage pipe. Encase subdrainage pipe in a minimum of 12 inches of filter material, placed in compacted layers 6 inches thick, and wrap in subsurface drainage geotextile, overlapping sides and ends at least 6 inches.
1. Compact each filter material layer with a minimum of two passes of a plate-type vibratory compactor.

C. Drainage Backfill for Site Retaining Walls: Place and compact granular structural fill material over subsurface drain, in width indicated, to within 12 inches of final subgrade, in compacted layers 6 inches thick. Overlay drainage backfill with 1 layer of subsurface drainage geotextile, overlapping sides and ends at least 6 inches.
1. Compact each granular fill material layer to specified compaction of soil backfills and fills requirements.
2. Place and compact impervious fill over drainage backfill in 6-inch thick compacted layers to final subgrade.

3.18 SUBBASE AND BASE COURSES

A. Place subbase and base course on subgrades free of mud, frost, snow, or ice.

B. On prepared subgrade, place subbase and base course under pavements and walks as follows:
   1. Install separation geotextile on prepared subgrade according to manufacturer's written instructions, overlapping sides and ends.
   2. Place base course material over subbase course under hot-mix asphalt pavement.
   3. Shape subbase and base course to required crown elevations and cross-slope grades.
   4. Place subbase and base course 6 inches or less in compacted thickness in a single layer.
   5. Place subbase and base course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.
   6. Compact subbase and base course at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 95 percent of maximum dry unit weight according to ASTM D 1557.

C. Pavement Shoulders: Place shoulders along edges of subbase and base course to prevent lateral movement. Construct shoulders, at least 12 inches (300 mm) wide, of satisfactory soil materials and compact simultaneously with each subbase and base layer to not less than the specified compaction of soil backfills and fills requirements.

3.19 DRAINAGE COURSE

A. Place drainage course on subgrades free of mud, frost, snow, or ice.

B. On prepared subgrade, place and compact drainage course under cast-in-place concrete slabs-on-grade as follows:
   1. Install subdrainage geotextile on prepared subgrade according to manufacturer's written instructions, overlapping sides and ends.
   2. Place drainage course 6 inches (150 mm) or less in compacted thickness in a single layer.
   3. Place drainage course that exceeds 6 inches (150 mm) in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches (150 mm) thick or less than 3 inches (75 mm) thick.
   4. Compact each layer of drainage course to required cross sections and thicknesses to not less than 95 percent of maximum dry unit weight according to ASTM D 1557.

3.20 FIELD QUALITY CONTROL

A. Special Inspections: Owner will engage a qualified special inspector to perform following special inspections:
   1. Determine prior to placement of fill that site has been prepared in compliance with requirements.
   2. Determine that fill material and maximum lift thickness comply with requirements.

3. Determine, at the required frequency, that in-place density of compacted fill complies with requirements.

B. Testing Agency: Owner will engage a qualified independent geotechnical engineering testing agency to perform field quality-control testing.

C. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earthwork only after test results for previously completed work comply with requirements.

D. Footing Subgrade: At footing subgrades, each soil stratum will be verified by a Geotechnical Engineer to confirm subgrade preparation and ability to support design bearing capacities.

E. Testing agency will test compaction of soils in place according to ASTM D 1556, ASTM D 2167, ASTM D 2922, and ASTM D 2937, as applicable.
1. Field in-place density tests may also be performed by the nuclear method according to ASTM D 2922, provided that calibration curves are periodically checked and adjusted to correlate to tests performed using ASTM D1556. With each density calibration check, check the calibration curves furnished with the moisture gages according to ASTM D 3017.
2. When field in-place density tests are performed using nuclear methods, make calibration checks for both density and moisture gages at the beginning of work, on each different type of material encountered and at intervals as directed by the engineer.
3. Building Slab Areas: At subgrade and at each compacted fill and backfill layer, at least one test for every 2000 sq. ft. or less of paved area or building slab, but in no case fewer than three tests.
4. Wall Backfill: At each compacted backfill layer, at least one test for every 100 feet or less of wall length, but no fewer than two tests along a wall face.
5. Trench Backfill: At each compacted initial and final backfill layer, at least one test for every 150 feet or less of trench length, but no fewer than two tests.
6. Pavement areas: At subgrade and at each compacted fill and backfill layer, at least one test for every 2000 sq. ft. or less of paved area or building slab, but in no case fewer than three tests.

F. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil to depth required; recompact and retest until specified compaction is obtained.

3.21 PROTECTION

A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.

1. Scarify or remove and replace soil material to depth as directed by Geotechnical Engineer or Architect; reshape and recompact.

C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.
   1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.22 DISPOSAL OF SURPLUS AND WASTE MATERIALS

A. Disposal: Remove surplus satisfactory soil and waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off Owner's property.

B. If hazardous waste or special waste as defined by the U.S. Environmental Protection Agency or State Department of Environmental Protection is encountered during excavation, the Contractor shall avoid disturbance of that material, and shall notify the Engineer immediately. The State Bureau of Oil and Hazardous Waste Control shall be notified and consulted prior to disturbance of the waste or contaminated soil. Removal and disposal of contaminated materials is not included in the Contract, and will be paid for by appropriate change order.

END OF SECTION 312000

SECTION 31 23 19

DEWATERING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes construction dewatering.

B. Related Sections:
1. Division 31 Section "Earth Moving" for excavating, backfilling, site grading, and for site utilities.
2. Division 31 Section "Excavation Support and Protection" for shoring, bracing, and sheet piling of excavations.
3. Division 33 Section "Subdrainage" for permanent foundation wall, underfloor, and footing drainage.

1.3 PERFORMANCE REQUIREMENTS

A. Dewatering Performance: Design, furnish, install, test, operate, monitor, and maintain dewatering system of sufficient scope, size, and capacity to control hydrostatic pressures and to lower, control, remove, and dispose of ground water and permit excavation and construction to proceed on dry, stable subgrades.

1. Delegated Design: Design dewatering system, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
2. Continuously monitor and maintain dewatering operations to ensure erosion control, stability of excavations and constructed slopes, that excavation does not flood, and that damage to subgrades and permanent structures is prevented.
3. Prevent surface water from entering excavations by grading, dikes, or other means.
4. Accomplish dewatering without damaging existing buildings, structures, and site improvements adjacent to excavation.
5. Remove dewatering system when no longer required for construction.

1.4 DELEGATED DESIGN SUBMITTALS

A. Delegated-Design Submittal: For dewatering system 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. Include layouts of piezometers and flow-measuring devices for monitoring performance of dewatering system.

2. Include a written plan for dewatering operations including control procedures to be adopted if dewatering problems arise

1.5 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer Retain first paragraph below if Contractor is responsible for field quality-control testing and inspecting.

B. Field quality-control reports.

C. Other Informational Submittals:

1. Show existing conditions of adjoining construction and site improvements that might be misconstrued as damage caused by dewatering operations.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer that has specialized in design of dewatering systems anddewatering work.

B. Regulatory Requirements: Comply with governing EPA notification regulations before beginning dewatering. Comply with hauling and disposal regulations of authorities having jurisdiction.

C. Preinstallation Conference: Conduct conference at Project site.

1. Review methods and procedures related to dewatering including, but not limited to, the following:

a. Inspection and discussion of condition of site to be dewatered including coordination with temporary erosion control measures and temporary controls and protections.
b. Geotechnical report.
c. Proposed site clearing and excavations.
d. Existing utilities and subsurface conditions.
e. Coordination for interruption, shutoff, capping, and continuation of utility services.
f. Construction schedule. Verify availability of Installer's personnel, equipment, and facilities needed to make progress and avoid delays.

g. Testing and monitoring of dewatering system.

1.7 PROJECT CONDITIONS

A. Interruption of Existing Utilities: Do not interrupt any utility serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility according to requirements indicated:

1. Notify Architect no fewer than seven days in advance of proposed interruption of utility.
2. Do not proceed with interruption of utility without Architect's written permission.

B. Project-Site Information: A geotechnical report has been prepared for this Project and is available for information only. The opinions expressed in this report are those of geotechnical engineer and represent interpretations of subsoil conditions, tests, and results of analyses conducted by geotechnical engineer. Owner will not be responsible for interpretations or conclusions drawn from this data.

1. Make additional test borings and conduct other exploratory operations necessary for dewatering.
2. The geotechnical report is referenced elsewhere in the Project Manual.

C. Survey Work: Engage a qualified land surveyor or professional engineer to survey adjacent existing buildings, structures, and site improvements, establishing exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.

1. During dewatering, regularly resurvey benchmarks, maintaining an accurate log of surveyed elevations for comparison with original elevations. Promptly notify Architect if changes in elevations occur or if cracks, sags, or other damage is evident in adjacent construction.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by dewatering operations.

1. Prevent surface water and subsurface or ground water from entering excavations, from ponding on prepared subgrades, and from flooding site and surrounding area.

2. Protect subgrades and foundation soils from softening and damage by rain or water accumulation.

B. Install dewatering system to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

C. Provide temporary grading to facilitate dewatering and control of surface water.

D. Do not allow water to accumulate in excavations. Establish and maintain temporary drainage ditches and other diversions outside excavation limits for each structure. Do not use excavated trenches as temporary drainage ditches

E. Monitor dewatering systems continuously.

F. Promptly repair damages to adjacent facilities caused by dewatering.

G. Protect and maintain temporary erosion and sedimentation controls, which are specified in Section "Erosion and Sedimentation Controls" and Division 31 Section "Site Clearing" during dewatering operations.

3.2 INSTALLATION

A. Install dewatering system utilizing wells, well points, or similar methods complete with pump equipment, standby power and pumps, filter material gradation, valves, appurtenances, water disposal, and surface-water controls.

1. Space well points or wells at intervals required to provide sufficient dewatering.
2. Use filters or other means to prevent pumping of fine sands or silts from the subsurface.

B. Before excavating below ground-water level, place system into operation to lower water to specified levels. Operate system continuously until drains, sewers, and structures have been constructed and fill materials have been placed or until dewatering is no longer required.

C. Provide an adequate system to lower and control ground water to permit excavation, construction of structures, and placement of fill materials on dry subgrades. Install sufficient dewatering equipment to drain water-bearing strata above and below bottom of foundations, drains, sewers, and other excavations.

1. Do not permit open-sump pumping that leads to loss of fines, soil piping, subgrade softening, and slope instability.

D. Reduce hydrostatic head in water-bearing strata below subgrade elevations of foundations, drains, sewers, and other excavations.

1. Maintain piezometric water level a minimum of 24 inches below surface of excavation.

E. Dispose of water removed by dewatering in a manner that avoids endangering public health, property, and portions of work under construction or completed. Dispose of water and sediment in a manner that avoids inconvenience to others. Provide sumps, sedimentation tanks, and other flow-control devices as required by authorities having jurisdiction.

F. Provide standby equipment on site, installed and available for immediate operation, to maintain dewatering on continuous basis if any part of system becomes inadequate or fails. If dewatering requirements are not satisfied due to inadequacy or failure of dewatering system, restore damaged structures and foundation soils at no additional expense to Owner.

1. Remove dewatering system from Project site on completion of dewatering. Plug or fill well holes with sand or cut off and cap wells a minimum of 36 inches below overlying construction.

G. Damages: Promptly repair damages to adjacent facilities caused by dewatering operations.

END OF SECTION 312319

This page intentionally left blank

SECTION 31 50 00

EXCAVATION SUPPORT AND PROTECTION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes temporary excavation support and protection systems.

B. Related Sections:
1. Division 01 Section "Temporary Facilities and Controls" for temporary utilities and support facilities.
2. Division 31 Section "Dewatering" for dewatering system for excavations.
3. Division 31 Section “Earth Moving” for earthwork.

1.3 PERFORMANCE REQUIREMENTS

A. Design, furnish, install, monitor, and maintain excavation support and protection system capable of supporting excavation sidewalls and of resisting soil and hydrostatic pressure and superimposed and construction loads.

1. Delegated Design: Design excavation support and protection system, including comprehensive engineering analysis by a qualified professional engineer licensed in the State of Maine, using performance requirements and design criteria indicated.
2. Provide professional engineering service need to assume engineering responsibility including preparation of Shop Drawings and a comprehensive engineering analysis.
3. Prevent surface water from entering excavations by grading, dikes, or other means.
4. Install excavation support and protection systems without damaging existing buildings, structures, and site improvements adjacent to excavation.
5. Monitor vibrations, settlements, and movements.

1.4 SUBMITTALS

A. Delegated-Design Submittal: For excavation support and protection system 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. Shop Drawings signed and sealed by the geotechnical engineer responsible for their preparation showing the location, layout and sizes of all members, details of connection, sequence of installation and removal.
   2. Written data and calculations and design assumptions for determination of loads and stresses acting on the temporary excavation support and protection systems.

B. Other Informational Submittals:

   1. Photographs or Videotape: Show existing conditions of adjacent construction and site improvements that might be misconstrued as damage caused by the absence of, the installation of, or the performance of excavation support and protection systems. Submit before Work begins.
   2. Record Drawings: Identifying and locating capped utilities and other subsurface structural, electrical, or mechanical conditions.

      a. Note locations and capping depth of wells and well points.

1.5 QUALITY ASSURANCE

A. Preinstallation Conference: Conduct conference at Project site.

   1. Review methods and procedures related to excavation support and protection system including, but not limited to, the following:

      a. Geotechnical report.
      b. Existing utilities and subsurface conditions.
      c. Proposed excavations.
      d. Proposed equipment.
      e. Monitoring of excavation support and protection system.
      f. Working area location and stability.
      g. Coordination with waterproofing.
      h. Abandonment or removal of excavation support and protection system.

B. Provide monitoring of the excavation support and protection system.

C. The Contractor shall have a minimum of five years experience within the last 10 years in excavation support and protection systems of similar type and complexity as is required for the project

1.6 PROJECT CONDITIONS

A. Interruption of Existing Utilities: Do not interrupt any utility serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility according to requirements indicated:

1. Notify Architect no fewer than seven days in advance of proposed interruption of utility.
2. Do not proceed with interruption of utility without Architect's / Owner's written permission.

B. Project-Site Information: A geotechnical report has been prepared for this Project and is available for information only. The opinions expressed in this report are those of geotechnical engineer and represent interpretations of subsoil conditions, tests, and results of analyses conducted by geotechnical engineer. Owner will not be responsible for interpretations or conclusions drawn from the data.

1. Make additional test borings and conduct other exploratory operations necessary for excavation support and protection.
2. The geotechnical report is referenced elsewhere in the Project Manual.

C. Survey Work: Engage a qualified land surveyor or professional engineer to survey adjacent existing buildings, structures, and site improvements; establish exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations. Locate datum level used to establish benchmark elevations sufficiently distant so as not to be affected by excavation operations.

1. During installation of excavation support and protection systems, regularly resurvey benchmarks, maintaining an accurate log of surveyed elevations and positions for comparison with original elevations and positions. Promptly notify Architect if changes in elevations or positions occur or if cracks, sags, or other damage is evident in adjacent construction.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 PREPARATION

A. Provide fully equipped rig(s) and appropriate tools in full-time operation at the site to complete the Work under this Section on schedule. Mobilize additional equip-ment to the site at no additional cost to the Owner to complete the Work of this Section on schedule.

B. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards that could develop during excavation support and protection system operations.

1. Shore, support, and protect utilities encountered.

C. Install excavation support and protection systems to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

D. Locate excavation support and protection systems clear of permanent construction so that forming and finishing of concrete surfaces are not impeded.

E. Monitor excavation support and protection systems daily during excavation progress and for as long as excavation remains open. Promptly correct bulges, breakage, or other evidence of movement to ensure that excavation support and protection systems remain stable.

F. Promptly repair damages to adjacent facilities caused by installing excavation support and protection systems.

3.2 BRACING

A. Bracing: Locate bracing to clear columns, floor framing construction, and other permanent work. If necessary to move brace, install new bracing before removing original brace.

1. Do not place bracing where it will be cast into or included in permanent concrete work unless otherwise approved by Architect.
2. Install internal bracing, if required, to prevent spreading or distortion of braced frames.
3. Maintain bracing until structural elements are supported by other bracing or until permanent construction is able to withstand lateral earth and hydrostatic pressures.

3.3 REMOVAL AND REPAIRS

A. Remove excavation support and protection systems when construction has progressed sufficiently to support excavation and bear soil and hydrostatic pressures. Remove in stages to avoid disturbing underlying soils or damaging structures, pavements, facilities, and utilities.

1. The bracing shall not be removed until the backfill has been placed and compacted to the required density to within two (2) feet below the level of bracing
2. Remove excavation support and protection systems in the public right of way completely. Remove excavation support and protection systems outside of the right of way as directed by the Engineer and to a minimum depth of 72 inches below overlaying construction and abandon remainder.
3. Any portion of excavation support and protection systems that extend below the bearing level of foundations shall be cut off and left in place so as not to disturb bearing soils upon removal of excavation support and protection systems.
4. The Contractor shall leave in place to be embedded in the backfill any portion of the excavation support and protection systems which the Architect may direct in writing for the purpose of preventing damage to the new construction, buildings, structures, streets, utilities and to maintain a stable excavation bottom. Elements left in place for convenience of the Contractor which were not specifically directed in writing to be left in place shall be at the Contractor's expense.
5. Fill voids immediately with approved backfill compacted to density specified in Division 31 Section "Earth Moving."
6. Repair or replace, as approved by Architect, adjacent work damaged or displaced by removing excavation support and protection systems.

END OF SECTION 315000

This page intentionally left blank

SECTION 32 12 16

ASPHALT PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Cold milling of existing hot-mix asphalt pavement.
2. Hot-mix asphalt patching.
3. Hot-mix asphalt paving.
4. Hot-mix asphalt paving overlay.
5. Pavement-marking paint.

B. Related Sections:

1. Division 02 Section "Structure Demolition" for demolition, removal, and recycling of existing asphalt pavements, and for geotextiles that are not embedded within courses of asphalt paving.
2. Division 31 Section "Earth Moving" for aggregate subbase and base courses and for aggregate pavement shoulders.

1.3 DEFINITION

A. Hot-Mix Asphalt Paving Terminology: Refer to ASTM D 8 for definitions of terms.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated. Include technical data and tested physical and performance properties.

1. Job-Mix Designs: Certification, by authorities having jurisdiction, of approval of each job mix proposed for the Work.
2. Job-Mix Designs: For each job mix proposed for the Work.
3. Job Mix Designs: Contractor shall submit a mix design using either the “Marshall Stability” or “Superpave” Mix Design Submittal Forms, included in

this specification, for each pavement course proposed for construction for the Owner's review and approval 45 days prior to schedule production and placement of the mix.

4. "Marshall Stability" design mix submittals shall include type/name of mix, gradation analysis, grade of asphalt cement, Marshall Stability in pounds flow, effective asphalt content in percent (%), and corresponding copies of the Maine Department of Transportation (MDOT) material specifications.
5. "Superpave" design mix submittals may be submitted in lieu of a "Marshall Stability" design mix, meeting the specifications of the Maine Department of Transportation.

B. Samples: For each paving fabric, 12 by 12 inches minimum.

C. Samples for Verification: For the following products, in manufacturer's standard sizes unless otherwise indicated:

1. Each paving fabric, 12 by 12 inches minimum.

D. Qualification Data: For qualified Installer.

E. Material Certificates: Contractor shall submit certificates stating that asphalt mix to be supplied complies with the specifications of the Maine Department of Transportation, latest revision, as well as copies the regulatory specifications corresponding to the asphalt mix formula and material. The certificates shall be signed by the asphalt mix producer and the Contractor.

F. Material Test Reports: For each paving material.

G. Material Test Reports: Provide two copies of each test.

1. Aggregate Material: Submit laboratory test reports that aggregates used in the bituminous mix conform to Section 703 of the MDOT Specifications, latest revision.
2. Asphalt Cement: Submit laboratory test reports that bituminous material used in the bituminous mix conforms to Section 702 of the MDOT Specifications, latest revision.
3. In-Place, Compacted Bituminous Concrete Mix: Submit laboratory test reports of samples cut from the in-place, compacted pavement indicating the percentage of theoretical maximum density (TMD), based on laboratory specimens of the mix combined in the proportions of the job mix formula.

1.5 QUALITY ASSURANCE

A. Manufacturer Qualifications: A paving-mix manufacturer registered with and approved by authorities having jurisdiction or the DOT of state in which Project is located.

B. Manufacturer Qualifications: Manufacturer shall be registered with and approved by authorities having jurisdiction and the MDOT.

C. Qualifications of Bituminous Concrete Producer: Use only materials which are furnished by a bulk bituminous concrete producer regularly engaged in production of hot-mix, hot-laid bituminous concrete.

D. Paving Contractor: Paving contractor shall be listed in the MDOT prequalified contractor list for paving projects and shall be valid at time of bidding and scheduled paving operations.

E. Testing Agency Qualifications: Qualified according to ASTM D 3666 for testing indicated.

F. Testing Agency Qualifications: Use only recognized commercial testing laboratories with not less than 5 years experience in conducting tests and evaluations of bituminous concrete materials and design.

G. Regulatory Requirements: Comply with materials, workmanship, and other applicable requirements of Maine DOT for asphalt paving work.

1. Measurement and payment provisions and safety program submittals included in standard specifications do not apply to this Section.

H. Preinstallation Conference: Conduct conference at Project site.

1. Review methods and procedures related to hot-mix asphalt paving including, but not limited to, the following:

a. Review proposed sources of paving materials, including capabilities and location of plant that will manufacture hot-mix asphalt.
b. Review condition of subgrade and preparatory work.
c. Review requirements for protecting paving work, including restriction of traffic during installation period and for remainder of construction period.
d. Review and finalize construction schedule and verify availability of materials, Installer's personnel, equipment, and facilities needed to make progress and avoid delays.
e. Review required testing and acceptance of work.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver pavement-marking materials to Project site in original packages with seals unbroken and bearing manufacturer's labels containing brand name and type of material, date of manufacture, and directions for storage.

B. Store pavement-marking materials in a clean, dry, protected location within temperature range required by manufacturer. Protect stored materials from direct sunlight.

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Do not apply asphalt materials if subgrade is wet or excessively damp, if rain is imminent or expected before time required for adequate cure, or if the following conditions are not met:

1. Tack Coat and Prime Coat: Minimum ambient temperature in the shade is 40 degree F and rising, immediately prior to application;
2. Asphalt Base Course: Minimum surface temperature of 40 degree F and rising at time of placement;
3. Asphalt Binder (Intermediate) Course: Minimum surface temperature of 40 degree F and rising at the time of placement; and,
4. Asphalt Surface Course: Minimum surface temperature is above 50 degree F at time of placement.

PART 2 - PRODUCTS

2.1 AGGREGATES

A. General: Use materials and gradations that have performed satisfactorily in previous installations.

B. Aggregates: Conform to Section 703 of MDOT Specifications, latest revision.

2.2 ASPHALT MATERIALS

A. Asphalt Binder: AASHTO M 320 or AASHTO MP 1a, PG 58-28.

B. Asphalt Cement – The type and grade of asphalt cement for the paving mixture shall comply with the applicable requirements of AASHTO Specification M226, Table 2, and meet MDOT specifications.

C. Asphalt Cement: Conform to Section 702 of MDOT Specifications.

D. Prime Coat: Asphalt emulsion prime coat complying with Maine DOT requirements.

E. Tack Coat: AASHTO M 140 emulsified asphalt, or AASHTO M 208 cationic emulsified asphalt, slow setting, diluted in water, of suitable grade and consistency for application.

F. Water: Potable.

2.3 AUXILIARY MATERIALS

2.4 MIXES

A. Hot Mix Asphalt – Per MDOT approved mix.

B. Hot-Mix Asphalt: Dense, hot-laid, hot-mix asphalt plant mixes approved by authorities having jurisdiction; designed according to procedures in AI MS-2, "Mix Design Methods for Asphalt Concrete and Other Hot-Mix Types"; and complying with the following requirements:

1. Provide mixes with a history of satisfactory performance in geographical area where Project is located.
2. Base Course: 403.207.
3. Surface Course: 403.210.

4. Provide mixes with a history of satisfactory performance in geographical area where Project is located.
5. Provide mixes complying with composition, grading, and tolerance requirements in ASTM D 3515 for the following nominal, maximum aggregate sizes:

   a. Base Course: 19.0mm.
   b. Surface Course: 9.5mm.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Verify that subgrade is dry and in suitable condition to begin paving.

B. Proof-roll subgrade below pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.

1. Completely proof-roll subgrade in one direction. Limit vehicle speed to 3 mph.
2. Proof roll with a loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons.
3. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Architect, and replace with compacted backfill or fill as directed.

C. Proceed with paving only after unsatisfactory conditions have been corrected.

D. Verify that utilities, traffic loop detectors, and other items requiring a cut and installation beneath the asphalt surface have been completed and that asphalt

surface has been repaired flush with adjacent asphalt prior to beginning installation of imprinted asphalt.

3.2 COLD MILLING

A. Clean existing pavement surface of loose and deleterious material immediately before cold milling. Remove existing asphalt pavement by cold milling to grades and cross sections indicated.

1. Mill to a depth of 2 inches.
2. Mill to a uniform finished surface free of excessive gouges, grooves, and ridges.
3. Control rate of milling to prevent tearing of existing asphalt course.
4. The Contractor shall coordinate the adjustment of manholes, meter boxes, drainage inlets, and valve boxes with the milling operation.
5. Repair or replace curbs, manholes, and other construction damaged during cold milling.
6. Excavate and trim unbound-aggregate base course, if encountered, and keep material separate from milled hot-mix asphalt.
7. Transport milled hot-mix asphalt to asphalt recycling facility.
8. Keep milled pavement surface free of loose material and dust.

B. All milled material shall become the property of the Contractor and shall be disposed of off-site or used in conformance with Section 312000, Earthwork, or for utilization as Reclaimed Asphalt Pavement, in conformance with the specification provided above, as approved by the Owner.

3.3 PATCHING

A. Hot-Mix Asphalt Pavement: Saw cut perimeter of patch and excavate existing pavement section to sound base. Excavate rectangular or trapezoidal patches, extending 12 inches into adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Remove excavated material. Recompact existing unbound-aggregate base course to form new subgrade.

B. Tack Coat: Apply uniformly to vertical surfaces abutting or projecting into new, hot-mix asphalt paving at a rate of 0.05 to 0.15 gal./sq. yd..

1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.
3. For patching where base or intermediate pavement is present, provide horizontal tack coat.

C. Patching: Partially fill excavated pavements with hot-mix asphalt base mix and, while still hot, compact. Cover asphalt base course with compacted, hot-mix surface layer finished flush with adjacent surfaces.

3.4 SURFACE PREPARATION

A. Proofroll crushed aggregate base in conformance with Section 312000 Earthwork, immediately prior to paving.

B. Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces. Ensure that prepared subgrade is ready to receive paving.

C. Prime Coat: Apply uniformly over surface of compacted unbound-aggregate base course at a rate of 0.15 to 0.50 gal./sq. yd.. Apply enough material to penetrate and seal but not flood surface. Allow prime coat to cure.

1. If prime coat is not entirely absorbed within 24 hours after application, spread sand over surface to blot excess asphalt. Use enough sand to prevent pickup under traffic. Remove loose sand by sweeping before pavement is placed and after volatiles have evaporated.
2. Protect primed substrate from damage until ready to receive paving.

D. Tack Coat: Apply uniformly to surfaces of existing pavement at a rate of 0.05 to 0.15 gal./sq. yd..

1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.
3. Adequate traffic control shall be provided to prohibit traffic from traversing applied area.
4. Any foreign matter on tack coat is to be removed and area re-tacked before applying pavement.

3.5 HOT-MIX ASPHALT PLACING

A. Plant Mix Hot Bituminous Pavement: Produce and place in conformance with Section 401 of MDOT Specifications.

B. Machine place hot-mix asphalt on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand to areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness when compacted.

1. Place hot-mix asphalt base course in number of lifts and thicknesses indicated.
2. Spread mix at minimum temperature of 275 deg Fand maximum temperature of 325 deg F.
3. Begin applying mix along centerline of crown for crowned sections and on high side of one-way slopes unless otherwise indicated.
4. Regulate paver machine speed to obtain smooth, continuous surface free of pulls and tears in asphalt-paving mat.

C. Place paving in consecutive strips not less than 10 feet wide unless infill edge strips of a lesser width are required.

1. After first strip has been placed and rolled, place succeeding strips and extend rolling to overlap previous strips. Complete a section of asphalt base course before placing asphalt surface course.

D. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

3.6 PAVEMENT OVERLAY

A. Raise all utility structures to grade.

B. Sweep entire area clean of all sand, dirt and debris.

C. Apply tack coat to all existing paved surfaces which abut proposed pavement.

3.7 TEMPORARY TRENCH PAVEMENT REPAIR

A. After trenching operations are complete, the Engineer may order temporary pavement repair.

B. Material: As specified within Contract Documents, meeting MDOT specifications, latest revision.

C. Clean surfaces of existing pavement which will be bonded to the temporary pavement. Apply tack coat.

D. Place material to a compacted depth of 2 inches or as required by contract documents.

E. Maintain temporary pavement smooth, free from potholes and to required grade.

F. Periodically inspect temporary pavement areas and repair as necessary, especially during the Winter months when the temporary pavement remains in place for an extended period. The Owner's Representative shall have the authority to order repair by the Contractor to areas which are, in his opinion, in unsatisfactory condition.

3.8 PERMANENT TRENCH PAVEMENT REPAIR

A. Saw edges of existing pavement to provide a clean vertical bonding face.

B. Remove temporary paving and sawn out existing paving.

C. Reset manhole frames and covers.

D. Apply a tack coat to the sawn edges and existing pavement that abuts proposed pavement.

E. Apply hot mix asphalt as directed by Contract Documents.

F. Roller compact both courses, compacting the final wear course to meet existing pavement surfaces exactly

3.9 JOINTS

A. Construct joints to ensure a continuous bond between adjoining paving sections. Construct joints free of depressions, with same texture and smoothness as other sections of hot-mix asphalt course.

1. Clean contact surfaces and apply tack coat to joints.
2. Offset longitudinal joints, in successive courses, a minimum of 6 inches.
3. Offset transverse joints, in successive courses, a minimum of 24 inches.
4. Construct transverse joints at each point where paver ends a day's work and resumes work at a subsequent time. Construct these joints as shown on Drawings.
5. Compact joints as soon as hot-mix asphalt will bear roller weight without excessive displacement.
6. Compact asphalt at joints to a density within 2 percent of specified course density.

3.10 COMPACTION

A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact hot-mix paving with hot, hand tampers or with vibratory-plate compactors in areas inaccessible to rollers.

1. Complete compaction before mix temperature cools to 185 deg F.

B. Breakdown Rolling: Complete breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Correct laydown and rolling operations to comply with requirements.

C. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling while hot-mix asphalt is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the following density:

1. Average Density: 95 percent of reference maximum theoretical density according to ASTM D 2041 for binder (intermediate) and surface courses.

2. Average Density: 95% ± 2.5% of reference maximum theoretical density according to ASTM D2041 for base courses.

D. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm.

E. Edge Shaping: While surface is being compacted and finished, trim edges of pavement to proper alignment. Bevel edges while asphalt is still hot; compact thoroughly.

F. Repairs: Remove paved areas that are defective or contaminated with foreign materials and replace with fresh, hot-mix asphalt. Compact by rolling to specified density and surface smoothness.

G. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.

H. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

3.11 INSTALLATION TOLERANCES

A. Pavement Thickness: Compact each course to produce the thickness indicated within the following tolerances:

1. Base Course: Plus or minus 1/4 inch.
2. Binder (Intermediate) Course: Plus or minus 1/4 inch.
3. Surface Course: Plus or minus 1/4 inch.

B. Pavement Surface Smoothness: Compact each course to produce a surface smoothness within the following tolerances as determined by using a 10-foot straightedge applied transversely or longitudinally to paved areas:

1. Base Course: 1/4 inch.
2. Binder (Intermediate) Course: 1/4 inch.
3. Surface Course: 1/4 inch.
4. Crowned Surfaces: Test with crowned template centered and at right angle to crown. Maximum allowable variance from template is 1/4 inch.

C. Contractor’s duties relating to testing include:

1. Notify Owner 72 hours prior to asphalt paving;
2. Notifying laboratory of conditions requiring testing; and
3. Coordinate with laboratory for field testing.

3.12 PAVEMENT MARKING

A. Do not apply pavement-marking paint until layout, colors, and placement have been verified with Architect.

B. Allow paving to age for 30 days before starting pavement marking.

C. Sweep and clean surface to eliminate loose material and dust.

D. Apply paint with mechanical equipment to produce pavement markings, of dimensions indicated, with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of 15 mils.

1. Broadcast glass beads uniformly into wet pavement markings at a rate of 6 lb/gal..

3.13 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections. Testing agency shall be paid by the Contractor.

B. Thickness: In-place compacted thickness of hot-mix asphalt courses will be determined according to ASTM D 3549.

C. Surface Smoothness: Finished surface of each hot-mix asphalt course will be tested for compliance with smoothness tolerances.

D. In-Place Density: Testing agency will take samples, at random locations, of uncompacted paving mixtures and compacted pavement according to AASHTO T 168.

1. Reference maximum theoretical density will be determined by averaging results from four samples of hot-mix asphalt-paving mixture delivered daily to site, prepared according to ASTM D 2041, and compacted according to job-mix specifications.
2. In-place density of compacted pavement will be determined by testing core samples according to ASTM D 1188 or ASTM D 2726.

   a. One core sample will be taken for every 1000 sq. yd. or less of installed pavement, with no fewer than 3 cores taken.
   b. Field density of in-place compacted pavement may also be determined by nuclear method according to ASTM D 2950 and correlated with ASTM D 1188 or ASTM D 2726.

E. Replace and compact hot-mix asphalt where core tests were taken.

F. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements at no cost to the Owner.

3.14 DISPOSAL

A. Except for material indicated to be recycled, remove excavated materials from Project site and legally dispose of them in an EPA-approved landfill.

   1. Do not allow milled materials to accumulate on-site.

3.15 ATTACHMENTS

NOTE: Attach any applicable MaineDOT Special Provisions as required.

END OF SECTION 321216

SECTION 32 13 13

CONCRETE PAVING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes exterior cement concrete pavement for the following:
   1. Walkways.
   2. Unit paver base.
   3. Utility pads.

B. Related Sections include the following:

   1. Division 03 Section "Cast-in-Place Concrete" for general building applications of concrete.
   2. Division 31 Section "Earth Moving" for subgrade preparation, grading, and subbase course.

1.2 DEFINITIONS

A. Cementitious Materials: Portland cement alone or in combination with one or more of blended hydraulic cement, fly ash and other pozzolans, and ground granulated blast-furnace slag.

1.3 SUBMITTALS

A. Product Data: For each type of manufactured material and product indicated.

B. Design Mixtures: For each concrete pavement mixture. Include alternate mixture designs when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

C. Material Test Reports: From a qualified testing agency indicating and interpreting test results for compliance of the following with requirements indicated, based on comprehensive testing of current materials:

   1. Aggregates..

D. Material Certificates: Signed by manufacturers certifying that each of the following materials complies with requirements:

   1. Cementitious materials.
   2. Fiber reinforcement.
   3. Admixtures.

4. Curing compounds.
5. Applied finish materials.
6. Bonding agent or epoxy adhesive.
7. Joint fillers.
8. Seal coat.

E. Field quality-control test reports.

F. Minutes of preinstallation conference.

1.4 QUALITY ASSURANCE

A. Manufacturer Qualifications: Manufacturer of ready-mixed concrete products who complies with ASTM C 94/C 94M requirements for production facilities and equipment.

1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."

B. Testing Agency Qualifications: An independent agency qualified according to ASTM C 1077 and ASTM E 329 for testing indicated, as documented according to ASTM E 548.

1. Personnel conducting field tests shall be qualified as ACI Concrete Field Testing Technician, Grade 1, according to ACI CP-01 or an equivalent certification program.

C. ACI Publications: Comply with ACI 301, "Specification for Structural Concrete," unless modified by requirements in the Contract Documents.

D. Concrete Testing Service: Engage a qualified independent testing agency to perform material evaluation tests and to design concrete mixtures.

E. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 01 Section "Project Management and Coordination."

1. Before submitting design mixtures, review concrete pavement mixture design and examine procedures for ensuring quality of concrete materials and concrete pavement construction practices. Require representatives, including the following, of each entity directly concerned with concrete pavement, to attend conference:

a. Contractor's superintendent.
b. Independent testing agency responsible for concrete design mixtures.
c. Ready-mix concrete producer.
d. Concrete pavement subcontractor.

F. Source Limitations: Obtain each type or class of cementitious material of the same brand from the same manufacturer's plant, obtain aggregate from one source, and obtain admixtures through one source from a single manufacturer.

1.5 PROJECT CONDITIONS

A. Traffic Control: Maintain access for vehicular and pedestrian traffic as required for other construction activities.

1.6 NOTIFICATION OF RELATED TRADES

A. Notify all other trades responsible for installing inserts, sleeves, anchors, when ready for such installation, and for final checking immediately before concrete is placed. Cooperate with such trades to obtain proper installation.

PART 2 - PRODUCTS

2.1 FORMS

A. Form Materials: Plywood, metal, metal-framed plywood, or other approved panel-type materials to provide full-depth, continuous, straight, smooth exposed surfaces.

1. Use flexible or curved forms for curves with a radius 100 feet or less.

2. Forms shall be constructed to conform to shapes, lines and dimensions shown, plumb and straight and shall be maintained sufficiently rigid to prevent deformation under load. Forms shall be sufficiently tight to prevent the leakage of concrete. Securely brace and shore forms to prevent displacement and to safely support the construction loads.

B. Form-Release Agent: Commercially formulated form-release agent that will not bond with, stain, or adversely affect concrete surfaces and will not impair subsequent treatments of concrete surfaces.

2.2 CONCRETE MATERIALS

A. Cementitious Material: Use the following cementitious materials, of the same type, brand, and source throughout the Project:

1. Portland Cement: ASTM C 150, Type I or II.

a. Fly Ash: ASTM C 618, Class C or F.
b. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.

B. Normal-Weight Aggregates: ASTM C 33, Class 4S coarse aggregate, uniformly graded. Provide aggregates from a single source.

1. Maximum Coarse-Aggregate Size: 3/4 inch nominal.
2. Fine Aggregate: Free of materials with deleterious reactivity to alkali in cement.

C. Water: ASTM C 94/C 94M.

D. Air-Entraining Admixture: ASTM C 260.

E. Chemical Admixtures: Provide admixtures certified by manufacturer to be compatible with other admixtures and to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material.

1. Water-Reducing Admixture: ASTM C 494/C 494M, Type A.
2. Water-Reducing and Retarding Admixture: ASTM C 494/C 494M, Type D.

2.3 FIBER REINFORCEMENT

A. Synthetic Fiber: Monofilament or fibrillated polypropylene fibers engineered and designed for use in concrete pavement, complying with ASTM C 1116, Type III, 1/2 to 1-1/2 inches long.

2.4 CURING MATERIALS

A. Absorptive Cover: AASHTO M 182, Class 2, burlap cloth made from jute or kenaf, weighing approximately 9 oz./sq. yd. dry.

B. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

C. Water: Potable.

D. Evaporation Retarder: Waterborne, monomolecular film forming; manufactured for application to fresh concrete.

2.5 RELATED MATERIALS

A. Expansion- and Isolation-Joint-Filler Strips: ASTM D 3575, polyethylene closed-cell expansion joint filler.

1. Product: SonoFlex F by W. R. Meadows (Sonneborn) or approved substitute.

B. Seal Coat: Seal coat for all exposed concrete walk surfaces shall consist of two coats of Hydrozo Clear 15 as manufactured by Hydrozo Coatings Company, Lincoln, Nebraska or Architect approved equal.

C. Bonding Agent: ASTM C 1059, Type II, non-redispersible, acrylic emulsion or styrene butadiene.

D. Epoxy Bonding Adhesive: ASTM C 881, two-component epoxy resin, capable of humid curing and bonding to damp surfaces, of class suitable for application temperature and of grade to requirements, and as follows:

1. Types I and II, non-load bearing, for bonding hardened or freshly mixed concrete to hardened concrete.

E. Joint Sealant: Single-component, pourable, plus 25 percent and minus 25 percent movement capability, traffic- and nontraffic-use, urethane joint sealant; ASTM C 920, Type S, Grade P, Class 25, Uses T and NT.

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. BASF Building Systems; Sonolastic NP1 (VOC 43).
b. Sherwin-Williams; Loxon 1K Smooth
c. Sika Corporation, Construction Products Division; Sikaflex - 1a.
d. Tremco Incorporated; Vulkem 116 or VOC Compliant (VOC 162 & 80).

2.6 CONCRETE MIXTURES

A. Prepare design mixtures, proportioned according to ACI 301, for each type and strength of normal-weight concrete determined by either laboratory trial mixes or field experience.

1. Use a qualified independent testing agency for preparing and reporting proposed concrete mixture designs for the trial batch method.

B. Proportion mixtures to provide normal-weight concrete with the following properties:

1. Compressive Strength (28 Days): 4000 psi.
2. Maximum Water-Cementitious Materials Ratio at Point of Placement: 0.45.
3. Slump Limit: 4 inches, plus or minus 1 inch.

C. Add air-entraining admixture at manufacturer's prescribed rate to result in normal-weight concrete at point of placement having an air content as follows:

1. Air Content: 7 percent plus or minus 1.5 percent for 3/4-inch nominal maximum aggregate size

D. Limit water-soluble, chloride-ion content in hardened concrete to 0.15 percent by weight of cement.

E. Chemical Admixtures: Use admixtures according to manufacturer's written instructions.
   1. Use water-reducing and retarding admixture when required by high temperatures, low humidity, or other adverse placement conditions.

F. Synthetic Fiber: Uniformly disperse in concrete mix at manufacturer's recommended rate, but not less than 3lb/cu. yd..

2.7 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M and ASTM C 1116. Furnish batch certificates for each batch discharged and used in the Work.

   1. When air temperature is between 85 deg F and 90 deg F, reduce mixing and delivery time from 1-1/2 hours to 75 minutes; when air temperature is above 90 deg F, reduce mixing and delivery time to 60 minutes.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine exposed subgrades and subbase surfaces for compliance with requirements for dimensional, grading, and elevation tolerances.

B. Proof-roll prepared subbase surface below concrete pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding.

   1. Completely proof-roll subbase in one direction and repeat in perpendicular direction. Limit vehicle speed to 3 mph.
   2. Proof-roll with a loaded 10-wheel tandem-axle dump truck weighing not less than 15 tons.
   3. Subbase with soft spots and areas of pumping or rutting exceeding depth of 1/2 inch require correction according to requirements in Division 31 Section "Earth Moving."

C. Proceed with concrete pavement operations only after nonconforming conditions have been corrected and subgrade is ready to receive pavement.

3.2 PREPARATION

A. Remove loose material from compacted subbase surface immediately before placing concrete.

3.3 EDGE FORMS AND SCREED CONSTRUCTION

A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides for pavement to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.

B. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

3.4 JOINTS

A. General: Form construction, isolation, and contraction joints and tool edgings true to line with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline, unless otherwise indicated.

1. When joining existing pavement, place transverse joints to align with previously placed joints, unless otherwise indicated.

B. Construction Joints: Set construction joints at side and end terminations of pavement and at locations where pavement operations are stopped for more than one-half hour unless pavement terminates at isolation joints.

1. Continue steel reinforcement across construction joints, unless otherwise indicated. Do not continue reinforcement through sides of pavement strips, unless otherwise indicated.
2. Provide tie bars at sides of pavement strips where indicated.

C. Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, walks, other fixed objects, and where indicated.

1. Locate expansion joints at intervals of 50 feet, unless otherwise indicated.
2. Align with existing joints where appropriate.
3. Extend joint fillers full width and depth of joint.
4. Terminate joint filler not less than 1/2 inch or more than 1 inch below finished surface if joint sealant is indicated.
5. Place top of joint filler flush with finished concrete surface if joint sealant is not indicated.
6. Furnish joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint-filler sections together.
7. Protect top edge of joint filler during concrete placement with metal, plastic, or other temporary preformed cap. Remove protective cap after concrete has been placed on both sides of joint.
8. Apply joint sealant material in accordance with manufacturer's instructions.

D. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness, as follows:

1. Grooved Joints: Form contraction joints after initial floating by grooving and finishing each edge of joint with grooving tool to a 1/4-inch radius. Repeat grooving of contraction joints after applying surface finishes. Eliminate groover marks on concrete surfaces.

E. Edging: Tool edges of pavement, gutters, curbs, and joints in concrete after initial floating with an edging tool to a 1/4-inch radius. Repeat tooling of edges after applying surface finishes. Eliminate tool marks on concrete surfaces.

3.5 CONCRETE PLACEMENT

A. Inspection: Before placing concrete, inspect and complete formwork installation, steel reinforcement, and items to be embedded or cast in. Notify other trades to permit installation of their work.

B. Remove snow, ice, or frost from subbase surface and reinforcement before placing concrete. Do not place concrete on frozen surfaces.

C. Moisten subbase to provide a uniform dampened condition at time concrete is placed. Do not place concrete around manholes or other structures until they are at required finish elevation and alignment.

D. Comply with ACI 301 requirements for measuring, mixing, transporting, and placing concrete.

E. Do not add water to concrete during delivery or at Project site.

F. Do not add water to fresh concrete after testing.

G. Deposit and spread concrete in a continuous operation between limits of construction joints until the placing of the panel or section is completed. Do not push or drag concrete into place or use vibrators to move concrete into place.

H. Consolidate concrete according to ACI 301 by mechanical vibrating equipment supplemented by hand spading, rodding, or tamping.

1. Consolidate concrete along face of forms and adjacent to transverse joints with an internal vibrator. Keep vibrator away from joint assemblies, reinforcement, or side forms. Use only square-faced shovels for hand spreading and consolidation. Consolidate with care to prevent dislocating reinforcement, dowels, and joint devices. Consolidate concrete during placement operations so concrete is thoroughly worked around reinforcement and other embedded items and into corners.

I. Screed pavement surfaces with a straightedge and strike off.

J. Commence initial floating using bull floats or darbies to impart an open textured and uniform surface plane before excess moisture or bleed water

appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.

K. Cold-Weather Placement: Comply with ACI 306.1 and as follows. Protect concrete work from physical damage or reduced strength that could be caused by frost, freezing actions, or low temperatures.

1. When air temperature has fallen to or is expected to fall below 40 deg F, uniformly heat water and aggregates before mixing to obtain a concrete mixture temperature of not less than 50 deg F and not more than 80 deg F at point of placement.
2. Do not use frozen materials or materials containing ice or snow.
3. Do not use calcium chloride, salt, or other materials containing antifreeze agents or chemical accelerators unless otherwise specified and approved in mix designs.
4. All temporary heat, from insulation, insulated blankets, coverings, or other equipment and materials necessary to protect the concrete work from physical damage caused by frost, freezing action, or low temperature shall be provided prior to start of placing operations. Prior to construction, proposed methods must be approved by the Engineer.

    a. When the air temperature has fallen to or is expected to fall below 40 deg. F, provide adequate means to maintain the temperature in the area where concrete is being placed between 50 and 70 deg. F. Temperature shall be maintained in this range for a minimum of 24 hours prior to concrete placement and 72 hours after concrete placement.

L. Hot-Weather Placement: Comply with ACI 301 and as follows when hot-weather conditions exist:

1. Cool ingredients before mixing to maintain concrete temperature below 90 deg F at time of placement. Chilled mixing water or chopped ice may be used to control temperature, provided water equivalent of ice is calculated to total amount of mixing water. Using liquid nitrogen to cool concrete is Contractor's option.
2. Cover steel reinforcement with water-soaked burlap so steel temperature will not exceed ambient air temperature immediately before embedding in concrete.
3. Fog-spray forms, steel reinforcement, and subgrade just before placing concrete. Keep subgrade moisture uniform without standing water, soft spots, or dry areas.

3.6 FLOAT FINISHING

A. General: Do not add water to concrete surfaces during finishing operations.

B. Float Finish: Begin the second floating operation when bleed-water sheen has disappeared and concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats, or by hand floating if area

is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.

1. Non-Slip Broom Finish (NSBrm-Fn): Provide a coarse finish by striating float-finished concrete surface 1/16 to 1/8 inch deep with a stiff-bristled broom, perpendicular to line of traffic.

    a. Apply non-slip broom finish to exterior concrete platforms, steps and ramps, and elsewhere as indicated.
    b. Coordinate required final finish with Architect before application.

3.7 CONCRETE PROTECTION AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.

B. Comply with ACI 306.1 for cold-weather protection.

C. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete, but before float finishing.

D. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.

E. Curing Methods: Cure concrete by moisture curing, moisture-retaining-cover curing, curing compound, or a combination of these as follows:

1. Moist Curing: Keep surfaces continuously moist for not less than seven days with the following materials:

    a. Water.
    b. Continuous water-fog spray.
    c. Absorptive cover, water saturated and kept continuously wet. Cover concrete surfaces and edges with 12-inch lap over adjacent absorptive covers.

2. Moisture-Retaining-Cover Curing: Cover concrete surfaces with moisture-retaining cover for curing concrete, placed in widest practicable width, with sides and ends lapped at least 12 inches, and sealed by waterproof tape or adhesive. Immediately repair any holes or tears during curing period using cover material and waterproof tape.

3.8 PAVEMENT TOLERANCES

A. Comply with tolerances of ACI 117 and as follows:

1. Elevation: 1/4 inch.
2. Thickness: Plus 3/8 inch, minus 1/4 inch.
3. Surface: Gap below 10-foot-long, unleveled straightedge not to exceed 1/4 inch.
4. Lateral Alignment and Spacing of Tie Bars and Dowels: 1 inch.
5. Vertical Alignment of Tie Bars and Dowels: 1/4 inch.
6. Alignment of Tie-Bar End Relative to Line Perpendicular to Pavement Edge: 1/2 inch.
7. Alignment of Dowel-Bar End Relative to Line Perpendicular to Pavement Edge: Length of dowel 1/4 inch per 12 inches.
8. Joint Spacing: 3 inches.
9. Contraction Joint Depth: Plus 1/4 inch, no minus.
10. Joint Width: Plus 1/8 inch, no minus.

3.9 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified independent testing and inspecting agency to perform field tests and inspections and prepare test reports.

B. Testing Services: Testing of composite samples of fresh concrete obtained according to ASTM C 172 shall be performed according to the following requirements:

1. Testing Frequency: Obtain at least 1 composite sample for each 50 cu. yd. 2000 sq. ft. or fraction thereof of each concrete mix placed each day.

    a. When frequency of testing will provide fewer than five compressive-strength tests for each concrete mixture, testing shall be conducted from at least five randomly selected batches or from each batch if fewer than five are used.

2. Slump: ASTM C 143/C 143M; one test at point of placement for each composite sample, but not less than one test for each day's pour of each concrete mix. Perform additional tests when concrete consistency appears to change.
3. Air Content: ASTM C 231, pressure method; one test for each composite sample, but not less than one test for each day's pour of each concrete mix.
4. Concrete Temperature: ASTM C 1064; one test hourly when air temperature is 40 deg F and below and when 80 deg F and above, and one test for each composite sample.
5. Compression Test Specimens: ASTM C 31/C 31M; cast and laboratory cure one set of three standard cylinder specimens for each composite sample.

6. Compressive-Strength Tests: ASTM C 39/C 39M; test 1 specimen at 7 days and 2 specimens at 28 days.

   a. A compressive-strength test shall be the average compressive strength from 2 specimens obtained from same composite sample and tested at 28 days.

C. Strength of each concrete mix will be satisfactory if average of any 3 consecutive compressive-strength tests equals or exceeds specified compressive strength and no compressive-strength test value falls below specified compressive strength by more than 500 psi.

D. Test results shall be reported in writing to Architect, concrete manufacturer, and Contractor within 48 hours of testing. Reports of compressive-strength tests shall contain Project identification name and number, date of concrete placement, name of concrete testing and inspecting agency, location of concrete batch in Work, design compressive strength at 28 days, concrete mixture proportions and materials, compressive breaking strength, and type of break for both 7- and 28-day tests.

E. Nondestructive Testing: Impact hammer, sonoscope, or other nondestructive device may be permitted by Architect but will not be used as sole basis for approval or rejection of concrete.

F. Additional Tests: Testing and inspecting agency shall make additional tests of concrete when test results indicate that slump, air entrainment, compressive strengths, or other requirements have not been met, as directed by Architect.

G. Remove and replace concrete pavement where test results indicate that it does not comply with specified requirements.

H. Additional testing and inspecting, at Contractor's expense, will be performed to determine compliance of replaced or additional work with specified requirements.

3.10 REPAIRS AND PROTECTION

A. Remove and replace concrete pavement that is broken, damaged, or defective or that does not comply with requirements in this Section.

B. Drill test cores, where directed by Architect, when necessary to determine magnitude of cracks or defective areas. Fill drilled core holes in satisfactory pavement areas with portland cement concrete bonded to pavement with epoxy adhesive.

C. Protect concrete from damage. Exclude traffic from pavement for at least 14 days after placement. When construction traffic is permitted, maintain pavement as clean as possible by removing surface stains and spillage of materials as they occur.

D. Maintain concrete pavement free of stains, discoloration, dirt, and other foreign material. Sweep concrete pavement not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION 321313

This page intentionally left blank

SECTION 32 16 13.43

GRANITE CURBING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Granite curbing.

B. Related Sections include the following:

1. Division 31 Section "Earth Moving" for excavation and compacted subgrade.

1.3 DESCRIPTION OF WORK

A. Provide all materials, equipment, and labor necessary for the placement of granite curbing as shown within the Contract Documents and as specified herein.

1.4 PROJECT CONDITIONS

A. Work on Public Ways: Comply with all regulations and requirements of local/state agencies having jurisdiction.

B. Weather Limitations: Comply with requirements in MDOT.

PART 2 - PRODUCTS

2.1 GRANITE CURBING

A. Provide curbing complying with MDOT Specifications Section 712.04, Vertical Curb, Type 1 and Sloped Granite Curbing, Type 5, complying with MDOT Material Specifications 712.04.

B. Circular granite curb shall be in reasonable close conformity with the shape and dimensions as shown in the Contract Documents and to the applicable material requirement.

C. Joint mortar shall be in accordance with MDOT Section 705.02.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install as indicated on Drawings and except as otherwise specified or indicated in compliance with MDOT 609.03.

B. Set curb with vertical face plumb, curb top parallel to adjacent surface.

C. The required spacing between sections of curb shall be assured by the use of an approved spacing device to provide an open joint between stones of at least 1/4 inch and no greater than 5/8 inch.

D. Set curb accurately to line and grade. Fit units as closely together as possible. Do not field cut curbing.

E. Backfilling: All remaining spaces under the curb shall be filled with approved material and thoroughly hard tamped so the curbing will have a firm uniform bearing on the foundation for the entire length and width. Any remaining excavated areas surrounding the curb shall be filled to the required grade with approved materials. This material shall be placed in layers not exceeding 8 inches in depth, loose measure and thoroughly tamped.

1. When backfill material infiltrates through the joints between the stones, small amounts of joint mortar or other approved material shall be placed in the back portion of the joint to prevent such infiltrating.
2. Reset any curb section disturbed during backfilling or otherwise reset to proper line and grade and properly backfill.

3.2 PROTECTION

A. Protect the curb and keep in good condition. Clean all exposed surfaces smeared or discolored and restored to a satisfactory condition or the curb stone removed and replaced.

END OF SECTION 321613.43

SECTION 32 39 13

VEHICLE BARRIER BOLLARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The Drawings, General Conditions of the Contract and Supplementary General Conditions apply to the work specified in this section.

1.2 SCOPE

A. The work of this section consists of site improvements and related items as indicated on the drawings and/or as specified herein and includes, but is not limited to, the following:
   1. Metal bollards for anti-ram passive vehicle barrier system.
   2. Bollard Cover Sleeves to match bollard size.

1.3 RELATED WORK UNDER OTHER SECTIONS

A. The following items of related work are specified and included in other sections of the specifications:
   1. Cast-in-Place Concrete - Section 03300

1.4 SYSTEM DESCRIPTION

A. General: Provide passive vehicle barrier system comprised of fixed and removable shallow passive bollards and stand alone foundation bollards. The system shall include all components required. System includes stainless steel bollard covers to match bollard size.

1.5 REFERENCES

A. ASTM A36 Standard Specification for Carbon Structural Steel

B. ASTM A123 - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

C. ASTM A500 Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes

D. ASTM A572 Standard Specification for High-Strength Low-Alloy Columbium-Vanadium Structural Steel

E. ASTM A992 Standard Specification for Structural Steel Shapes

F. ASTM D7803- Standard Practice for Preparation of Zinc (Hot-Dip Galvanized) Coated Iron and Steel Product and Hardware Surfaces for Powder Coating

G. ASTM B117 - Practice for Operating Salt-Spray (Fog) Apparatus.

H. ASTM D523 - Test Method for Specular Gloss.

I. ASTM D714 - Test Method for Evaluating Degree of Blistering in Paint.

J. ASTM G155 - Standard Practice for Operating Xenon Arc Light Apparatus for Exposure of Non-Metallic Materials

K. ASTM D1654 - Test Method for Evaluation of Painted or Coated Specimens Subjected to Corrosive Environments.

L. ASTM D2244 - Test Method for Calculation of Color Differences from Instrumentally Measured Color Coordinates.

M. ASTM D2794 - Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact).

N. ASTM D3359 - Test Method for Measuring Adhesion by Tape Test.

O. ASTM F3016 - Standard Test Method for Surrogate Testing of Vehicle Impact Protective Devices at Low Speeds

P. AWS D1.1/D1.1M - Structural Welding Code - Steel (2010)

1.6 ACTION SUBMITTALS

A. Shop Drawings: Submit shop drawings for each type of specified product including:
   1. Manufacturer’s literature including full description of materials, finshes colors and options.
   2. Color Samples: Submit manufacturer’s standard colors for selection.
   3. Installation details and instructions.
   4. Material certifications.
   5. Vehicle impct rating certifications.
   6. Maintenance Data: Submit manufacturer’s field touch-up, cleaning, and maintenance instructions.
   7. Warranty Documentation: Submit sample of manufacturer’s warranty

PART 2 – PRODUCTS

2.1 VEHICLE BARRIER BOLLARDS

A. Basis of Design Manufacturer: Subject to compliance with the requiremetns, provide products manufactured by Gibraltar Perimeter Security, L.P., Marble Falls, Texas. The entire barrier system shall be obtained from the manufacturer.

B. Bollard B1S: Gibraltar model G-1611F Fixed Shallow Bollard design. This system shall be tested and certified to meet ASTM F3016-19, Impact Condition Designation S10, Penetration Rating P1, with the capability of stopping a 5,000lb surrogate vehicle traveling at speeds up to 10 mph.

C. Bollard B2S: Gibraltar model G-1631F Fixed Shallow Bollard design. This system shall be tested and certified to meet ASTM F3016-19, Impact Condition Designation S30, Penetration Rating P1, with the capability of stopping a 5,000lb surrogate vehicle traveling at speeds up to 30mph.

D. Bollard B2S-R: Gibralatar model G-1631R Removable Shallow Bollard. This system shall be tested and certified to meet ASTM F3016-19, Impact Condition Designation S30, Penetration Rating P1, with the capability of stopping a 5,000lb surrogate vehicle traveling at speeds up to 30mph.

E. Bollard B3S: Gibraltar model G-1030 Engineered Stand Alone Foundation Bollard tested to the pass requirements in accordance with ASTM F2656-15 and achieve a rating of M30 P1 with the capacity of stopping a 15,000lb vehicle traveling at speeds of up to 30mph.

2.2 Bollard Cover Sleeves

A. Basis of Design Manufacturer: Reliance Foundry Company Limited, Surrey, BC V3S 7G7 1-8770789-3245. www.reliance-foundry.com

B. Stainless Steel Cover Sleeve
1. Cylindrical bollard cover with flat top.
2. Height 36” to match bollard.
3. Diameter 6” and 8” to match bollard.
4. Stainless steel: ASTM A312, Grade TP 316 Schedule 10.
5. Finish: Brushed, selected by Architect.
6. Warrantee: Provide manufacturer’s standard warranty against defects in materials and workmanship.
   a. Warranty Period: Five years from date of instalation.
   b. Coatings: Two years, against peeling, cracking, or significant color change.
7. Installation: Set crew and foam adhesive or as selected by Architect.

2.2 MATERIAL

A. Steel material for bollards shall conform to the following ASTM requirements:
   1. Welded Joints Perforemd by welders certified to AWS D1.1
   2. Steel Tubing: ASTM A500
   3. Steel Plates ASTM A36/A572 gr. 50
   4. W-Beams ASTM A992

2.3 FABRICATION

A. Fabrication of the members shall be in accordance to manufacturer's instructions, the plan details, and this specification.

B. Bollard coating system shall protect against the effects of long-term corrosion.
   1. The standard coating shall be Hot Dip Galvanized to ASTM A123.
   2. Architect shall specify the coating type (wet paint, powder coat, etc.), color and design to the manufacturer at the time of ordering.
   3. If complex powder coat design is required, the manufacturer may use a combination of powder coat and wet paint processes to achieve the final design.
   4. For standard solid color coating, the powder coating will consist of a multi-step, two coat powder coating process. The bottom coat is a zinc rich primer followed by a standard semi-gloss black top-coat.
   5. If the Archtiecct specifies a galvanized, then powder coated finish, the powder coating will be applied in accordance with ASTM D7803.

C. Bollard Cover Sleeve: Stanless steel covers shall bem 316 stanless, schedule 10 brushed finish.

PART 3 - EXECUTION

3.1 Installation

A. The barrier shall be installed per manufacturures instructions as approved in shop drawing submittals.
   1. Construct concrete foundations to the dimensions specified by the plans.
   2. Excavate a properly sized area for post foundations and install reinforcing steel in accordance with the plans.
   3. Place the concrete, install the posts and plumb. Refer to contract or submittal plans for more installation details.

B. Bollard cover shall be installed per manufacturures instructions as approved in shop drawing submittals and as slected byhte Archtiect.

END OF SECTION

SECTION 32 93 00

PLANTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Plants.
2. Planting soils.
3. Tree stabilization.

B. Related Sections:

1. Division 31 Section "Site Clearing" for protection of existing trees and plantings, topsoil stripping and stockpiling, and site clearing.
2. Division 31 Section "Earth Moving" for excavation, filling, and rough grading and for subsurface aggregate drainage and drainage backfill materials.

1.3 DEFINITIONS

A. Backfill: The earth used to replace or the act of replacing earth in an excavation.

B. Balled and Burlapped Stock: Plants dug with firm, natural balls of earth in which they were grown, with ball size not less than diameter and depth recommended by ANSI Z60.1 for type and size of plant required; wrapped with burlap, tied, rigidly supported, and drum laced with twine with the root flare visible at the surface of the ball as recommended by ANSI Z60.1.

C. Balled and Potted Stock: Plants dug with firm, natural balls of earth in which they are grown and placed, unbroken, in a container. Ball size is not less than diameter and depth recommended by ANSI Z60.1 for type and size of plant required.

D. Bare-Root Stock: Plants with a well-branched, fibrous-root system developed by transplanting or root pruning, with soil or growing medium removed, and with not less than minimum root spread according to ANSI Z60.1 for type and size of plant required.

E. Container-Grown Stock: Healthy, vigorous, well-rooted plants grown in a container, with a well-established root system reaching sides of container and maintaining a firm ball when removed from container. Container shall be rigid enough to hold ball shape and protect root mass during shipping and be sized according to ANSI Z60.1 for type and size of plant required.

F. Duff Layer: The surface layer of native topsoil that is composed of mostly decayed leaves, twigs, and detritus.

G. Fabric Bag-Grown Stock: Healthy, vigorous, well-rooted plants established and grown in-ground in a porous fabric bag with well-established root system reaching sides of fabric bag. Fabric bag size is not less than diameter, depth, and volume required by ANSI Z60.1 for type and size of plant.

H. Finish Grade: Elevation of finished surface of planting soil.

I. Manufactured Topsoil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.

J. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. This includes insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. It also includes substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.

K. Pests: Living organisms that occur where they are not desired, or that cause damage to plants, animals, or people. These include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.

L. Planting Area: Areas to be planted.

M. Planting Soil: Standardized topsoil; existing, native surface topsoil; existing, in-place surface soil; imported topsoil; or manufactured topsoil that is modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.

N. Plant; Plants; Plant Material: These terms refer to vegetation in general, including trees, shrubs, vines, ground covers, ornamental grasses, bulbs, corms, tubers, or herbaceous vegetation.

O. Root Flare: Also called "trunk flare." The area at the base of the plant's stem or trunk where the stem or trunk broadens to form roots; the area of transition between the root system and the stem or trunk.

P. Stem Girdling Roots: Roots that encircle the stems (trunks) of trees below the soil surface.

Q. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

R. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.

S. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil; but in disturbed areas such as urban environments, the surface soil can be subsoil.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated, including soils.

1. Plant Materials: Include quantities, sizes, quality, and sources for plant materials.

B. Samples for Verification: For each of the following:

1. Bark Mulch: 1-quart (1-liter) volume of each organic mulch required; in sealed plastic bags labeled with composition of materials by percentage of weight and source of mulch. Each Sample shall be typical of the lot of material to be furnished; provide an accurate representation of color, texture, and organic makeup.
2. Mineral Mulch: 5 lb (2.5 kg)of each mineral mulch required, in sealed plastic bags labeled with source of mulch. Sample shall be typical of the lot of material to be delivered and installed on the site; provide an accurate indication of color, texture, and makeup of the material.

C. Certification:

1. Submit seed vendor's certified statement for each grass seed mixture required, stating botanical and common name, percentage by weight, and percentages of purity, germination, and weed seed for each grass seed species.

D. Product Certificates: For each type of manufactured product, from manufacturer, and complying with the following:

1. Manufacturer's certified analysis of standard products.
2. Analysis of other materials by a recognized laboratory made according to methods established by the Association of Official Analytical Chemists, where applicable.

E. Maintenance Instructions: Recommended procedures to be established by Owner for maintenance of plants during a calendar year. Submit before start of required maintenance periods.

F. Warranty: Sample of special warranty.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: A qualified landscape Installer whose work has resulted in successful establishment of plants.

1. Professional Membership: Installer shall be a member in good standing of either the Professional Landcare Network or the American Nursery and Landscape Association.
2. Experience: Five years' experience in landscape installation in addition to requirements in Division 01 Section "Quality Requirements."
3. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.

B. Soil-Testing Laboratory Qualifications: An independent or university laboratory, recognized by the State Department of Agriculture, with the experience and capability to conduct the testing indicated and that specializes in types of tests to be performed.

C. Soil Analysis: For each unamended soil type, furnish soil analysis and a written report by a qualified soil-testing laboratory stating percentages of organic matter; gradation of sand, silt, and clay content; cation exchange capacity; deleterious material; pH; and mineral and plant-nutrient content of the soil.

1. Testing methods and written recommendations shall comply with USDA's Handbook No. 60.
2. The soil-testing laboratory shall oversee soil sampling; with depth, location, and number of samples to be taken per instructions from Architect. A minimum of three representative samples shall be taken from varied locations for each soil to be used or amended for planting purposes.
3. Report suitability of tested soil for plant growth.

a. Based upon the test results, state recommendations for soil treatments and soil amendments to be incorporated. State recommendations in weight per 1000 sq. ft. (92.9 sq. m) or volume per cu. yd. (0.76 cu. m) for nitrogen, phosphorus, and potash nutrients and soil amendments to be added to produce satisfactory planting soil suitable for healthy, viable plants.
b. Report presence of problem salts, minerals, or heavy metals, including aluminum, arsenic, barium, cadmium, chromium, cobalt, lead, lithium, and vanadium. If such problem materials are present, provide additional recommendations for corrective action.

D. Provide quality, size, genus, species, and variety of plants indicated, complying with applicable requirements in ANSI Z60.1.

1. Selection of plants purchased under allowances will be made by Architect, who will tag plants at their place of growth before they are prepared for transplanting.

E. Measurements: Measure according to ANSI Z60.1. Do not prune to obtain required sizes.

1. Trees and Shrubs: Measure with branches and trunks or canes in their normal position. Take height measurements from or near the top of the root flare for field-grown stock and container grown stock. Measure main body of tree or shrub for height and spread; do not measure branches or roots tip to tip. Take caliper measurements 6 inches (150 mm) above the root flare for trees up to 4-inch (100-mm) caliper size, and 12 inches (300 mm) above the root flare for larger sizes.
2. Other Plants: Measure with stems, petioles, and foliage in their normal position.

F. Plant Material Observation: Architect may observe plant material either at place of growth or at site before planting for compliance with requirements for genus, species, variety, cultivar, size, and quality. Architect retains right to observe trees and shrubs further for size and condition of balls and root systems, pests, disease symptoms, injuries, and latent defects and to reject unsatisfactory or defective material at any time during progress of work. Remove rejected trees or shrubs immediately from Project site.

1. Notify Architect of sources of planting materials seven days in advance of delivery to site.

G. Source Quality Control:

1. General: Ship landscape materials with certificates of inspection as required by governmental authorities. Comply with governing regulations applicable to landscape materials.
2. Analysis and Standards: Package standard products with manufacturer's certified analysis. For other materials, provide analysis and approval by a Maine Certified Landscape Professional (207-225-3998).
3. Topsoil: Before delivery of topsoil, furnish written statement giving location of properties from which topsoil is to be obtained.
4. Plant Material:

a. Plant materials shall mean trees, shrubs, ground covers, and plants of all descriptions, required to be furnished for the project and shall conform to all provisions of ANSI Z60.1.
b. Substitutions: In the event that trees, shrubs, or other plant material specified in the plant list are in the opinion of the

Contractor, impossible or unreasonably difficult to obtain, the Contractor shall immediately notify the Owner's Representative to discuss appropriate substitutions. No substitutions of plant material may be made without the prior approval of the Owner's Representative. When authorized, adjustment of Contract amount will be made.

5. Inspection: The Owner's Representative reserves the right to inspect any plant materials either at the place of growth or at the site before planting, for compliance with requirements for name, variety, size, quality and health.
6. All Work of planting shall be done by a proficient landscape Contractor with five years minimum experience.
7. The plant supplier/nursery shall be ALCA certified.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of conformance with state and federal laws if applicable. Protect materials from deterioration during delivery, and while stored at the site.

B. Plant Materials:

1. In preparing plants for moving, all precautions customary in good trade practice shall be taken. All plants shall be dug immediately before moving unless otherwise specified. Broken, loose, or manufactured balls will be rejected.
2. All plants shall be packed, transported, and handled with utmost care to insure adequate protection against injury and drying. Do not bend or bind-tie trees or shrubs in such manner as to damage bark, break branches or destroy natural shape. Provide protective covering during delivery.
3. Deliver plant materials after preparations for planting have been completed and plant immediately. If planting is delayed more than 6 hours after delivery, set all plants in shade, protect from weather and mechanical damage, and keep roots moist.
4. Label all plant materials of each variety with a securely attached waterproof tag bearing legible designation of botanical and common name.

C. Bulk Materials:

1. Do not dump or store bulk materials near structures, utilities, walkways and pavements, or on existing turf areas or plants.
2. Provide erosion-control measures to prevent erosion or displacement of bulk materials, discharge of soil-bearing water runoff, and airborne dust reaching adjacent properties, water conveyance systems, or walkways.

3. Accompany each delivery of bulk fertilizers and soil amendments with appropriate certificates.

D. Deliver bare-root stock plants freshly dug. Immediately after digging up bare-root stock, pack root system in wet straw, hay, or other suitable material to keep root system moist until planting.

E. Do not prune trees and shrubs before delivery. Protect bark, branches, and root systems from sun scald, drying, wind burn, sweating, whipping, and other handling and tying damage. Do not bend or bind-tie trees or shrubs in such a manner as to destroy their natural shape. Provide protective covering of plants during shipping and delivery. Do not drop plants during delivery and handling.

F. Handle planting stock by root ball.

G. Deliver plants after preparations for planting have been completed, and install immediately. If planting is delayed more than six hours after delivery, set plants and trees in their appropriate aspect (sun, filtered sun, or shade), protect from weather and mechanical damage, and keep roots moist.

1. Heel-in bare-root stock. Soak roots that are in dry condition in water for two hours. Reject dried-out plants.
2. Set balled stock on ground and cover ball with soil, peat moss, sawdust, or other acceptable material.
3. Do not remove container-grown stock from containers before time of planting.
4. Water root systems of plants stored on-site deeply and thoroughly with a fine-mist spray. Water as often as necessary to maintain root systems in a moist, but not overly-wet condition.

1.7 PROJECT CONDITIONS

A. Field Measurements: Verify actual grade elevations, service and utility locations, irrigation system components, and dimensions of plantings and construction contiguous with new plantings by field measurements before proceeding with planting work.

B. Interruption of Existing Services or Utilities: Do not interrupt services or utilities to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary services or utilities according to requirements indicated:

1. Notify Construction Manager no fewer than two days in advance of proposed interruption of each service or utility.
2. Do not proceed with interruption of services or utilities without Construction Manager's written permission.

C. Planting and Seeding Seasons: Unless variance is requested in writing and approved by the Owner's Representative, planting and seeding shall be done within the following dates:

1. Lawns: April 1 - September 15.
2. Plant Materials:

   a. Potted and Container Spring: April 1 - July 15.
   b. Grown Plants Fall: Aug. 15 - Nov. 15.

3. Balled and Burlapped Spring: April 1 - June 15.
4. Plants Fall: Aug. 15 - Oct. 15.

D. Weather Limitations: Proceed with planting only when existing and forecasted weather conditions permit planting to be performed when beneficial and optimum results may be obtained. Apply products during favorable weather conditions according to manufacturer's written instructions and warranty requirements.

E. Coordination with Turf Areas (Lawns): Plant trees, shrubs, and other plants after finish grades are established and before planting turf areas unless otherwise indicated.

1. When planting trees, shrubs, and other plants after planting turf areas, protect turf areas, and promptly repair damage caused by planting operations.

1.8 WARRANTY

A. Special Warranty: Installer agrees to repair or replace plantings and accessories that fail in materials, workmanship, or growth within specified warranty period.

1. Failures include, but are not limited to, the following:

   a. Death and unsatisfactory growth, except for defects resulting from abuse, lack of adequate maintenance, or neglect by Owner, or incidents that are beyond Contractor's control.
   b. Structural failures including plantings falling or blowing over.
   c. Deterioration of metals, metal finishes, and other materials beyond normal weathering.

2. Warranty Periods from Date of Substantial Completion :

   a. Trees, Shrubs, Vines, and Ornamental Grasses: 12 months.

b. Ground Covers, Biennials, Perennials, and Other Plants: 12 months.

3. Include the following remedial actions as a minimum:

a. Immediately remove dead plants and replace unless required to plant in the succeeding planting season.
b. Replace plants that are more than 25 percent dead or in an unhealthy condition at end of warranty period.
c. A limit of one replacement of each plant will be required except for losses or replacements due to failure to comply with requirements.
d. Provide extended warranty for period equal to original warranty period, for replaced plant material.

1.9 MAINTENANCE SERVICE

A. Initial Maintenance Service for Trees and Shrubs: Provide maintenance by skilled employees of landscape Installer. Maintain as required in Part 3. Begin maintenance immediately after plants are installed and continue until plantings are acceptably healthy and well established but for not less than maintenance period below.

1. Maintenance Period: Three months from date of Substantial Completion.

B. Initial Maintenance Service for Ground Cover and Other Plants: Provide maintenance by skilled employees of landscape Installer. Maintain as required in Part 3. Begin maintenance immediately after plants are installed and continue until plantings are acceptably healthy and well established but for not less than maintenance period below.

1. Maintenance Period: Three months from date of Substantial Completion.

C. Continuing Maintenance Proposal: From Installer to Owner, in the form of a standard yearly (or other period) maintenance agreement, starting on date initial maintenance service is concluded. State services, obligations, conditions, and terms for agreement period and for future renewal options.

PART 2 - PRODUCTS

2.1 PLANT MATERIAL

A. General: Furnish nursery-grown plants true to genus, species, variety, cultivar, stem form, shearing, and other features indicated in Plant Schedule or Plant Legend shown on Drawings and complying with ANSI Z60.1; and with healthy root systems developed by transplanting or root pruning. Provide well-shaped, fully branched, healthy, vigorous stock, densely foliated when in leaf

and free of disease, pests, eggs, larvae, and defects such as knots, sun scald, injuries, abrasions, and disfigurement.

1. All plants shall be nursery grown unless otherwise stated, and shall have been growing under the same climatic conditions as the location of this project for at least two (2) years prior to award date of this contract.
2. Trees with damaged, crooked, or multiple leaders; tight vertical branches where bark is squeezed between two branches or between branch and trunk ("included bark"); crossing trunks; cut-off limbs more than 3/4 inch (19 mm) in diameter; or with stem girdling roots will be rejected.
3. Collected Stock: Do not use plants harvested from the wild, from native stands, from an established landscape planting, or not grown in a nursery unless otherwise indicated.

B. Provide plants of sizes, grades, and ball or container sizes complying with ANSI Z60.1 for types and form of plants required. Plants of a larger size may be used if acceptable to Architect, with a proportionate increase in size of roots or balls.

C. Root-Ball Depth: Furnish trees and shrubs with root balls measured from top of root ball, which shall begin at root flare according to ANSI Z60.1. Root flare shall be visible before planting.

D. If formal arrangements or consecutive order of plants is shown on Drawings, select stock for uniform height and spread, and number the labels to assure symmetry in planting.

E. Deciduous Shrubs: Provide balled and burlapped (B&B) deciduous shrubs otherwise noted in plant list. Container grown deciduous shrubs will be acceptable in lieu of balled and burlapped deciduous shrubs as approved by the Owner's Representative.

F. Coniferous and Broadleafed Evergreens: Provide balled and burlapped (B&B) evergreens. Container grown evergreens will be acceptable as approved by the Owner's Representative.

G. Deciduous Trees: Provide balled and burlapped (B&B) deciduous trees unless otherwise noted in plant list. Container grown deciduous trees will be accepted in lieu of balled and burlapped deciduous trees as approved by the Owner's Representative.

H. Ground Cover: Provide plants established and well-rooted in removable containers or integral peat pots and with no less than the minimum number and length of runners required by ANSI Z60.1 for the pot size shown or listed.

2.2 INORGANIC SOIL AMENDMENTS

A. Lime: ASTM C 602, agricultural liming material containing a minimum of 80 percent calcium carbonate equivalent and as follows:

1. Class: T, with a minimum of 99 percent passing through No. 8 (2.36-mm) sieve and a minimum of 75 percent passing through No. 60 (0.25-mm) sieve.
2. Class: O, with a minimum of 95 percent passing through No. 8 (2.36-mm) sieve and a minimum of 55 percent passing through No. 60 (0.25-mm) sieve.
3. Provide lime in form of ground dolomitic limestone.

B. Sulfur: Granular, biodegradable, and containing a minimum of 90 percent sulfur, with a minimum of 99 percent passing through No. 6 (3.35-mm) sieve and a maximum of 10 percent passing through No. 40 (0.425-mm) sieve.

C. Iron Sulfate: Granulated ferrous sulfate containing a minimum of 20 percent iron and 10 percent sulfur.

D. Aluminum Sulfate: Commercial grade, unadulterated.

E. Perlite: Horticultural perlite, soil amendment grade.

F. Agricultural Gypsum: Minimum 90 percent calcium sulfate, finely ground with 90 percent passing through No. 50 (0.30-mm) sieve.

G. Sand: Clean, washed, natural or manufactured, and free of toxic materials.

H. Diatomaceous Earth: Calcined, 90 percent silica, with approximately 140 percent water absorption capacity by weight.

I. Zeolites: Mineral clinoptilolite with at least 60 percent water absorption by weight.

2.3 ORGANIC SOIL AMENDMENTS

A. Compost: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 3/4-inch (19-mm) sieve; soluble salt content of 5 to 10 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:

1. Organic Matter Content: 50 to 60 percent of dry weight.

B. Peat Humus: Peat humus shall be a natural peat approved by the Owner's Representative consisting or sedge, sphagnum or reed peat of such physical condition as will pass through a 1 in. screen and will be readily incorporated with the topsoil. The peat humus shall be free from sticks, stones, roots and other objectionable matter.

C. Manure: Well-rotted, unleached, stable or cattle manure containing not more than 25 percent by volume of straw, sawdust, or other bedding materials; free

of toxic substances, stones, sticks, soil, weed seed, debris, and material harmful to plant growth.

2.4 FERTILIZERS

A. : Commercial, raw or steamed, finely ground; a minimum of **4** percent nitrogen and **20** percent phosphoric acid.

B. Superphosphate: Commercial, phosphate mixture, soluble; a minimum of 20 percent available phosphoric acid.

C. Fertilizer: Fertilizer shall contain available elements in conformity with the standards of the Association of Official Agricultural Chemists. The fertilizer shall indicate the weight, contents and guarantee analysis shown thereon or on a securely attached tag, as applicable.

1. Granular fertilizer shall be a commercial grade fertilizer containing the following percentages of available nutrients by weight:

   a. Nitrogen 10 percent
   b. Phosphoric Acid 10 percent
   c. Potash 10 percent

2. Water soluble fertilizer shall be completely soluble in water and contain the following percentages of available nutrients by weight. It shall contain a coloring agent.

   a. Nitrogen 16 percent
   b. Phosphoric Acid 32 percent
   c. Potash 16 percent

3. Slow release fertilizer packets shall be slow release fertilizer contained in a polyethylene perforated bag with micropore holes. Each bag shall contain 4 ounces of minimum water soluble fertilizer to be effective for 8 years. Packages shall contain the following percentage of available elements by weight.

   a. Nitrogen 20 percent
   b. Phosphoric Acid 10 percent
   c. Potash 5 percent

D. The Owner's Representative may approve the use of other fertilizers providing they contain an equivalent amount of nutrients in an acceptable form.

E. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:

1. Composition: 1 lb/1000 sq. ft. (0.45 kg/92.9 sq. m) of actual nitrogen, 4 percent phosphorous, and 2 percent potassium, by weight.
2. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.

F. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:

1. Composition: 20 percent nitrogen, 10 percent phosphorous, and 10 percent potassium, by weight.
2. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing laboratory.

G. Planting Tablets: Tightly compressed chip type, long-lasting, slow-release, commercial-grade planting fertilizer in tablet form. Tablets shall break down with soil bacteria, converting nutrients into a form that can be absorbed by plant roots.

1. Size: **10-gram** tablets.
2. Nutrient Composition: 20 percent nitrogen, 10 percent phosphorous, and 5 percent potassium, by weight plus micronutrients.

H. Chelated Iron: Commercial-grade FeEDDHA for dicots and woody plants, and commercial-grade FeDTPA for ornamental grasses and monocots.

2.5 TOPSOIL

A. Loam or approved topsoil removed within the confines of the project area shall be reused in accordance with Section 312000, Earthwork. If quantity of stockpiled topsoil is insufficient, provide new topsoil which is fertile, friable, natural loam, surface soil, reasonably free of subsoil, clay lumps, brush, weeds and other litter, and free of roots, stumps, stones larger than 2 in. in any dimension, and other extraneous or toxic matter harmful to plant growth. Sand, silt, and clay contents comprising existing or new topsoil shall fall within the following ranges:

1. Sand 50% - 70%
2. Silt 2% - 40%
3. Clay 10% - 28%

B. Submit representative soil samples of new topsoil from off-site sources as well as existing topsoil removed from within confines of site to qualified soil testing laboratory to ascertain what amendments may be necessary to obtain proper tilth, nutrient characteristics, and pH balance in accordance with the following. Provide amendments as necessary at rates indicated on the soil test.

1. Organic Matter: greater than 5% organic matter (by weight).
2. pH Range: 5.8 to 6.2.

3. Phosphorus/Potassium: medium to medium high range.
4. Soluble Salt: not greater than 500 ppm.

2.6 PLANTING SOILS

A. Planting Soil : Existing, native surface topsoil formed under natural conditions with the duff layer retained during excavation process and stockpiled on-site. Verify suitability of native surface topsoil to produce viable planting soil. Clean soil of roots, plants, sod, stones, clay lumps, and other extraneous materials harmful to plant growth.

B. Planting Soil : Imported topsoil or manufactured topsoil from off-site sources. Obtain topsoil displaced from naturally well-drained construction or mining sites where topsoil occurs at least 4 inches (100 mm) deep; do not obtain from agricultural land, bogs, or marshes.

1. Additional Properties of Imported Topsoil or Manufactured Topsoil: Screened and free of stones 1 inch (25 mm) or larger in any dimension; free of roots, plants, sod, clods, clay lumps, pockets of coarse sand, paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, building debris, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, acid, and other extraneous materials harmful to plant growth; free of obnoxious weeds and invasive plants including quackgrass, Johnsongrass, poison ivy, nutsedge, nimblewill, Canada thistle, bindweed, bentgrass, wild garlic, ground ivy, perennial sorrel, and bromegrass; not infested with nematodes; grubs; or other pests, pest eggs, or other undesirable organisms and disease-causing plant pathogens; friable and with sufficient structure to give good tilth and aeration. Continuous, air-filled pore space content on a volume/volume basis shall be at least 15 percent when moisture is present at field capacity. Soil shall have a field capacity of at least 15 percent on a dry weight basis.

2.7 MULCHES

A. Planting Bed Mulch: Provide shredded bark mulch for planting beds. Do not use material that is decayed or mixed with soil, weeds or other foreign matter. Use material that is large enough in size to prevent it from drifting and blowing in normal wind storms. Submit samples to Owner's Representative for approval prior to delivery of bark mulch to site.

B. Mineral Mulch: Hard, durable river stone, washed free of loam, sand, clay, and other foreign substances, of following type, size range, and color:

1. Type: Rounded riverbed smooth-faced stone.
2. Size Range: 1 inch to 3 inches, even mix.
3. Color: Mixed natural colors.

2.8 WEED-CONTROL BARRIERS

A. Nonwoven Geotextile Filter Fabric: Polypropylene or polyester fabric, 3 oz./sq. yd. (101g/sq. m) minimum, composed of fibers formed into a stable network so that fibers retain their relative position. Fabric shall be inert to biological degradation and resist naturally-encountered chemicals, alkalis, and acids.

B. Composite Fabric: Woven, needle-punched polypropylene substrate bonded to a nonwoven polypropylene fabric, 4.8 oz./sq. yd. (162 g/sq. m).

2.9 PESTICIDES

A. General: Pesticide registered and approved by EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.

B. Pre-Emergent Herbicide (Selective and Non-Selective): Effective for controlling the germination or growth of weeds within planted areas at the soil level directly below the mulch layer.

C. Post-Emergent Herbicide (Selective and Non-Selective): Effective for controlling weed growth that has already germinated.

2.10 TREE STABILIZATION MATERIALS

A. Stakes and Guys: Provide stakes of sound new hardwood, free of known holes and other defects. Provide wire ties and guys of 2-strand, twisted, pliable galvanized iron wire not lighter than 12 ga. with zinc-coated turnbuckles or an approved equal. Provide new 2-ply garden hose not less than 1/2 in. hose size, cut to required lengths to protect tree trunks from damage by wires or an approved equal.

B. Wrapping: Wrapping material for tree trunks shall be furnished in strips approximately 4 to 6 inches wide consisting of first quality, 8 oz. per sq. yd. burlap, approved waterproof paper tape or polyethylene film, ASTM D 2103.

1. Upright and Guy Stakes: Rough-sawn, sound, new hardwood, free of knots, holes, cross grain, and other defects, 2-by-2-inch nominal (38-by-38-mm actual) by length indicated, pointed at one end.
2. Wood Deadmen: Timbers measuring 8 inches (200 mm) in diameter and 48 inches (1200 mm) long, treated with specified wood pressure-preservative treatment.
3. Flexible Ties: Wide rubber or elastic bands or straps of length required to reach stakes or turnbuckles and compression springs.
4. Guys and Tie Wires: ASTM A 641/A 641M, Class 1, galvanized-steel wire, two-strand, twisted, 0.106 inch (2.7 mm) in diameter.

5. Tree-Tie Webbing: UV-resistant polypropylene or nylon webbing with brass grommets.
6. Guy Cables: Five-strand, 3/16-inch- (4.8-mm-) diameter, galvanized-steel cable, with zinc-coated turnbuckles, a minimum of 3 inches (75 mm) long, with two 3/8-inch (10-mm) galvanized eyebolts.
7. Flags: Standard surveyor's plastic flagging tape, white, 6 inches (150 mm) long.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive plants for compliance with requirements and conditions affecting installation and performance.

1. Verify that no foreign or deleterious material or liquid such as paint, paint washout, concrete slurry, concrete layers or chunks, cement, plaster, oils, gasoline, diesel fuel, paint thinner, turpentine, tar, roofing compound, or acid has been deposited in soil within a planting area.
2. Do not mix or place soils and soil amendments in frozen, wet, or muddy conditions.
3. Suspend soil spreading, grading, and tilling operations during periods of excessive soil moisture until the moisture content reaches acceptable levels to attain the required results.
4. Uniformly moisten excessively dry soil that is not workable and which is too dusty.

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

C. If contamination by foreign or deleterious material or liquid is present in soil within a planting area, remove the soil and contamination as directed by Architect and replace with new planting soil.

3.2 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities and turf areas and existing plants from damage caused by planting operations.

B. Install erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

C. Lay out individual tree and shrub locations and areas for multiple plantings. Stake locations, outline areas, adjust locations when requested, and obtain Architect's acceptance of layout before excavating or planting. Make minor adjustments as required.

D. Preparation of Planting Soil: Before mixing, clean topsoil of roots, plants, sods, stones, clay lumps, and other extraneous materials harmful or toxic to plant growth. Mix specified soil amendments with topsoil at the rates specified. Unless otherwise specified or indicated on the Drawings, the following planting soil mixture (thoroughly mixed by volume) shall be used for backfill around trees and shrubs: dehydrated processed manure 1 part; topsoil 8 parts; peat moss 3 parts.

3.3 PLANTING AREA ESTABLISHMENT

A. Preparation of Planting Beds: Loosen subgrade of planting bed areas to a minimum depth of 6 in. using a cultimulcher or similar equipment. Remove stones over 1 1/2 in. in any dimension, and sticks, stones, rubbish and other extraneous matter. Spread planting soil mixture to the 6” minimum depth and as required to meet lines, grades and elevations shown, after light rolling and natural settlement.

B. Loosen subgrade of planting areas to a minimum depth of 12 inches (300 mm). Remove stones larger than 2 inches (50 mm) in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.

1. Apply fertilizer directly to subgrade before loosening.

   a. Delay mixing fertilizer with planting soil if planting will not proceed within a few days.
   b. Mix lime with dry soil before mixing fertilizer.

   c. Spread approximately one-half the thickness of planting soil over loosened subgrade. Mix thoroughly into top **4 inches (100 mm)** of subgrade. Spread remainder of planting soil.

C. Finish Grading: Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

D. Before planting, obtain Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

3.4 EXCAVATION FOR TREES AND SHRUBS

A. Excavate pits in accordance with Typical Planting Details with vertical sides and with bottom of excavation slightly raised at center to provide proper drainage. Loosen hard subsoil in bottom of excavation. For balled and burlapped (B&B) trees and shrubs, make excavations at least twice as wide as the ball diameter and a minimum of 1 ft. 6 in. wider than root spread.

B. Planting Pits and Trenches: Excavate circular planting pits with sides sloping inward at a 45-degree angle. Excavations with vertical sides are not acceptable. Trim perimeter of bottom leaving center area of bottom raised slightly to support root ball and assist in drainage away from center. Do not further disturb base. Ensure that root ball will sit on undisturbed base soil to prevent settling. Scarify sides of planting pit smeared or smoothed during excavation.

1. Excavate approximately three times as wide as ball diameter for balled and burlapped stock.
2. Excavate at least 12 inches (300 mm) wider than root spread and deep enough to accommodate vertical roots for bare-root stock.
3. Do not excavate deeper than depth of the root ball, measured from the root flare to the bottom of the root ball.
4. If area under the plant was initially dug too deep, add soil to raise it to the correct level and thoroughly tamp the added soil to prevent settling.
5. Maintain required angles of repose of adjacent materials as shown on the Drawings. Do not excavate subgrades of adjacent paving, structures, hardscapes, or other new or existing improvements.
6. Maintain supervision of excavations during working hours.
7. Keep excavations covered or otherwise protected when unattended by Installer's personnel.

C. Obstructions: Notify Architect if unexpected rock or obstructions detrimental to trees or shrubs are encountered in excavations.

D. Drainage: Notify Architect if subsoil conditions evidence unexpected water seepage or retention in tree or shrub planting pits.

3.5 TREE, SHRUB, AND VINE PLANTING

A. Before planting, verify that root flare is visible at top of root ball according to ANSI Z60.1. If root flare is not visible, remove soil in a level manner from the root ball to where the top-most root emerges from the trunk. After soil removal to expose the root flare, verify that root ball still meets size requirements.

B. Remove stem girdling roots and kinked roots. Remove injured roots by cutting cleanly; do not break.

C. Set balled and burlapped stock plumb and in center of planting pit or trench with root flare 2 inches (50 mm) above adjacent finish grades.

1. Use planting soil for backfill.
2. After placing some backfill around root ball to stabilize plant, carefully cut and remove burlap, rope, and wire baskets from tops of root balls and from sides, but do not remove from under root balls. Remove pallets, if any, before setting. Do not use planting stock if root ball is cracked or broken before or during planting operation.

3. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
4. Place planting tablets in each planting pit when pit is approximately one-half filled; in amounts recommended in soil reports from soil-testing laboratory. Place tablets beside the root ball about 1 inch (25 mm) from root tips; do not place tablets in bottom of the hole.
5. Continue backfilling process. Water again after placing and tamping final layer of soil.

D. Set container-grown stock plumb and in center of planting pit or trench with root flare 2 inches (50 mm) above adjacent finish grades.

1. Use planting soil for backfill.
2. Carefully remove root ball from container without damaging root ball or plant.
3. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
4. Place planting tablets in each planting pit when pit is approximately one-half filled; in amounts recommended in soil reports from soil-testing laboratory. Place tablets beside the root ball about 1 inch (25 mm) from root tips; do not place tablets in bottom of the hole.
5. Continue backfilling process. Water again after placing and tamping final layer of soil.

6. Use planting soil for backfill.
7. Carefully remove root ball from fabric bag without damaging root ball or plant. Do not use planting stock if root ball is cracked or broken before or during planting operation.
8. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
9. Place planting tablets in each planting pit when pit is approximately one-half filled; in amounts recommended in soil reports from soil-testing laboratory. Place tablets beside the root ball about 1 inch (25 mm) from root tips; do not place tablets in bottom of the hole.
10. Continue backfilling process. Water again after placing and tamping final layer of soil.
11. Use planting soil for backfill.
12. Spread roots without tangling or turning toward surface, and carefully work backfill around roots by hand. Puddle with water until backfill layers are completely saturated. Plumb before backfilling, and maintain plumb while working backfill around roots and placing layers above roots.
13. Place planting tablets in each planting pit when pit is approximately one-half filled; in amounts recommended in soil reports from soil-testing laboratory. Place tablets beside soil-covered roots about 1 inch (25 mm)

from root tips; do not place tablets in bottom of the hole or touching the roots.

14. Continue backfilling process. Water again after placing and tamping final layer of soil.

E. When planting on slopes, set the plant so the root flare on the uphill side is flush with the surrounding soil on the slope; the edge of the root ball on the downhill side will be above the surrounding soil. Apply enough soil to cover the downhill side of the root ball.

F. Dish completed planting pits to form shallow (4") saucer to collect water. Mulch pits, trenches and planted areas with at least 4 in. thickness of shredded bark or equivalent substitute approved by Owner's Representative.

G. Apply anti-desiccant using power spray to provide an adequate film over trunks, branches, stems, twigs, and foliage. If deciduous trees or shrubs are moved in full-leaf, spray with anti-desiccant at nursery before moving and again 2 weeks after planting.

H. Prune, thin out and shape trees and shrubs in accordance with standard horticultural practice. Remove dead, broken, or diseased branches. Prune trees to retain required height and spread. Unless otherwise directed by the Owner's Representative, do not cut tree leaders, and remove only injured or dead branches from flowering trees, if any. Prune shrubs to retain natural character and accomplish their use in the landscape design. Pruning cuts shall be made to outside the branch color or branch bark ridge; tree paint is not permitted. Required shrub sizes are the size after pruning. Remove and replace excessively pruned or misformed stock resulting from improper pruning.

I. Wrap tree trunks of 2 in. caliper and larger. Start at ground and cover trunk to height of first branches and securely attach. Inspect tree trunks for injury, improper pruning and insect infestation and take corrective measures required before wrapping. Wrapping shall only be present from November 1st to April 1st.

J. Immediately after planting, guy and stake trees of 1-1/2 in. caliper or larger or over 6 ft. in height on planting schedule. Allow plants to have normal sway to promote strong growth.

K. Plant labels shall be removed immediately after acceptance by Architect.

3.6 FERTILIZING TREES AND SHRUBS

A. Water Soluble Fertilizer:

1. The first liquid feeding will be permitted as the first watering only during backfilling of the plant, unless otherwise directed by the Owner's Representative. All seedlings will be liquid fed during planting. The second

liquid feeding will be made the following spring season, no later than June 30th.

2. Liquid fertilizer shall be completely dissolved and mixed in water at the rate of 6 lbs. of the fertilizer concentrate to 100 gallons of water.
3. The resulting solution shall be poured in the plant pit as directed by the Owner's Representative. A second application at the same rate shall be applied as directed by the Owner's Representative. The solution shall be applied at the following rates for each application:

    a. Plants up to 2 ft. in height shall receive 4 quarts.
    b. Plants above 2 ft. and up to 6 ft. shall receive 6 quarts.
    c. Plants above 6 ft. and up to 12 ft. shall receive 12 quarts.
    d. Plants above 12 ft. shall receive 16 quarts.

B. Slow Release Fertilizer Packets:
1. All woody plants except evergreen seedlings shall be fertilized with slow release fertilizer packets at the time of planting, unless otherwise directed by the Owner's Representative. Fertilizer packets shall be placed equidistantly within the planting pit adjacent to the ball or root mass, but not in direct contact with roots. Placement depth shall be 6 to 8 inches. Packets shall not be cut, ripped or damaged.
2. If it becomes necessary to remove and replace dead or unhealthy plants, damaged or broken packets shall be replaced with new packets. The application rates shall be as follows:

Type of Plants	No. of Packets
Evergreen Trees	
Under 18 inches height	1
18 inches to 3 ft. height	2
3 ft. to 6 ft. height	3
Over 6 ft. height	4
Deciduous Trees	
Under 6 ft. height	2
6 ft. to 12 ft. height or under 4 in. caliper	3
Over 4 inches caliper	4
Shrubs	
Under 2 ft. height or spread	1
2 ft. to 3 ft. height or spread	2
Over 3 ft. height or spread	3
Vines and Ground Covers	1

3.7 MECHANIZED TREE SPADE PLANTING

A. Trees may be planted with an approved mechanized tree spade at the designated locations. Do not use tree spade to move trees larger than the

maximum size allowed for a similar field-grown, balled-and-burlapped root-ball diameter according to ANSI Z60.1, or larger than the manufacturer's maximum size recommendation for the tree spade being used, whichever is smaller.

B. When extracting the tree, center the trunk within the tree spade and move tree with a solid ball of earth.

C. Cut exposed roots cleanly during transplanting operations.

D. Use the same tree spade to excavate the planting hole as was used to extract and transport the tree.

E. Plant trees as shown on Drawings, following procedures in "Tree, Shrub, and Vine Planting" Article.

F. Where possible, orient the tree in the same direction as in its original location.

3.8 TREE, SHRUB, AND VINE PRUNING

A. Remove only dead, dying, or broken branches. Do not prune for shape.

B. Prune, thin, and shape trees, shrubs, and vines as directed by Architect.

C. Prune, thin, and shape trees, shrubs, and vines according to standard professional horticultural and arboricultural practices. Unless otherwise indicated by Architect, do not cut tree leaders; remove only injured, dying, or dead branches from trees and shrubs; and prune to retain natural character.

D. Do not apply pruning paint to wounds.

3.9 TREE STABILIZATION

1. Upright Staking and Tying: Stake trees of 2- through 5-inch (50- through 125-mm) caliper. Stake trees of less than 2-inch (50-mm) caliper only as required to prevent wind tip out. Use a minimum of two stakes of length required to penetrate at least 18 inches (450 mm) below bottom of backfilled excavation and to extend to the dimension shown on Drawings above grade. Set vertical stakes and space to avoid penetrating root balls or root masses.

3.10 GROUND COVER AND PLANT PLANTING

A. Set out and space ground cover and plants other than trees, shrubs, and vines in even rows with triangular spacing.

B. Dig holes large enough to allow spreading of roots.

C. For rooted cutting plants supplied in flats, plant each in a manner that will minimally disturb the root system but to a depth not less than two nodes.

D. Work soil around roots to eliminate air pockets and leave a slight saucer indentation around plants to hold water.

E. Water thoroughly after planting, taking care not to cover plant crowns with wet soil.

F. Protect plants from hot sun and wind; remove protection if plants show evidence of recovery from transplanting shock.

3.11 PLANT MAINTENANCE

A. Maintain plantings by pruning, cultivating, watering, weeding, fertilizing, mulching, restoring planting saucers, adjusting and repairing tree-stabilization devices, resetting to proper grades or vertical position, and performing other operations as required to establish healthy, viable plantings. Spray or treat as required to keep trees and shrubs free of insects and disease.

B. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace mulch materials damaged or lost in areas of subsidence.

C. Apply treatments as required to keep plant materials, planted areas, and soils free of pests and pathogens or disease. Use integrated past management practices whenever possible to minimize the use of pesticides and reduce hazards. Treatments include physical controls such as hosing off foliage, mechanical controls such as traps, and biological control agents.

3.12 PLANT ACCEPTANCE

A. The acceptability of the plant material furnished and planted under this Contract shall be at the end of a period of establishment, 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. The establishment period shall extend for a period of one (1) calendar year from the date of final acceptance of the project. During this period, the Contractor shall water, cultivate and prune the plants, repair guy wires and stakes, mouse bait as may be required 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 mice and other 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 this planting season. Otherwise, they shall be replaced during the next subsequent planting season. No payment shall be made for unsatisfactory work during the establishment period.

B. The period of establishment shall commence at the date of final acceptance. Necessary replacements shall be made so that at the time of final acceptance all plants shall be in a healthy, vigorous growing condition and free from sizable die-back.

C. 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 Owner's Representative. In the case of individual doubtful plants, the Contractor may call upon the Owner's Representative to make a determination as to their acceptability, but it shall not be incumbent on the Owner's Representative to furnish the Contractor with exact lists of replacements.

D. All replacements of plants shall be completed by the end of the planting season prior to the final acceptance date. Any small quantity of plants which fail between the end of the planting season and the final acceptance date shall be canceled from the list of accepted plants and the Contractor will receive no payment for them. If a sizable number fails, the Owner's Representative may extend the date of final acceptance to the subsequent planting season, in which case, the Contractor will be subject to liquidated damages, to be established by the Owner’s Representative. All replacement planting shall conform in every way to the requirements of the original planting. The Owner's Representative may require that any replacement plants that are not dormant, or that are planted late in the season, be sprayed, as directed, with an approved anti-desiccant.

3.13 PESTICIDE APPLICATION

A. Apply pesticides and other chemical products and biological control agents in accordance with authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.

B. Pre-Emergent Herbicides (Selective and Non-Selective): Apply to tree, shrub, and ground-cover areas in accordance with manufacturer's written recommendations. Do not apply to seeded areas.

C. Post-Emergent Herbicides (Selective and Non-Selective): Apply only as necessary to treat already-germinated weeds and in accordance with manufacturer's written recommendations.

3.14 CLEANUP AND PROTECTION

A. During planting, keep adjacent paving and construction clean and work area in an orderly condition.

B. Protect plants from damage due to landscape operations and operations of other contractors and trades. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged plantings.

C. After installation and before Substantial Completion , remove nursery tags, nursery stakes, tie tape, labels, wire, burlap, and other debris from plant material, planting areas, and Project site.

3.15 RESTORATION

A. All pavements, seeded and planted areas, structures and substructures not specifically provided for in the contract disturbed by the Contractor during the execution of the work shall be restored by the Contractor, in a manner satisfactory to the Owner's Representative, to their original conditions at no additional cost to the Owner.

3.16 DISPOSAL

A. Remove surplus soil and waste material including excess subsoil, unsuitable soil, trash, and debris and legally dispose of them off Owner's property.

END OF SECTION 329300

This page intentionally left blank

SECTION 33 05 13

MANHOLES AND CATCH BASINS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes storm drainage structures outside the building, with the following components:

1. Precast drainage manholes.
2. Precast catch basins.
3. Stormwater inlets.
4. Frames, covers and grates.

B. Related Sections include the following:

1. Division 31 Section "Earth Moving" for soil materials, excavating, backfilling, and site grading.
2. Division 31 Section "Dewatering" for dewatering of excavations.
3. Division 31 Section "Excavation Support and Protection" for protection of excavations.

1.3 SUBMITTALS

A. Product Data: Manufacturers' product data and installation instructions for frames, covers, grates, precast items, manhole sleeves, joint sealants and frost barrier.

B. Shop Drawings: For the following:

1. Manholes: Include plans, elevations, sections, details, and frames and covers. Include design calculations, and concrete design-mix report for cast-in-place manholes.
2. Catch Basins: Include plans, elevations, sections, details, and frames, covers, and grates.
3. Stormwater Inlets: Include plans, elevations, sections, details, and frames, covers, and grates.

C. Antifloatation Slab Design Certificate: The Contractor may provide the precast structures requiring antifloatation slabs as one complete unit. If provided as a monolithic unit, submit a certificate of design signed by a Professional Engineer licensed in the State of Maine, certifying that the structure including the slab has been designed to withstand all forces including soil, traffic and hydrostatic in accordance with all applicable laws, regulations, rules and codes.

D. Field quality-control test reports.

1.4 QUALITY ASSURANCE

A. Provide complete manhole, catch basin, and precast concrete structures capable of supporting AASHTO H20 loading.

B. All precast concrete shall comply with ASTM C913 "Standard Specification for Precast Concrete Water and Wastewater Structures."

C. Precast Manhole and Catch Basin Components: ASTM C478.

D. Average strength of 4,000 psi at 28 days. Light pole bases shall have an average strength of 5,000 psi at 28 days.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Handle manholes according to manufacturer's written rigging instructions.

PART 2 - PRODUCTS

2.1 MANHOLES

A. All sewer construction shall comply with the standards and specifications of the City of Portland, ME.

B. Provide complete manhole and precast concrete structures capable of supporting AASHTO H-20 loading. Precast concrete shall comply with ASTM C913 "Standard Specification for Precast Concrete Water and Wastewater Structures

C. Base Sections: Precast monolithic construction with steps.

D. Barrel Sections: Precast with steps.

E. Top Sections: Precast eccentric cone with steps. Use flat cover only if shown on drawings.

F. Steps: Conform to ASTM C478 for load carrying capacity and pull out resistance, installed at 12- inches on center forming a continuous ladder. Acceptable

manufacturers: Reliabel Steel Products, Inc., M.A. Industries, Inc. or equal to above.

G. Pipe to Manhole Connections:
   1. Pipe to Manhole connections shall be flexible, watertight manhole sleeves.
   2. Cast into the manhole base and sized to the type of pipe being used
   3. Type of flexible joint being used shall be approved by the Engineer. Install materials according to the Manufacturer's instruction. Acceptable manufacturers; Lock Joint by Interpace Corporation, Kor N Seal by Trelleborg, Press Wedge II by Press-Seal Gasket Corporation, A-Lok Manhole Pipe Seal by A-Loc Corporation, or approved equivalent.

H. Joints Between Precast Sections: Watertight, shiplap type, seal with two rings of 1-inch diameter butyl rubber sealant.

I. Waterproofing: The exterior surface of all manholes shall be given two coats of bituminous waterproofing material at an application rate of 75-100 square feet per gallon, per coat. The coating shall be applied after the manholes have cured adequately and can be applied by brush or spray in accordance with the manufacturers writing instruction. Sufficient time shall be allowed between coats to permit sufficient drying so that the application of the second coast has no affect on the first.

2.2 CATCH BASINS

A. Provide complete manhole and precast concrete structures capable of supporting AASHTO H-20 loading. Precast concrete shall comply with ASTM C913 "Standard Specification for Precast Concrete Water and Wastewater Structures

B. Base Sections: Precast monolithic construction. Drain manholes shall have steps..

C. Barrel Sections: Precast. Drain manholes shall have steps .

D. Top Sections: Precast concentric cone, eccentric, or flat cover if required by grade.

E. Steps: Conform to ASTM C478 for load carrying capacity and pull out resistance, installed at 12- inches on center forming a continuous ladder. Acceptable manufacturers: Reliabel Steel Products, Inc., M.A. Industries, Inc. or equal to above.

F. Pipe to Manhole Connections:
   1. Pipe to Manhole connections shall be flexible, watertight manhole sleeves.
   2. Cast into the manhole base and sized to the type of pip being used
   3. Type of flexible joint being used shall be approved by the Engineer. Install materials according to the Manufacturer's instruction. Acceptable manufacturers; Lock Joint by Interpace Corporation, Kor N Seal by Trelleborg, Press Wedge II by Press-Seal Gasket Corporation, A-Lok Manhole Pipe Seal by A-Loc Corporation, or approved equivalent.

G. Joints between precast sections: Watertight, shiplap type, seal with two rings of 1-inch diameter butyl rubber sealant.

2.3 CATCH BASIN TRASH HOODS/INLET FILTERS

A. Furnish and install inlet hoods over the outlet pipes of catch basins and manholes at the locations indicated on the plans.

B. Inlet Filters shall be Trash Guard "Plus"® is manufactured using 100% recycled HDPE material by Trash Guard" Plus"® Incorporated. Trash Guard Inc. P.O. Box 10 Roseboro, NC. 28382 and distributed exclusively by ACF Environmental, 2831 Cardwell Road, Richmond, VA. 23234. 800-448-3636.
   1. Models TRG-23x24 for 12' pipes and Model TRG-28x30 for 15" and 18" pipes.
   2. Provide Round Manhole Adaptor kits for circular structure installation.
   3. Engineer approved substitutions will be permitted

2.4 STORMWATER INLETS

A. Curb Inlets: Vertical curb opening, of materials and dimensions indicated.

B. Gutter Inlets: Horizontal gutter opening, of materials and dimensions indicated. Include heavy-duty frames and grates.

C. Combination Inlets: Vertical curb and horizontal gutter openings, of materials and dimensions indicated. Include heavy-duty frames and grates.

D. Frames and Grates: Dimensions, opening pattern, free area, and other attributes indicated.

2.5 CONCRETE

A. General: Cast-in-place concrete according to ACI 318/318R, ACI 350R, and the following:

   1. Cement: ASTM C 150, Type II.
   2. Fine Aggregate: ASTM C 33, sand.
   3. Coarse Aggregate: ASTM C 33, crushed gravel.
   4. Water: Potable.

B. Portland Cement Design Mix: 4000 psi minimum, with 0.45 maximum water-cementitious materials ratio.

   1. Reinforcement Fabric: ASTM A 185, steel, welded wire fabric, plain.
   2. Reinforcement Bars: ASTM A 615/A 615M, Grade 60, deformed steel.

C. Ballast and Pipe Supports: Portland cement design mix, 3000 psi minimum, with 0.58 maximum water-cementitious materials ratio.

1. Reinforcement Fabric: ASTM A 185, steel, welded wire fabric, plain.
2. Reinforcement Bars: ASTM A 615/A 615M, Grade 60, deformed steel.

2.6 MASONRY MATERIALS

A. Concrete Masonry Units: ASTM C139.

B. Mortar: Type M, ASTM C270. Use Type II Portland cement, Type S lime. Proportions for Mortar: 1 part Portland cement, 1/4 part hydrated lime,3 to 3 3/4 parts sand.

2.7 BRICK

A. Brick for manholes shall meet the latest AASHTO Specification Designation M-91.

2.8 FRAMES, GRATES AND COVERS

A. Cast iron: ASTM A48 Class 30.

B. Castings shall be smooth with no sharp edges.

C. Constructed to support H-20 loading.

D. Manhole frames and covers: Minimum 24" dia. opening, minimum weight 300 pounds.

1. Standard frame and cover: Castings shall be from East Jordan Foundry, refer to Contract Documents for casting model number and application.
2. Special frame and cover: Castings shall be 30” Pamrex Hinged Locking Cover by Pamm
3. Access Covers, or approved equal. Refer to Contract Documents.
4. Utility name shall be cast into cover.

E. Catch Basin Frames and Grates: Castings shall be from East Jordan Foundry, refer to Contract Documents for casting model number and application.

2.9 MISCELLANEOUS

A. Joint Sealants: Butyl Rubber Sealant: One inch diameter strips as manufactured by Kent Seal, or Engineer approved equal.

B. Dampproofing: Bituminous coating to be Dehydrate No. 4 Dampproof by W.R. Grace of Bitumastic Super Service Black by Koppers Co. for field application, or Engineer approved equal.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavation, trenching, and backfilling are specified in Division 31 Section "Earth Moving."

3.2 MANHOLE INSTALLATION

A. Placement: Place bases on compacted bedding material so manhole structure is plumb and pipe inverts are at proper elevations. Place barrel and top sections in the appropriate height combinations. Plug all lifting holes inside and out with non-shrink grout.

B. Joints: Follow manufacturer's instructions for sealing joints between precast sections. Provide two rings of 1-inch diameter butyl rubber sealant. Point joints inside and out with butyl caulk.

C. Frame and Covers: Set to final grade as shown on the Drawings or set flush with pavement grade in paved areas or 2" below finish grade in unpaved roads or 24" above grade in cross-country areas. Provide adequate temporary covers (conforming with applicable local, State and Federal regulations) to prevent accidental entry until final placement of frame and cover is made.

D. Set manhole frames and covers to final grade only after pavement base course has been applied, or after final grading of gravel roads.

E. Inverts: See detail on drawings.

F. Steps: Replace steps out of plumb and out of proper horizontal placement.

3.3 CATCH BASIN INSTALLATION

A. Placement: Place bases on compacted bedding material so catch basins structure is plumb and pipe inverts are at proper elevations. Place barrel and top sections in the appropriate height combinations. Plug all lifting holes inside and out with non-shrink grout.

B. Joints: Follow manufacturer’s instructions for sealing joints between precast sections. Provide two rings of 1-inch diameter butyl rubber sealant. Point joints inside and out with butyl caulk.

C. Frame and covers: Set to final grade as shown on the drawings. Use two rings of 1-inch diameter butyl rubber sealant between frame and chimney joints. Provide downward force to frame so as to compress the joint and provide a watertight seal and prevent future settlement. Point compressed joint with butyl rubber caulk sealant.

D. Inverts: See detail on drawings.

3.4 CONCRETE PLACEMENT

A. Place cast-in-place concrete according to ACI 318/318R.

3.5 ALTERING EXISTING MANHOLES AND CATCH BASINS

A. When altering existing manholes or catch basins, the structure shall be dismantled sufficiently to allow reconstruction in accordance with the applicable requirements as shown on the Drawings for complete manholes. Each altered manhole or catch basin shall be cleaned of all accumulated silt, debris or foreign matter prior to final acceptance of work.

3.6 CLOSING ABANDONED SANITARY MANHOLES AND CATCH BASINS

A. Abandoned Manholes or Catch Basins: Excavate around manhole or catch basin as required and use either procedure below:

1. Remove manhole or catch basin and close open ends of remaining piping.
2. Remove top of manhole or catch basin down to at least 36 inches below final grade. Fill to within 12 inches of top with stone, rubble, gravel, or compacted dirt. Fill to top with concrete.

B. Backfill to grade according to Division 31 Section "Earth Moving."

3.7 FIELD QUALITY CONTROL

A. Testing and Acceptance: All sanitary sewer components shall comply with the testing requirements of the governing authority.

1. General:

a. Perform either a vacuum test or combination of the exfiltration and infiltration tests on all manholes.
b. All testing must be performed in the presence of the City
c. Suitably plug all pipes entering each manhole and brace plugs to prevent blow out.

2. Exfiltration Tests After Backfilling:

a. Fill each manhole with water to the top of the manhole frame.
b. A period of up to 2 hours may be permitted, if the Contractor so wishes, to allow for absorption.
c. At the end of the absorption period, refill each manhole with water to the top of the manhole frame and begin the 4-hour test period.

d. At the end of the 4-hour test period, refill each manhole to the top of the manhole frame and measure the volume of water added. The leakage for each manhole shall not exceed 1/16 gallon per foot of diameter per vertical foot (above ground water) per 4-hour period.

3. Infiltration Tests:

   a. When the groundwater is above the bottom of the manhole, infiltration testing may be performed on that portion of the manhole below water level.
   b. After a 15-minute period, if no water is visibly moving down the interior surfaces of a manhole, the portion of the manhole below groundwater may be considered to be satisfactorily watertight.
   c. The remaining portion above the groundwater level must be tested for exfiltration as specified above.

4. Vacuum Test:

   a. The manhole shall be tested by a vacuum test after assembly of the manhole, connection piping and backfilling.
   b. Plug all lifting holes completely with non-shrink grout.
   c. Properly tighten all boot clamps and brace all plugs to prevent them from being sucked into the manhole.
   d. Install the testing equipment according to the manufacturer's instructions.
   e. A vacuum of 10 inches of Hg shall be drawn on the manhole and the loss of 1 inch of Hg vacuum timed. The manhole shall be considered to have passed the test if the time for the loss of 1 inch of Hg vacuum is two (2) minutes or longer.
   f. If the manhole fails the initial test, the Contractor shall locate the
   g. If the manhole fails the initial test, the Contractor shall locate the leak(s) and make repairs. The manhole shall be retested until a satisfactory test result is obtained.
   h. If a satisfactory vacuum test cannot be obtained, the manhole shall be water exfiltration tested and repaired as necessary.

5. Manhole Repairs:

   a. Correct leakage by reconstruction, replacement of gaskets and/or other methods as approved by the District.
   b. The use of lead-wood or expanding mortar will not be permitted.

6. After the manholes have been backfilled and prior to final acceptance, any signs of leaks or weeping visible inside the manholes shall be repaired and the manhole made watertight.

END OF SECTION 330513

SECTION 330516

UTILITY STRUCTURES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes storm drainage structures outside the building, with the following components:
   1. Electric/Tel-data manholes, hand holes and splice boxes.

B. Related Sections include the following:

   1. Division 31 Section "Earth Moving" for soil materials, excavating, backfilling, and site grading.
   2. Division 31 Section "Dewatering" for dewatering of excavations.
   3. Division 31 Section "Excavation Support and Protection" for protection of excavations.
   4. Division 26 for grounding requirements

1.3 SUBMITTALS

A. Product Data: Manufacturers' product data and installation instructions for utility structures.

B. Shop Drawings: For the following:

   1. Precast Concrete Items: Include plans, elevations, sections, details, and frames, covers, and grates.
   2. B. Antifloatation Slab Design Certificate: The Contractor may provide the precast structures requiring antifloatation slabs as one complete unit. If provided as a monolithic unit, submit a certificate of design signed by a Professional Engineer registered in the State of Maine, certifying that the structure including the slab has been designed to withstand all forces including soil, traffic and hydrostatic in accordance with all applicable laws, regulations, rules and codes

1.4 DELIVERY, STORAGE, AND HANDLING

A. Handle concrete structures according to manufacturer's written rigging instructions.

PART 2 - PRODUCTS

2.1 ELECTRIC/TEL-DATA MANHOLES

A. Provide precast concrete manholes meeting utility provide requirements and as detailed on the plans.
   1. Provide complete precast concrete structures capable of supporting AASHTO H20 loading.
   2. Provide One-piece units and units with interlocking mating sections, complete with accessories, hardware, and features.

B. Comply with ASTM C 858.

C. Knockout Panels: Precast openings in walls, arranged to match dimensions and elevations of approaching duct, plus an additional 12 inches vertically and horizontally to accommodate alignment variations.

D. Ground Rod Sleeve: Provide a 3-inch PVC sleeve in manhole floors 2 inches from the wall adjacent to, but not underneath, the duct entering the structure.

E. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.

2.2 UTILITY STRUCTURE ACCESSORIES

A. Accessories for Utility Structures: Utility equipment and accessory items used for utility structure access and utility support, listed and labeled for intended use and application.

B. Manhole Frames, Covers, and Chimney Components: Comply with structural design loading specified for manhole.

   1. Frame and Cover: Weatherproof, gray cast iron complying with ASTM A 48/A 48M, Class 30B with milled cover-to-frame bearing surfaces; diameter, as indicated onteh plans or as required by the owning utility, 30 inches minimum. .

      a. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.

   2. Cover Legend: Cast in. Selected to suit system and

3. Manhole Chimney Components: Precast concrete rings with dimensions matched to those of roof opening.

   a. Mortar for Chimney Ring and Frame and Cover Joints: Comply with ASTM C 270, Type M, except for quantities less than 2.0 cu. ft. where packaged mix complying with ASTM C 387, Type M, may be used.

C. Manhole Sump Frame and Grate: ASTM A 48/A 48M, Class 30B, gray cast iron.

D. Pulling Eyes in Concrete Walls: Eyebolt with reinforcing-bar fastening insert, 2-inch-diameter eye, and 1-by-4-inch bolt.

   1. Working Load Embedded in 6-Inch, 4000-psi Concrete: 13,000-lbf minimum tension.

E. Pulling-in and Lifting Irons in Concrete Floors: 7/8-inch-diameter, hot-dip galvanized, bent steel rod; stress relieved after forming; and fastened to reinforcing rod. Exposed triangular opening.

   1. Ultimate Yield Strength: 40,000-lbf shear and 60,000-lbf tension.

F. Bolting Inserts for Concrete Utility Structure Cable Racks and Other Attachments: Flared, threaded inserts of noncorrosive, chemical-resistant, nonconductive thermoplastic material; 1/2-inch ID by 2-3/4 inches deep, flared to 1-1/4 inches minimum at base.

   1. Tested Ultimate Pullout Strength: 12,000 lbf minimum.

G. Ground Rod Sleeve: 3-inch PVC sleeve in manhole floors 2 inches from the wall adjacent to, but not underneath, the ducts routed from the facility.

H. Cable Rack Assembly: Nonmetallic. Components fabricated from nonconductive, fiberglass-reinforced polymer. Stanchions: Nominal 36 inches high by 4 inches wide, with provisions to connect to other sections to form a continuous unit, with minimum of nine holes for arm attachment.

   1. Arms: Arranged for secure, drop-in attachment in horizontal position at any location on cable stanchions, and capable of being locked in position. Arms shall be available in lengths ranging from 3 inches with 450-lb minimum capacity to 20 inches with 250-lb minimum capacity. Top of arm shall be nominally 4 inches wide, and arm shall have slots along full length for cable ties.

I. Duct-Sealing Compound: Nonhardening, safe for contact with human skin, not deleterious to cable insulation, and workable at temperatures as low as 35 deg F. Capable of withstanding temperature of 300 deg F without slump and adhering to clean surfaces of plastic ducts, metallic conduit, conduit and duct coatings, concrete, masonry, lead, cable sheaths, cable jackets, insulation materials, and common metal

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavation and Backfill: Comply with Section 312000 "Earth Moving," but do not use heavy-duty, hydraulic-operated, compaction equipment.

B. Restoration: Replace area immediately after backfilling is completed in public right of way or after construction vehicle traffic in immediate area is complete in other areas

C. Restore surface features at areas disturbed by excavation, and re-establish original grades unless otherwise indicated.

3.2 ELECTRIC/TEL-DATA MANHOLE INSTALLATION

A. Install as shown on drawings and in accordance with utility provider specifications.

B. Precast Concrete Handhole and Manhole Installation:

1. Comply with ASTM C 891 unless otherwise indicated.
2. Install units level and plumb and with orientation and depth coordinated with connecting duct, to minimize bends and deflections required for proper entrances.
3. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1-inch sieve to No. 4 sieve and compacted to same density as adjacent undisturbed earth.

C. Elevations:

1. Manhole Roof: Install with rooftop at least 15 inches below finished grade.
2. Manhole Frame: In paved areas and trafficways, set frames flush with finished grade. Set other manhole frames 1 inch above finished grade.
3. Install handholes with bottom below frost line, 54 inches below grade.
4. Handhole Covers: In paved areas and trafficways, set surface flush with finished grade. Set covers of other handholes 1 inch above finished grade.
5. Where indicated, cast handhole cover frame integrally with handhole structure.

D. Drainage: Install drains in bottom of manholes where indicated. Coordinate with drainage provisions indicated.

E. Manhole Access: Circular opening in manhole roof; sized to match cover size.

1. Install chimney, constructed of precast concrete collars and rings, to support cast-iron frame to connect cover with manhole roof opening. Provide moisture-tight masonry joints and waterproof grouting for frame to chimney.

SECTION 33 11 00

WATER UTILITY DISTRIBUTION PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes water-distribution piping and related components outside the building for water service, with the following components:

1. Water mains.
2. Water services.
3. Water fittings.

B. This Section includes water-distribution piping and related components outside the building for fire-service mains, with the following components:

1. Water mains.
2. Water services.
3. Water fittings.
4. Fire hydrants.

C. Utility-furnished products include water meters that will be furnished to the site, ready for installation.

1.3 SUBMITTALS

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

B. Field quality-control test reports.

C. Operation and Maintenance Data: For water valves and specialties to include in emergency, operation, and maintenance manuals.

D. Manufacturer’s Certificate: Certify that products meet or exceed specified local requirements.

1.4 QUALITY ASSURANCE

A. Regulatory Requirements:

1. Comply with standards of authorities having jurisdiction for potable-water-service piping, including materials, installation, testing, and disinfection.

2. Comply with standards of authorities having jurisdiction for fire-suppression water-service piping, including materials, hose threads, installation, and testing.

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

1.5 DELIVERY, STORAGE, AND HANDLING

A. Store pipe, fittings, and seals in accordance with manufacturer's recommendations.

B. Protect stored piping from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor when storing inside.

C. Protect flanges, fittings, and specialties from moisture and dirt.

D. Store plastic piping protected from direct sunlight. Support to prevent sagging and bending.

1.6 PROJECT CONDITIONS

A. Interruption of Existing Water-Distribution Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water-distribution service according to requirements indicated:

1. Notify Owner's Representative or Local Utility no fewer than two days in advance of proposed interruption of service.
2. Do not proceed with interruption of water-distribution service without written authorization from Owner's Representative or Local Utility.

1.7 COORDINATION

A. Coordinate connection to water main with utility company.

PART 2 - PRODUCTS

2.1 COPPER TUBE AND FITTINGS

A. Soft Copper Tube: ASTM B 88, Type K, water tube, annealed temper.

B. Hard Copper Tube: ASTM B 88, Type K (ASTM B 88M, Type A), water tube, drawn temper.

C. Copper, Compression Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, compression fittings. Furnish only wrought-copper fittings if indicated.

2.2 HDPE PIPE AND FITTINGS

A. HDPE, ASTM Pipe: ASTM D 2239, PE 3408 to give pressure rating not less than the following:

1. SIDR No. 9; 160 psig SIDR No. 7; 200 psig.
2. Insert Fittings for HDPE Pipe: ASTM D 2609, made of PA, PP, or PVC with serrated male insert ends matching inside of pipe. Include bands or crimp rings.
3. Molded HDPE Fittings: ASTM D 3350, PE resin, socket- or butt-fusion type, made to match HDPE pipe dimensions and class.

B. HDPE, AWWA Pipe: AWWA D 2239; with PE 3408 to give pressure rating not less than the following

1. DR No. 11; 160 psig DR No. 9; 200 psig.
2. HDPE, AWWA Fittings: AWWA C906, socket- or butt-fusion type, with DR number matching pipe and PE compound number required to give pressure rating as indicated.

2.3 PVC PIPE AND FITTINGS

A. PVC, Schedule 80 Pipe: ASTM D 1785.

1. PVC, Schedule 80 Socket Fittings: ASTM D 2467.
2. PVC, Schedule 80 Threaded Fittings: ASTM D 2464.

2.4 DUCTILE-IRON PIPE AND FITTINGS

A. Approved Manufacturers:

1. American Cast Iron Pipe.
2. Griffin Pipe.
3. U.S. Pipe.

4. Clow Pipe.
5. Atlantic States Pipe

B. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151, Class 52, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated. The pipe to be centrifugally cast, bituminous coated, double cement lined, seal-coated and manufactured in accordance with the latest revision of AWWA C150 and C151. Note that the cement lining called for above shall be twice the thickness specified in the latest ANSI Specification A21.4 and the interior to be asphalt seal- coated twice. The asphalt seal-coat to be such as not to impart taste or odor to the water contained therein.

1. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
2. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

C. Push-on-Joint, Ductile-Iron Pipe: AWWA C151, Class 52, with push-on-joint bell and plain spigot end unless grooved or flanged ends are indicated. The pipe to be centrifugally cast, bituminous coated, double cement lined, seal-coated and manufactured in accordance with the latest revision of AWWA C150 and C151. Note that the cement lining called for above shall be twice the thickness specified in the latest ANSI Specification A21.4 and the interior to be asphalt seal- coated twice. The asphalt seal-coat to be such as not to impart taste or odor to the water contained therein.

1. Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
2. Gaskets: AWWA C111, rubber.

D. Flanges: ASME 16.1, Class 125, cast iron.

2.5 DUCTILE IRON FITTINGS

A. Material shall be ASTM A536 latest, grade 70-50-05, in accordance with AWWA C110 (latest revision) for fittings larger than 24" and C153 (latest revision) for fittings 3" thru 24".

B. Fittings shall be cement lined AWWA C104 (latest revision) or fusion bonded epoxy coated with a 5 mil nominal thickness per AWWA C550 and C116.

C. Interior seal coated AWWA C104 with minimum of 4 mils dry film thickness.

D. Exterior bituminous coated, 4 mils minimum dry film thickness or fusion bonded epoxy coated with a 5 mil nominal thickness per AWWA C550 and C116.

E. Sleeves shall not be cement lined, but shall be bituminous coated inside to 4 mils dry film thickness. All sleeves shall be long body type.

F. Mechanical joint with accessories furnished: D.I. glands, gaskets, Cor-Ten T-bolts and nuts.

G. Pressure Ratings:

1. Class 350 pressure rating in accordance with AWWA C153 - 3"-24" sizes.
2. Class 250 pressure rating in accordance with AWWA C110 - 30"-48" sizes.

H. The "compact design" fittings must provide adequate space for the MJ joint and accessories to be installed without special tools (i.e. Lowell wrench can be used).

I. Approved Manufacturers

1. In conformance with Portland Water District specifications.

2.6 RESTRAINED JOINT GASKETS

A. Approved Manufacturers:

1. American Fast-Grip Gasket – American Pipe.
2. Field Lok 350 Gasket – US Pipe.

B. All accepted restrained joint gaskets in the distribution system shall be rated in accordance with the performance requirements of ANSI/AWWA C111/A21.11.

C. Required Applications

1. Any hydrant branch or service with a distance greater than 18’ shall have an approved restrained joint gasket in the bell ends.
2. Where a casing is required, all joints within the casing shall have an approved restrained joint gasket unless restrained joint pipe is used.
3. At any time as required by a PWD Engineer.
4. Any live service tap where there is a joint between the connection and the end of the service.

2.7 GATE VALVES

A. Approved Gate Valves

1. U.S.P.
2. AFC Series 2500
3. Mueller A-2360/61
4. Clow Series F6100

B. Valve shall meet the latest revision of the AWWA C-509 or C-515 Standard.

C. Valve shall have a smooth unobstructed water way which shall be a minimum diameter of the valve.

D. Valve ends to be specified and shall be furnished with Cor-ten (or equal) bolts and nuts.

E. Valve shall be rated for zero leak rate at 200 psi differential working pressure and have

1. 400 psi hydrostatic test for structural integrity.

F. Sealing - Valve shall have a minimum of 2 "O" rings situated such that the "O" rings above the thrust collar can be replaced with the valve under pressure and in the open position.

G. Stem - Valve stem shall:

1. open right with a stem nut made of grade D,E manganese bronze;
2. be non-rising;
3. be designed with a thrust collar integrally cast to the stem;
4. be designed with two (2) thrust washers, placed one above and one below the stem thrust collar;
5. be constructed of grade D,E manganese bronze;
6. be such that the thrust washers are made of a synthetic polymer with physical properties required.

H. Valve Body - The body, including the stuffing box and the bonnet, shall be constructed of cast iron or ductile iron, meeting the latest revision of AWWA C-153.

I. Valve Wedge:

1. shall be constructed of ductile iron (less guiding mechanism);
2. shall be fully encapsulated and permanently bonded with a resilient elastomer;
3. shall be constructed such to allow the flushing of any interior exposed surface during operations.

J. Coatings:

1. the internal and external valve body, including the stuffing box, bonnet, and interior of the wedge shall be fusion bonded epoxy coated with 8 mils D.F.T.
2. interior shall meet latest version of AWWA C-550.
3. shall be holiday free, interior and exterior, per testing method described in AWWA C-550, Sec. 5.1.

K. Operating Nut:

1. shall be two (2) inch square ductile iron:
2. with a countersunk hold down nut (made of 316 stainless steel or silicone bronze). This applies to stems that are tapered; or
3. with a stainless steel pin inserted thru the stem. This applies to stems of full diameter.

L. Bolts – The seal plate and bonnet bolts shall be stainless steel (Type 316 or Type 304).

M. Valves 12” nominal diameter and smaller shall be directly operated by the nut on the valve stem and mounted vertically. Number of turns to open or close shall closely match the formula: (3 x D) + 2. For example, a 12” valve should open or close with approximately (3 x 12) + 2 = 38 turns of the operating nut.

N. Valves larger than 12” nominal diameter shall be designed to be installed horizontally and shall have bevel gear operators driven by the operating nut. Valves 14” – 24” nominal diameter shall have 4:1 bevel gear operators. Valves with 30” – 36” nominal diameters shall have 6:1 bevel gear operators and valves with 42” – 48” nominal diameters shall have 8:1 bevel gear operators. Number of turns to open or close shall closely match the formula: ((3 x D) + 2) times the bevel gear ratio. For example, a 24” valve should open or close with approximately ((3 x 24) + 2) x 4 = 296 turns of the operating nut.

O. General Provisions

1. Vendor shall identify any and all exceptions to the specifications.
2. Vendor shall provide standard brochures for item quoted.
3. Vendor may be required to supply a valve for inspection and determination of coating process.

2.8 GATE VALVE ACCESSORIES AND SPECIALTIES

A. Tapping-Sleeve Assemblies:

1. Approved Manufacturers:

a. AFC.
b. Mueller Co.
c. U.S. Pipe.
d. Tyler / Union.
e. Powerseal Model 3490 and 3490MJ (Fabricated Steel)

2. For sizes 12” and smaller tapping sleeve shall be ductile iron or approved fabricated steel:

a. Tapping sleeve shall be mechanical joint with recessed outlet flange for tapping valve.
b. Tapping sleeve shall conform to AWWA C-207, Class D, with rated maximum working pressure of 200 psi.
c. The side rubber gaskets shall be rectangular in cross-section and fit into grooved channels in the casting. These gaskets shall extend the entire length of the sleeve and shall not require cutting or trimming to match MJ end gaskets.
d. Tapping sleeve shall be AB-CD pattern to permit use of plain rubber and ducktipped gaskets for various O.D. piping sizes.

e. Mechanical joint with accessories furnished; glands, gaskets, and Cor-Ten T-bolts and nuts or equal.
f. All flange outlet bolts shall be stainless steel (Type 304).
g. Interior and exterior to be bituminous coated with a minimum of 4 mils dry film thickness or fusion bonded epoxy coated.
h. The sleeve shall be provided with a ¾" F.I.P.T. test port and brass lug.

B. Valve Boxes:

1. The valve box bottom section shall be slide-type with bell-type base with bottom lip. Manufacturer: North American Manufacture
2. The valve box top section shall be slide-type, 36 inches long (minimum). No top flange and no "bead" or bottom flange. Manufacturer: North American Manufacture
3. The valve box cover shall be a 2" drop-type cover to fit the 7-1/4" opening of the top section. Manufacturer: Bibby St-Croix (no substitute)
4. The valve box intermediate (mid) section shall be slide-type with a minimum 3" belled bottom. Base section No. 645 may be used as an alternate. Manufacturer: North American Manufacture
5. Material shall be cast iron or ductile iron free from defects.
6. Interior and exterior of all components shall be bituminous coated with a minimum of 4 mils dry film thickness.

C. Indicator Posts: UL 789, FMG-approved, vertical-type, cast-iron body with operating wrench, extension rod, and adjustable cast-iron barrel of length required for depth of burial of valve.

2.9 FIRE HYDRANTS

A. Approved Hydrants

1. Clow Eddy – with lower stern machined from bar stock
2. American Darling Models: B62B-1, B62B-5

B. The hydrant shall open right.

C. The operating nut shall:

1. be D.I. or bronze
2. be pentagon in shape with dimensions: Top 1-13/16" tapering to 1-7/8" on bottom.

D. Nozzles shall be:

1. 2 each – 2-1/2" National Standard Thread
2. 1 each – 4-1/2" National Standard Threadbottom.

E. Port covers shall be supplied without chains and shall have the same size pentagon operator as specified in 2.5(C) above.

F. Traffic model hydrant with breakaway feature

G. Barrel length(s) shall be:

1. 6 ft. cover, 6-1/2 ft. bury; or
2. 5-1/2 ft. cover, 6 ft. bury, or
3. 5 ft. cover, 5'-6" bury

H. Hydrant shoe or base shall have the following:

1. 6" MJ inlet;
2. 5-1/4" valve opening with non-draining bronze seat that is permanently plugged;
3. Valve seat and sub-seat arrangement shall be bronze to bronze;
4. Horizontal and vertical blocking planes manufactured into hydrant base

I. Bolts:

1. All buried mechanical joint bolts and nuts (T-head, etc.) shall be Cor-Ten or equal;
2. All buried flange joint bolts shall be stainless steel (Type 304) or silicone bronze.

J. Protective Coatings shall consist of the following:

1. All paintings and coatings shall be a minimum of 3 mils total dry film thickness, unless noted
2. The internal area of the hydrant base, which is normally exposed to water and which includes the internal body of hydrant shoes, including lower valve plate, shall be epoxy coated
3. All internal and external cast iron or ductile iron components shall be coated with an approved bituminous coating, 3 mils minimum
4. Coatings for upper barrel - exterior:

    a. Surface preparation blast clean SSPC-SP-6
    b. Primer Sherwin Williams Red Oxide E61RC21, 1.5 mils, dry
    c. Finish coat Sherwin Williams – Regal Yellow, F78Y30, 1.5 mils, dry or sufficient paint to hide the second coat
    d. Total dry film thickness - 3 mils minimum.

5. Coatings for bonnet, operating nut, port cap:

    a. Surface preparation: Blast clean, SSPC-SP-6
    b. Exterior primer
    c. Exterior aluminum
    d. Total dry film thickness: 3 mils minimum.

K. Flow Indicator Collars: PWD personnel shall install flow indicator collars on all new hydrants.

L. Field Test of Installed Hydrant

1. Hydrant flow shall completely stop with no more than 200 ft. lb. of torque applied to the operating nut.
2. Failure to shut completely at no more than 200 ft. lb. of torque will be cause for rejection of that hydrant.

2.10 CORPORATION STOPS

A. Approved Manufacturers

1. A.Y. McDonald
2. Cambridge Brass
3. Ford Meter Box Co.
4. Mueller Co.

B. Conforming to AWWA C-800.

C. 3/4” to 2” curb stops shall be ball valve design with brass ball that is teflon coated or brass ball with teflon seats.

D. The ball shall be supported by seats which are water tight in either direction.

E. The valve shall have a full port opening.

F. The body of the corporation stop shall be of heavy duty design.

G. The valve working pressure shall be 300 p.s.i.

2.11 CURB STOPS

A. Approved Manufacturers

1. A.Y. McDonald
2. Cambridge Brass
3. Ford Meter Box Co.
4. Mueller Co.

B. Conforming to AWWA C-800

C. 3/4” to 2” curb stops shall be ball valve design with brass ball that is teflon coated or brass ball with teflon seats.

D. The ball shall be supported by seats which are water tight in either direction.

E. The valve shall have a full-port opening.

F. The valve shall open with ¼ turn (90) with a check or stop.

G. The valve shall not have a drain.

H. The valve stem shall have 2 “O” rings and a bronze ring lock which holds the stem solidly in the valve body.

I. The valve body shall be of heavy duty design.

J. The valve working pressure shall be 300 p.s.i.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Refer to Division 31 Section "Earth Moving" for excavating, trenching, and backfilling.

3.2 INSTALLATION

A. General:

1. Install all pipe and fittings in strict accordance with the manufacturer's instructions and recommendations, and in conformance with Local Water District’s standards.
2. Install all pipes and fittings in accordance with the lines and grades shown on the Drawings and as required for a complete installation. Minimum depth of cover for water main shall be 5' - 6".
3. Install adapters, as required, when connecting pipes constructed from different materials.

B. Pipe Laying:

1. Firmly support the pipe and fittings on bedding material as shown on the Drawings and as specified in the appropriate Sections of these Specifications.
2. Do not permanently support the pipe or fittings on saddles, blocking stones, or any material which does not provide firm and uniform bearing along the outside length of the pipe.
3. Thoroughly compact the material under the pipe to obtain a substantial unyielding bed shaped to fully support the pipe.
4. Excavate suitable holes for the joints so that only the barrel of the pipe received bearing pressure from the supporting material after placement.
5. Lay each pipe length so it forms a close joint with the adjoining length and bring the inverts to the required grade.
6. Do not drive the pipe down to grade by striking it with a shovel handle, timber, rammer, or any other unyielding object.
7. When each pipe length has been properly set, place and compact enough of the bedding material between the pipe and the sides of the trench to hold the pipe in correct alignment.
8. After filling the sides of the trench, place and lightly tamp bedding material to complete the bedding as shown on the Drawings.
9. Take all necessary precautions to prevent flotation of the pipe in the trench.

C. Temporary Plugs:

1. When pipe installation work in trenches is not in progress, close the open ends of the pipe with temporary watertight plugs.
2. If water is in the trench when work is resumed, do not remove plugs until all danger of water entering the pipe is eliminated.
3. Do not use the pipelines as conductors for trench drainage during construction.

D. Jointing Push-On Pipe:

1. Connect pipe in accordance with the latest manufacturer's instructions and recommendations.
2. Clear each pipe length, coupling and fitting of all debris and dirt before installation.
3. Shove home each length of pipe against the pipe previously laid and hold securely in position. Do not pull or cramp joints.
4. Make all pipe joints as watertight as possible with no visible leakage and no sand, silt, clay, or soil of any description entering the pipeline at the joints.
5. Immediately after making a joint, fill the holes for the joints with bedding material, and compact.

E. Jointing Bolted Joints:

1. Before the pieces are assembled, remove rust-preventative coatings from machined surfaces.
2. Pipe Ends, Sockets, Sleeves, Housings, and Gaskets: Thoroughly clean and smooth burrs and other defects.

F. Jointing Mechanical Joints:

1. Thoroughly brush surfaces against which the gasket will come in contact with a wire brush prior to assembly of the joint.
2. Clean and lubricate the gasket, bell, and spigot by washing with soapy water.
3. Slip gland and gasket, in that order, over the spigot, and insert the spigot into the bell until it is correctly seated.
4. Seat gasket evenly in the bell at all points, centering the spigot, and press the gland firmly against the gasket.
5. After all bolts have been inserted and the nuts have been made up finger tight, progressively and uniformly tighten diametrically opposite nuts all around the joint to the proper tension by means of a torque wrench.
6. The correct range of torque as indicated by a torque wrench and the length of wrench (if not a torque wrench) used by an average man to produce such range of torque, is as follows:

TORQUE RANGE VALUES

Range of torque 60-90 ft.-lb.

Length of wrench 10 in.

7. If effective sealing of the joint is not attained at the maximum torque indicated above, disassemble the joint, thoroughly clean, and reassemble.
8. Do not overstress bolts to tighten a leaking joint.

G. Pipe Cutting:

1. Cut in accordance with manufacturer's recommendations.
2. Cut the pipe with a hand saw, metal-inserted abrasive wheel (except asbestoscement pipe), or pipe cutter with blades (not rollers).
3. Examine all cut ends for possible cracks caused by cutting.

H. Pipe Insulation:

1. Install 2 in. thick x 4 ft. wide between pipe and culvert or over pipe when noted on plans.
2. Between culvert and pipe, extend insulation 6 ft. each side of the culvert along the pipe.
3. For dual pipe trenches the insulation shall be 8 ft. wide.
4. Provide 6 in. sand blanket above and below insulation or as shown on Drawings.

I. Pipe Deflection Allowances: Per manufacturer's recommendations or Local Water District recommendations, whichever is more stringent.

J. Valve Installation:

1. Install in accordance with the specifications for the pipe to which they are to be connected.
2. Make up valve joints in accordance with the Contract Drawings.
3. The valves shall bear no stresses due to loads from the adjacent pipe.
4. Inspect, clean, and lubricate before installation.

K. Bracing and Blocking:

1. Block and anchor all bends, 22½° or greater, tees, plugs, etc. with concrete to prevent movement of the pipe in the joints due to internal or external pressures.
2. Use thrust blocks behind all hydrants.
3. Use 2’x2’x4’ concrete blocks manufactured from Pepin Concrete or approved equal. If blocks are poured, wrap joints and bolts with poly before pouring concrete.
4. Place concrete around fittings to the walls of the trench, as shown on the Drawings, so placed that joints may be caulked or tightened, if necessary.
5. Do not backfill until the concrete has set.
6. If the soil does not provide firm support for thrust block placement, provide retainer clamps and tie rods as shown on the Drawings and/or directed by the Owner's Representative.
7. Thrust restraint glands for mechanical joint fittings manufactured by Megalug or Grip Ring.

L. Hydrant Installation:

1. Set hydrants, buried valves and valve boxes plumb, and center with each valve box directly over the valve.
2. Carefully tamp earth fill around the valve box to a distance of 4 ft. on all sides of the box, or to the undisturbed trench face, if less than 4 ft.
3. Set as shown on the Drawings or as directed by the Engineer.
4. Clean interiors of all foreign matter before installation and inspect in opened and closed positions.

M. Air Vents and Blowoffs, Corporation Stops, Curb Stops, Valve Boxes, Copper Tubing and Styrofoam Insulation: Install in accordance with Local Water District requirements, the Drawings and as directed by the Engineer.

N. Vertical Separation From Sanitary Sewer:

1. Whenever water mains must cross sewers, lay at such an elevation that the top of the sewer is at least 18 in. below the bottom of the water main.
2. When the elevation of the sewer cannot be buried to meet the above requirements, center one full length of water main over the sewer so that both joints will be as far from the sewer as possible.

O. Water Service Leads and Stops:

1. Provide and install corporation valves, water service leads, and curb stops for proposed building connections as shown on the Drawings, or where directed by the Architect.

3.3 PRESSURE TESTING AND DISINFECTION

A. Pressure testing and disinfection shall be in accordance with AWWA C600 and AWWA C651 standards.

B. Pressure testing and disinfection shall be performed in strict accordance with Local Water District requirements.

C. Pressure testing and disinfection shall be performed in the presence of the representative of the Portland Water District.

END OF SECTION 331100

SECTION 33 31 00

SANITARY UTILITY SEWERAGE PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes gravity-flow, non-pressure sanitary sewerage outside the building.

1.3 PERFORMANCE REQUIREMENTS

A. Gravity-Flow, Nonpressure, Drainage-Piping Pressure Rating: 10-foot head of water.

1.4 SUBMITTALS

A. Product Data: For pipe and fittings.

B. Manufacturer's Certificate: Certify that products meet or exceed specified local requirements.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Do not store plastic pipe, and fittings in direct sunlight.

B. Protect pipe, pipe fittings, and seals from dirt and damage.

1.6 PROJECT CONDITIONS

A. Portions of the existing sanitary sewer traversing the site shall remain active during construction and upon completion of project. Refer to Grading and Utility plan for proposed modification. Construction activities shall not interfere or impede existing flows. Damage to existing sewer infrastructure shall be repaired by Contractor at their expense.

PART 2 - PRODUCTS

2.1 PVC PIPE AND FITTINGS

A. PVC Sewer Pipe and Fittings, NPS 15 and Smaller: ASTM D 3034, SDR 35, with bell-and-spigot ends for gasketed joints with ASTM F 477, elastomeric seals.

B. Provide commercially manufactured wyes or tees for service connections. Fitting must have single piece gasket.

2.2 NONPRESSURE-TYPE PIPE COUPLINGS

A. Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition coupling, for joining underground nonpressure piping. Include ends of same sizes as piping to be joined, and corrosion-resistant-metal tension band and tightening mechanism on each end.

B. Sleeve Materials:
   1. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
   2. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

C. Unshielded Flexible Couplings: Elastomeric sleeve with stainless-steel shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.

   1. Available Manufacturers:

      a. Dallas Specialty & Mfg. Co.
      b. Fernco Inc.
      c. Logan Clay Products Company (The).
      d. Mission Rubber Company; a division of MCP Industries, Inc.
      e. NDS Inc.
      f. Plastic Oddities, Inc.

2.3 RIGID INSULATION

A. Extruded closed – cell rigid foamed polystyrene, 2 inch thickness, width of trench, Styrofoam HI-60 by Dow Chemical, or approved equal.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavation, trenching, and backfilling are specified in Division 31 Section "Earth Moving."

3.2 PIPING INSTALLATION

A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground storm drainage piping. Location and arrangement of piping layout take design considerations into account. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.

B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.

C. Install gravity-flow, nonpressure drainage piping according to the following:

1. Install piping pitched down in direction of flow, at minimum slope of 2 percent, unless otherwise indicated.
2. Install piping NPS 6 and larger with restrained joints at tee fittings and at changes in direction. Use cast-in-place concrete supports or anchors.
3. Install PVC sewer piping according to ASTM D 2321 and ASTM F 1668.
4. Install HDPE pipe according to ASTM D 2774 and ASTM F 645.
5. Install reinforced-concrete sewer piping according to ASTM C 1479 and ACPA's "Concrete Pipe Installation Manual."

D. No pipe installed will be allowed to begin at any point other than a manhole or other appurtenance without the expressed consent of the Owner's Representative. The interior of each length of pipe will be swabbed and wiped clean before installing the next length. No length of pipe shall be installed until the previous length has had sufficient fine material placed and tamped about it to secure it firmly in place to prevent any disturbance. Bell ends shall be installed uphill. Whenever the work is stopped temporarily, or for any reason whatsoever, the end of the pipe shall be carefully protected against dirt, water, or other extraneous material. Bedding shall be as shown on the drawings.

E. The pipe shall be bedded in a compact granular or stone pipe bedding placed on a flat trench bottom to the limits indicated on the drawings.

F. The pipe shall be cut as necessary for appurtenances. Sufficient short lengths of pipe shall be furnished so that pipe entering and leaving appurtenances shall not be more than 2 feet in length measured from the inside face of the manhole.

G. Pipe Cutting: The cutting of the pipe shall be done in accordance with the pipe manufacturer's recommendations. The pipe material shall be cut by using a saw or milling process, approved by the pipe manufacturer and not by using any impact device, such as a hammer and chisel, to break the pipe. The pipe shall be cut, not broken. The cut end of the pipe shall be square to the axis of the pipe and any rough edges ground smooth.

3.3 PIPE JOINT CONSTRUCTION

A. Join gravity-flow, nonpressure drainage piping according to the following:
   1. Join PVC sewer piping according to ASTM D 2321 and ASTM D 3034 for elastomeric-seal joints or ASTM D 3034 for elastomeric gasket joints.
   2. HDPE, AWWA pipe (for 3” to 8”); HDPE, AWWA fittings; and heat-fusion joints.
   3. Join dissimilar pipe materials with nonpressure-type flexible couplings.

3.4 PIPE INSULATION

A. Install 2-in. thick x 4-ft. wide insulation over pipe when noted on plans or as directed by the Owner's Representative.

3.5 CLOSING ABANDONED SANITARY SEWERAGE PIPING

A. Abandoned Piping: Close open ends of abandoned underground piping indicated to remain in place. Include closures strong enough to withstand hydrostatic and earth pressures that may result after ends of abandoned piping have been closed. Use either procedure below:

   1. Close open ends of piping with at least 8-inch-thick, brick masonry bulkheads.
   2. Close open ends of piping with threaded metal caps, plastic plugs, or other acceptable methods suitable for size and type of material being closed. Do not use wood plugs.

B. Backfill to grade according to Division 31 Section "Earth Moving."

3.6 IDENTIFICATION

A. Materials and their installation are specified in Division 31 Section "Earth Moving." Arrange for installation of green warning tape directly over piping and at outside edge of underground structures.

   1. Use detectable warning tape over nonferrous piping.

3.7 FIELD QUALITY CONTROL AND TESTING

A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspection to be performed with Owner’s Representative present. Inspect after approximately 24 inches of backfill is in place, and again at completion of Project.

   1. Submit separate reports for each system inspection.
   2. Defects requiring correction include the following:

a. Alignment: Less than full diameter of inside of pipe is visible between structures.
b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
c. Crushed, broken, cracked, or otherwise damaged piping.
d. Infiltration: Water leakage into piping.
e. Exfiltration: Water leakage from or around piping.

3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
4. Reinspect and repeat procedure until results are satisfactory.

B. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.

1. Do not enclose, cover, or put into service before inspection and approval.
2. Test completed piping systems according to requirements of authorities having jurisdiction.
3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
4. Submit separate report for each test.

C. Hydrostatic Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction and the following:

1. Allowable leakage is maximum of 50 gal./inch of nominal pipe size per mile of pipe, during 24-hour period.
2. Close openings in system and fill with water.
3. Purge air and refill with water.
4. Disconnect water supply.
5. Test and inspect joints for leaks.
6. Option: Test ductile-iron piping according to AWWA C600, "Hydrostatic Testing" Section. Use test pressure of at least 10 psig.

D. Air Tests: Test sanitary sewerage according to requirements of authorities having jurisdiction, UNI-B-6, and the following:

1. Equipment Requirements:

a. Pneumatic Plugs: Sealing length equal to or greater than the diameter of the pipe to be tested.
b. Pneumatic Plugs: Size and type to resist internal test pressures without requiring external bracing or blocking.
c. All air used shall pass through a single control panel.
d. Use three individual hoses for the following connections:

1) From control panel to pneumatic plugs for inflation.
2) From control panel to sealed line for introducing the low pressure air.
3) From sealed line to control panel for continually monitoring the air pressure rise in the sealed line.

2. Procedures:

a. Pneumatic Plug Seal Testing:

1) Before being used in the actual test installation, lay one length of pipe on the ground and seal at both ends with the pneumatic plugs to be checked.
2) Introduce air into the plugs to 25 psig.
3) Sealed pipe shall be pressurized to 5 psig.
4) The plugs shall hold against this pressure without bracing and without movement of the plugs out of the pipe.

b. Pipe:

1) Place plugs in the line and inflate to 25 psig.
2) Introduce low pressure air into sealed line until the internal air pressure reaches 4 psig greater than the average back pressure of groundwater over the pipe.
3) Wait at least two minutes for the air pressure to stabilize.
4) After the stabilization (3.5 psig minimum pressure in the pipe), disconnect the air hose from the control panel to the air supply. The portion of line being tested shall be termed "acceptable" if the time required in minutes for the pressure to decrease from 3.5 to 2.5 psig (greater than the average back pressure of any groundwater that may be over the pipe) is greater than 4 minutes.

c. Where Groundwater is Known to Exist:

1) Install a one-half inch diameter capped pipe nipple, approximately 10′ long, through the manhole wall on top of one of the pipes entering the manhole, at the time the pipe is installed.
2) Immediately prior to the performance of the Line Acceptance Test, determine the groundwater by removing the pipe cap, blowing air through the pipe nipple into the ground so as to clear it, and then connect a clear plastic tube to the nipple.
3) The hose shall be held vertically and a measurement of the height in feet shall be divided by 2.3 to establish the pounds of pressure that will be added to all readings. (For example, if the height of water is 11-1/2 feet, then the added pressure will be 5 psig, add the 2.5 psig to 7.5 psig. The allowable drop of one pound and the timing remain the same).

d. Should the pipe, as laid, fail to meet these requirements, perform the necessary work to meet these requirements, without additional cost to the Owner.

E. Leaks and loss in test pressure constitute defects that must be repaired.

F. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

3.8 INFILTRATION AND EXFILTRATION TESTS

A. If the installation fails to meet the above requirements for the air test, the Contractor may either run an Exfiltration or infiltration test, as directed and if approved by the Engineer.

B. Leakage shall not exceed 100 gallons per inch diameter/day/mile of pipe, when tested by either internal pressure or external pressure means. Should the pipe, as laid, fail to meet these requirements, the Contractor shall perform the necessary work at his expense to meet these requirements. Where groundwater is high, the Engineer may elect to accept infiltration measurements in lieu of exfiltration tests.

C. Infiltration Tests:

1. Requires groundwater levels to be a minimum of one foot above the crown of the pipe of the high end of the section being tested.
2. Infiltration Test Procedures:

   a. Engineer to determine length of sewer main and connecting lines to be tested.
   b. No more than 1,000 feet of sewer main is to be laid before testing.
   c. With all connecting pipes plugged (other than those included in test section) install a V notch weir in downstream end of pipe.
   d. Allow time for water to buildup behind weir until steady, uniform flow passes through V notch.
   e. Take and record readings under direction of the Engineer.

D. Exfiltration Test:

1. Procedures:

   a. Engineer to determine length of sewer to be tested.
   b. Properly cap or plug and block service laterals, stubs and fitting into sewer lines being tested.
   c. Plug downstream ends of test section providing a water supply connection standpipe in manhole upstream.
   d. Fill test section and upstream standpipe and allow time for water absorption in manholes.
   e. Measure drop in upstream standpipe over 4 - 15 minute periods and compute leakage.

3.9 CLEANING

A. Clean interior of piping of dirt and superfluous materials. Flush with potable water.

END OF SECTION 333100

This page intentionally left blank

SECTION 33 41 00

STORM UTILITY DRAINAGE PIPING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes gravity-flow, nonpressure storm drainage outside the building, with the following components:

1. Storm drain piping.

1.3 DEFINITIONS

A. PE: Polyethylene plastic.

B. PP: Polypropylene plastic.

C. PVC: Polyvinyl chloride plastic.

1.4 PERFORMANCE REQUIREMENTS

A. Gravity-Flow, Nonpressure, Drainage-Piping Pressure Rating: 10-foot head of water. Pipe joints shall be at least silttight, unless otherwise indicated.

1.5 SUBMITTALS

A. Product Data: For the following:

1. Storm drain piping.

B. Field quality-control test reports.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Do not store plastic manholes, pipe, and fittings in direct sunlight.

B. Protect pipe, pipe fittings, and seals from dirt and damage.

1.7 PROJECT CONDITIONS

A. Interruption of Existing Storm Drainage Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:

1. Notify Construction Manager, Owner no fewer than two days in advance of proposed interruption of service.
2. Do not proceed with interruption of service without Owner's written permission.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 PIPING MATERIALS

A. Refer to Part 3 "Piping Applications" Article for applications of pipe, fitting, and joining materials.

2.3 PE PIPE AND FITTINGS

A. Corrugated PE Drainage Pipe and Fittings NPS 10 and Smaller: AASHTO M 252M, Type S, with smooth waterway for coupling joints.

1. Product: HP Storm by Advanced Drainage Systems, Inc. (ADS)
2. Silttight Couplings: PE sleeve with ASTM D 1056, Type 2, Class A, Grade 2 gasket material that mates with tube and fittings.

B. Corrugated PE Pipe and Fittings NPS 12 to NPS 60: smooth
1. interior and annular exterior corrugated polypropylene (PP) pipemeeting the requirements of ASTM F2764, ASTM F2881 or AASHTO M330 Type S (double-wall) or D (triple-wall), for respective diameters.

2. Material for 12- through 60-inch pipe and fitting production shall be an impact modified copolymer meeting the material requirements of ASTM F2764, ASTM F2881 and AASHTO M330, for respective pipe diameter.
3. Silttight Couplings: PE sleeve with ASTM D 1056, Type 2, Class A, Grade 2 gasket material that mates with pipe and fittings.
4. Watertight joints shall be bell-and-spigot meeting the watertight requirements of ASTM D3212. Gaskets shall comply with the requirements of ASTM F477. Gaskets shall be installed by the pipe manufacturer and covered with a removable wrap to ensure the gasket is free from debris. A joint lubricant supplied by the manufacturer shall be used on the gasket and bell during assembly.
5. Fittings shall conform to ASTM F2764, ASTM F2881 or AASHTO M330, with the exception of meeting the watertight joint performance requirements of ASTM D3212. Gasketed bell & spigot connections shall utilize a spun-on, welded or integral bell and spigot with gaskets meeting ASTM F477.
.

2.4 PVC PIPE AND FITTINGS

A. PVC Pressure Pipe: AWWA C900, Class 150, for gasketed joints and using ASTM F 477, elastomeric seals.

1. Fittings NPS 4 to NPS 8: PVC pressure fittings complying with AWWA C907, for gasketed joints and using ASTM F 477, elastomeric seals.
2. Fittings NPS 10 and Larger: Ductile-iron, compact fittings complying with AWWA C153, for push-on joints and using AWWA C111, rubber gaskets.

B. PVC Sewer Pipe and Fittings, NPS 15 and Smaller: ASTM D 3034, SDR 35, with bell-and-spigot ends for gasketed joints with ASTM F 477, elastomeric seals.

2.5 NONPRESSURE-TYPE PIPE COUPLINGS

A. Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition coupling, for joining underground nonpressure piping. Include ends of same sizes as piping to be joined, and corrosion-resistant-metal tension band and tightening mechanism on each end.

B. Sleeve Materials:
1. For Cast-Iron Soil Pipes: ASTM C 564, rubber.
2. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.
3. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

C. Unshielded Flexible Couplings: Elastomeric sleeve with corrosion-resistant-metal tension band and tightening mechanism on each end.

1. Available Manufacturers:

a. Dallas Specialty & Mfg. Co.

b. Fernco Inc.
c. Logan Clay Products Company (The).
d. Mission Rubber Company; a division of MCP Industries, Inc.
e. NDS Inc.
f. Plastic Oddities, Inc.

D. Ring-Type Flexible Couplings: Elastomeric compression seal with dimensions to fit inside bell of larger pipe and for spigot of smaller pipe to fit inside ring.

1. Available Manufacturers:

a. Fernco Inc.
b. Logan Clay Products Company (The).
c. Mission Rubber Company; a division of MCP Industries, Inc.

2.6 RIGID INSULATION

A. Extruded closed – cell rigid foamed polystyrene, 2 inch thickness, width of trench, Styrofoam HI-60 by Dow Chemical, or approved equal.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavation, trenching, and backfilling are specified in Division 31 Section "Earth Moving."

3.2 PIPING APPLICATIONS

A. Pipe couplings and special pipe fittings with pressure ratings at least equal to piping rating may be used in applications below, unless otherwise indicated.

1. Use nonpressure-type flexible couplings where required to join gravity-flow, nonpressure sewer piping, unless otherwise indicated.

a. Shielded flexiblecouplings for same or minor difference OD pipes.
b. Unshielded, increaser/reducer-pattern, flexiblecouplings for pipes with different OD.
c. Ring-type flexible couplings for piping of different sizes where annular space between smaller piping's OD and larger piping's ID permits installation.

2. Use pressure-type pipe couplings for force-main joints.

B. Special Pipe Fittings: Use for pipe expansion and deflection. Pipe couplings and special pipe fittings with pressure ratings at least equal to piping rating may be used in applications below, unless otherwise indicated.

C. Gravity-Flow, Nonpressure Sewer Piping: Use the following pipe materials for each size range:
   1. NPS 4 and NPS 6: Corrugated PE drainage pipe and fittings, silttight couplings, and coupled joints.
   2. NPS 4 and NPS 6: PVC sewer pipe and fittings, gaskets, and gasketed joints.
   3. NPS 8 to NPS 12: Corrugated PE drainage pipe and fittings in NPS 8 and NPS 10 and corrugated PE pipe and fittings in NPS 12, silttight couplings, and coupled joints.
   4. NPS 8 to NPS 12: PVC sewer pipe and fittings, gaskets, and gasketed joints.
   5. NPS 8 to NPS 12: PVC profile gravity sewer pipe and fittings, gaskets, and gasketed joints.
   6. NPS 15: Corrugated PE pipe and fittings, silttight couplings, and coupled joints.
   7. NPS 15: PVC sewer pipe and fittings, gaskets, and gasketed joints.
   8. NPS 18 to NPS 36: PVC sewer pipe and fittings, gaskets, and gasketed joints.
   9. NPS 42 to NPS 60: Corrugated PE pipe and fittings, silttight couplings, and coupled joints.

3.3 PIPING INSTALLATION

A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground storm drainage piping. Location and arrangement of piping layout take design considerations into account. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.

B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements.

C. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.

D. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.

E. Tunneling: Install pipe under streets or other obstructions that cannot be disturbed by tunneling, jacking, or a combination of both.

F. Install gravity-flow, nonpressure drainage piping according to the following:

   1. Install piping pitched down in direction of flow, at minimum slope of 0.5 percent, unless otherwise indicated.
   2. Install piping below frost line.

3. Install PE corrugated sewer piping according to CPPA's "Recommended Installation Practices for Corrugated Polyethylene Pipe and Fittings."
4. Install PVC sewer piping according to ASTM D 2321 and ASTM F 1668.

3.4 PIPE JOINT CONSTRUCTION

A. Basic pipe joint construction is specified in Division 33 Section "Common Work Results for Utilities." Where specific joint construction is not indicated, follow piping manufacturer's written instructions.

B. Join gravity-flow, nonpressure drainage piping according to the following:
   1. Join corrugated PE piping according to CPPA 100 and the following:

      a. Use silttight couplings for Type 2, silttight joints.
   2. Join PVC sewer piping according to ASTM D 2321 and ASTM D 3034 for elastomeric-seal joints or ASTM D 3034 for elastomeric gasket joints.
   3. Join dissimilar pipe materials with nonpressure-type flexible couplings.

3.5 CONNECTIONS

A. Connect nonpressure, gravity-flow drainage piping in building's storm building drains specified in Division 22 Section "Facility Storm Drainage Piping."

   1. Protect existing piping, manholes, and structures to prevent concrete or debris from entering while making tap connections. Remove debris or other extraneous material that may accumulate.

3.6 IDENTIFICATION

A. Materials and their installation are specified in Division 31 Section "Earth Moving." Arrange for installation of green warning tape directly over piping and at outside edge of underground structures.

   1. Use detectable warning tape over ferrous piping.
   2. Use detectable warning tape over nonferrous piping and over edges of underground structures.

3.7 FIELD QUALITY CONTROL

A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches of backfill is in place, and again at completion of Project.

   1. Submit separate reports for each system inspection.
   2. Defects requiring correction include the following:

a. Alignment: Less than full diameter of inside of pipe is visible between structures.
b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
c. Crushed, broken, cracked, or otherwise damaged piping.
d. Infiltration: Water leakage into piping.
e. Exfiltration: Water leakage from or around piping.

3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
4. Reinspect and repeat procedure until results are satisfactory.

B. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.

1. Do not enclose, cover, or put into service before inspection and approval.
2. Test completed piping systems according to authorities having jurisdiction.
3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
4. Submit separate report for each test.
5. Gravity-Flow Storm Drainage Piping: Test according to requirements of authorities having jurisdiction, UNI-B-6, and the following:

a. Exception: Piping with silttight joints unless required by authorities having jurisdiction.
b. Option: Test plastic piping according to ASTM F 1417.
c. Option: Test concrete piping according to ASTM C 924.

C. Leaks and loss in test pressure constitute defects that must be repaired.

D. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

3.8 CLEANING

A. Clean interior of piping of dirt and superfluous materials. Flush with potable water.

END OF SECTION 334100

This page intentionally left blank

SECTION 33 42 01

STORMWATER TREATMENT SYSTEM

PART 1 - GENERAL

1.01 SUMMARY

A. Section includes installation of subsurface chamber Stormwater Treatment System

B. Provide excavation and base preparation per geotechnical engineer's recommendations and/or as shown on the design drawings, to provide adequate support for project design loads and safety from excavation sidewall collapse. Excavations shall be in accordance with the owner's and OSHA requirements.

C. Provide and install R-Tank, R-TankHD, or R-TankSD system (hereafter called R-Tank) and all related products including fill materials, geotextiles, geogrids, inlet and outlet pipe with connections per the manufacturer's installation guidelines provided in this section.

D. Provide and construct the cover of the R-Tank system including; stone backfill, structural fill cover, and pavement section as specified.

E. Protect R-Tank system from construction traffic after installation until completion of all construction activity in the installation area.

F. System Description: Subsurface sand filter system with RTank storage units, Isolator row chambers and aggregates. The system includes precast concrete manholes piping and PVC liners as shown on the plans and specified in other sections.

G. Related Requirements:
   1. Division 31200 Section "Earthmoving" for earthwork requirements
   2. Division 334713 Pond and Reservoir Liners" for system liner

1.02 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Prior to the start of the installation, a preinstallation conference shall occur with the representatives from the design team, the general contractor, the excavation contractor, the R-Tank installation contractor, and the manufacturer's representative.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings:
   1. Submit proposed R-Tank layout drawings. Drawings shall include typical section details as well as the required base elevation of stone and tanks, minimum cover requirements and tank configuration.
   2. Submit construction load limit documentation prepared by the manufacturer
   3. Submit construction sequence and protection plan to protect the subsurface system from Construction traffic.
   4. Submit manufacturer's product data, including compressive strength and unit weight.
   5. Submit manufacturer’s installation instructions.
   6. Submit R-Tank sample for review. Reviewed and accepted samples will be returned to the Contractor.
   7. Submit material certificates for geotextile, geogrid, base course and backfill materials.
   8. Submit required experience and personnel requirements as specified i.
   9. Any proposed equal alternative product substitution to this specification must be submitted for review and approved prior to bid opening. Review package should include third party reviewed performance data that meets or exceeds criteria in Table 2.01 B. Samples: For each exposed product and for each color and texture specified.

1.04 QUALITY ASSURANCE

A. Installer Qualifications: Installation Contractor shall demonstrate the following experience:
   1. A minimum of three R-Tank or equivalent projects completed within 2 years; and,
   2. A minimum of 25,000 cubic feet of storage volume completed within 2 years.
   3. Contractor experience requirement may be waived if the manufacturer’s representative provides on-site training and review during construction.

B. Installation Personnel: Performed only by skilled workers with satisfactory record of performance on bulk earthworks, pipe, chamber, or pond/landfill construction projects of comparable size and quality.

C. Contractor must have manufacturer’s representative available for site review if requested by Owner.

PART 2 - PRODUCTS

2.01 Cultec Chambers

A. The chambers will be manufactured by CULTEC, Inc. of Brookfield, CT. (203-775-4416 or 1-800-428-5832)
   1. The chamber will be vacuum thermoformed of black high molecular weight high density polyethylene (HMWHDPE).
   2. The chamber will be arched in shape, open bottomed.

3. The chamber will be joined using an interlocking overlapping rib method. Connections must be fully shouldered overlapping ribs, having no separate couplings or separate end walls.
4. The nominal chamber dimensions of the CULTEC Recharger® 330XLHD shall be 30.5 inches (775 mm) tall, 52 inches (1321 mm) wide and 8.5 feet (2.59 m) long. The installed length of a joined Recharger® 330XLHD shall be 7 feet (2.13 m).
5. Maximum inlet opening on the chamber endwall is 24 inches (600 mm).
6. The chamber will have two side portals to accept CULTEC HVLV™ FC-24 Feed Connectors to create an internal manifold. The nominal dimensions of each side portal will be 10.5 inches (267 mm) high by 12 inches (305 mm) wide. Maximum allowable pipe size in the side portal is 10 inches (250 mm).
7. The nominal chamber dimensions of the CULTEC HVLV™ FC-24 Feed Connector shall be 12 inches (305 mm) tall, 16 inches (406 mm) wide and 24.2 inches (614 mm) long.
8. The nominal storage volume of the Recharger® 330XLHD chamber will be 7.459 ft3 / ft (0.693 m3 / m) - without stone. The nominal storage volume of a joined Recharger® 330XLHD shall be 52.213 ft3 / unit (1.478 m3 / unit) - without stone.
9. The nominal storage volume of the HVLV™ FC-24 Feed Connector will be 0.913 ft3 / ft (0.085 m3 / m) - without stone.
10. The Recharger® 330XLHD chamber will have fifty-six discharge holes bored into the sidewalls of the unit's core to promote lateral conveyance of water.
11. The Recharger® 330XLHD chamber shall have 16 corrugations.
12. The endwall of the chamber, when present, will be an integral part of the continuously formed unit. Separate end plates cannot be used with this unit.
13. The Recharger® 330XLRHD Stand Alone unit must be formed as a whole chamber having two fully formed integral endwalls and having no separate end plates or separate end walls.
14. The Recharger® 330XLSHD Starter unit must be formed as a whole chamber having one fully formed integral endwall and one partially formed integral endwall with a lower transfer opening of 14 inches (356 mm) high x 34.5 inches (876 mm) wide.
15. The Recharger® 330XLIHD Intermediate unit must be formed as a whole chamber having one fully open endwall and one partially formed integral endwall with a lower transfer opening of 14 inches (356 mm) high x 34.5 inches (876 mm) wide.
16. The Recharger® 330XLEHD End unit must be formed as a whole chamber having one fully formed integral endwall and one fully open end wall and having no separate end plates or end walls.
17. The HVLV™ FC-24 Feed Connector must be formed as a whole chamber having two open end walls and having no separate end plates or separate end walls. The unit will fit into the side portals of the Recharger® 330XLHD and act as cross feed connections.
18. Chambers must have horizontal stiffening flex reduction steps between the ribs.
19. The chamber will be designed to withstand AASHTO H-25 load rating when installed according to CULTEC's recommended installation instructions.
20. Heavy duty units are designated by a colored stripe formed into the part along the length of the chamber.

21. The chamber will have a raised integral cap at the top of the arch in the center of each unit to be used as an optional inspection port or clean-out.
22. The units may be trimmed to custom lengths by cutting back to any corrugation.
23. The chamber shall be manufactured in an ISO 9001:2000 certified facility.

2.02 R-Tank Units

A. R -Tank - Injection molded plastic tank plates assembled to form a 95% void modular structure of predesigned height (custom for each project.

B. R-Tank units shall meet the following Physical & Chemical Characteristics:

PROPERTY	DESCRIPTION	R-Tank^{LD} VALUE	R-Tank^{HD} VALUE	R-Tank^{SD} VALUE
Void Area	Volume available for water storage	95%	95%	95%
Surface Void Area	Percentage of exterior available for infiltration	90%	90%	90%
Compressive Strength	ASTM D 2412 / ASTM F 2418	30.0 psi	33.4 psi	42.9 psi
HS-20 Minimum Cover	Cover required to support HS-20 loads	N/A	20″	18″
HS-25 Minimum Cover	Cover required to support HS-25 loads	N/A	24″	19″
Maximum Cover	Maximum allowable cover depth	3 feet	< 7 feet	< 10 feet
Unit Weight	Weight of plastic per cubic foot of tank	3.29 lbs / cf	3.62 lbs/cf	3.96 lbs / cf
Rib Thickness	Thickness of load-bearing members	0.18 inches	0.18 inches	0.18 inches
Service Temperature	Safe temperature range for use	-14 – 167° F	-14 – 167° F	-14 – 167° F

C. Supplier: ACF Environmental 2831 Cardwell Road Richmond, VA 23234 (T): 800-448-3636; (F): 804-743-7779 www.acfenvironmental.com

2.03 Geosynthetics

A. Geotextile. A geotextile envelope is required to prevent backfill material from entering the R-Tank modules.
   1. Standard Application: The standard geotextile shall be an 8 oz per square yard nonwoven geotextile (ACF N080 or equivalent).

B. Geogrid. Install geogrid (ACF BX12 or equivalent) to reinforce backfill above the R-Tank system.

2.04 Backfill & Cover Materials

A. Bedding Materials: Stone (angular and smaller than 1.5” in diameter) or soil (GW, GP, SW, or SP as classified by the Unified Soil Classification System) shall be used below the R-Tank system (3” minimum). Material must be free from lumps, debris, and any sharp objects that could cut the geotextile. Material shall be within 3 percent of the optimum moisture content as determined by ASTM D698 at the time of installation. For infiltration applications bedding material shall be free draining.

B. Side and Top Backfill: Free draining stone (angular and smaller than 1.5” in diameter) or soil (GW, GP, SW, or SP as classified by the Unified Soil Classification System) shall be used adjacent to (24” minimum) and above (for the first 12”) the R-Tank system. Material must be free from lumps, debris and any sharp objects that could cut the geotextile. Material shall be within 3 percent of the optimum moisture content as determined by ASTM D698 at the time of installation.

C. Additional Cover Materials: Structural Fill shall consist of granular materials meeting the gradational requirements of SM, SP, SW, GM, GP or GW as classified by the Unified Soil Classification System. Structural fill shall have a maximum of 25 percent passing the No. 200 sieve, shall have a maximum clay content of 10 percent and a maximum Plasticity Index of 4. Material shall be within 3 percent of the optimum moisture content as determined by ASTM D698 at the time of installation.

2.05 Other Materials

A. Utility Marker: Install metallic tape at corners of R-Tank system to mark the area for future utility detection.

PART 3 - EXECUTION

3.01 Assembly of R-Tank Units

A. On-site assembly of tanks shall be performed in accordance with the R-Tank Installation Manual, Section 2.

3.02 Layout and Excavation

A. Installer shall stake out, excavate, and prepare the subgrade area to the required plan grades and dimensions, ensuring that the excavation is at least 2 feet greater than R-Tank dimensions in each direction allowing for installation of geotextile filter fabric, R-Tank modules, and free draining backfill materials.

B. All excavations must be prepared with OSHA approved excavated sides and sufficient working space.

C. Protect partially completed installation against damage from other construction traffic by establishing a perimeter with high visibility construction tape, fencing, barricades, or other means until construction is complete.

D. Base of the excavation shall be uniform, level, and free of lumps or debris and soft or yielding subgrade areas. A minimum 2,000 pounds per square foot bearing capacity is required.
   1. Standard Applications: Compact subgrade to a minimum of 95% of Standard Proctor (ASTM D698) density or as required by the Owner's engineer.

E. Unsuitable Soils or Conditions: All questions about the base of the excavation shall be directed to the Architect, who will approve the subgrade conditions prior to placement of stone. The Architect shall determine the required bearing capacity of the R-Tank subgrade; however in no case shall a bearing capacity of less than 2,000 pounds per square foot be provided.
   1. If unsuitable soils are encountered at the subgrade, or if the subgrade is pumping or appears excessively soft, repair the area in accordance with contract documents and/or as directed by the Architect.
   2. If indications of the water table are observed during excavation, the Architect shall be contacted to provide recommendations.

F. Do not start installation of the R-Tank system until unsatisfactory subgrade conditions are corrected and the subgrade conditions are accepted by the owner's engineer.

3.03 Preparation of Base

A. Place a thin layer (3" unless otherwise specified) of bedding material (Section 2.03 A), over the subgrade to establish a level working platform for the R-Tank modules. Level to within ½" (+/- ¼") or as shown on the plans. Native subgrade soils or other materials may be used if determined to meet the requirements of 2.03 A and are accepted by the owner's engineer.
   1. Standard Applications: Static roll or otherwise compact bedding materials until they are firm and
      unyielding.

B. Outline the footprint of the R-Tank system on the excavation floor using spray paint or chalk line to ensure a 2' perimeter is available around the R-Tank system for proper installation and compaction of backfill.

3.04 Installation of the R-Tanks

A. Where a geotextile wrap is specified on the stone base, cut strips to length and install in excavation, removing wrinkles so material lays flat. Overlap geotextile a minimum 12" or as recommended by manufacturer.

B. Where an impervious liner (for containment) is specified, install the liner per manufacturer's recommendations and the contract documents. The R-Tank units

shall be separated from impervious liner by a non-woven geotextile fabric installed accordance with Section 3.04A.

C. Install R-Tank modules by placing side by side, in accordance with the design drawings. No lateral connections are required. It is advisable to use a string line to form square corners and straight edges along the perimeter of the R-Tank system. The modules are to be oriented as per the design drawing (15.75" x 28.15") with required depth as shown on plans. The large side plate of the tank should be placed on the perimeter of the system. This will typically require that the two ends of the tank area will have a row of tanks placed perpendicular to all other tanks. If this is not shown in the construction drawings, it is a simple field adjustment that will have minimal effect on the overall system footprint. Refer to R-Tank Installation Guide for more details.

D. Wrap the R-Tank top and sides in specified geotextile. Cut strips of geotextile so that it will cover the sides and top, encapsulating the entire system to prevent soil entry into the system. Overlap geotextile 12" or as recommended by manufacturer. Take great care to avoid damage to geotextile (and, if specified, impervious liner) during placement.

E. Identify locations of inlet, outlet and any other penetrations of the geotextile (and optional liner). These connections should be installed flush (butted up to the R-Tank) and the geotextile fabric shall be cut to enable hydraulic continuity between the connections and the R-Tank units. These connections shall be secured using pipe boots with stainless steel pipe clamps. Support pipe in trenches during backfill operations to prevent pipe from settling and damaging the geotextile, impervious liner (if specified) or pipe. Connecting pipes at 90 degree angles facilitates construction, unless otherwise specified. Ensure end of pipe is installed snug against R-Tank system.

F. Install Inspection and Maintenance Ports in locations noted on plans. At a minimum one maintenance port shall be installed within 10' of each inlet & outlet connection, and with a maximum spacing of one maintenance port for every 2,500 square feet. Install all ports as noted in the R-Tank Installation Guide.

G. If required, install ventilation pipes and vents as specified on drawings to provide ventilation for proper hydraulic performance. The number of pipes and vents will depend on the size of the system. Vents are often installed using a 90 degree elbow with PVC pipe into a landscaped area with 'U" bend or venting bollard to inhibit the ingress of debris. A ground level concrete or steel cover can be used.

3.05 Backfilling of the R-Tank Units

A. Backfill and fill with recommended materials as follows:
   1. Place freely draining backfill materials (Section 2.03 B) around the perimeter in lifts with a maximum thickness of 12". Each lift shall be placed around the entire perimeter such that each lift is no more than 24" higher than the side backfill along any other location on the perimeter of the R-Tank system. No fill shall be placed over top of tanks until the side backfill has been completed.

2. Each lift shall be compacted at the specified moisture content to a minimum of 95% of the Standard Proctor Density until no further densification is observed (for self-compacting stone materials). The side lifts must be compacted with walk behind compaction equipment. Even when "self-compacting" backfill materials are selected, a walk behind vibratory compactor must be used.
3. Take care to ensure that the compaction process does not allow the machinery to come into contact with the modules due to the potential for damage to the geotextile and R-Tank units.
4. No compaction equipment is permissible to operate directly on the R-Tank modules.
5. Following placement of side backfill, a uniform 12" lift of the freely draining material (Section 2.03 B) shall be placed over the R-Tank and lightly compacted using a walk-behind trench roller. Alternately, a roller (maximum gross vehicle weight of 6 tons) may be used. Roller must remain in static mode until a minimum of 24" of cover has been placed over the modules. Sheep foot rollers should not be used.
6. Install a geogrid (required for traffic applications) over the initial 12" lift of backfill. Geogrid shall extend a minimum of 3 feet beyond the limits of the excavation wall.
7. Following placement and compaction of the initial cover, subsequent lifts of structural fill (Section 2.03 C) shall be placed at the specified moisture content and compacted to a minimum of 95% of the Standard Proctor Density and shall cover the entire footprint of the R-Tank system. During placement of fill above the system, unless otherwise specified, a uniform elevation of fill shall be maintained to within 12" across the footprint of the R-Tank system. Do not exceed maximum cover depths listed in Table 2.01 B.
8. Place additional layers of geotextile and/or geogrid at elevations as specified in the design details. Each layer of geosynthetic reinforcement placed above the R-Tank system shall extend a minimum of 3 feet beyond the limits of the excavation wall.

B. Only low pressure tire or track vehicles shall be operated over the R-Tank system during construction. No machinery should drive on top of the tank until a minimum of 18" of backfill and compaction is achieved. Dump Trucks and Pans shall not be operated within the R-Tank system footprint at any time. Where necessary the heavy equipment should unload in an area adjacent to the R-Tank system and the material should be moved over the system with tracked equipment.

C. Ensure that all unrelated construction traffic is kept away from the limits of excavation until the project is complete and final surface materials are in place. No non-installation related loading should be allowed over the R-Tank system until the final design section has been constructed (including pavement).

D. Place surfacing materials, such as groundcovers (no large trees), or paving materials over the structure with care to avoid displacement of cover fill and damage to surrounding areas.

E. Backfill depth over R-Tank system must be within the limitations shown in the table in Section 2.01 B. If the total backfill depth does not comply with this table, contact engineer or manufacturer's representative for assistance.

END OF SECTION

This page intentionally left blank

SECTION 33 46 00

SUBDRAINAGE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes subdrainage systems for the following:

1. Foundations.
2. Underslab areas.
3. Retaining walls.
4. Landscaped areas.

1.3 DEFINITIONS

A. ABS: Acrylonitrile-butadiene-styrene plastic.

B. HDPE: High-density polyethylene plastic.

C. PE: Polyethylene plastic.

D. PP: Polypropylene plastic.

E. PS: Polystyrene plastic.

F. PVC: Polyvinyl chloride plastic.

G. Subdrainage: Drainage system that collects and removes subsurface or seepage water.

1.4 SUBMITTALS

A. Product Data: For the following:

1. Perforated-wall pipe and fittings.
2. Solid-wall pipe and fittings.
3. Drainage conduits.

4. Drainage panels.
5. Geotextile filter fabrics.

B. Approval of waterproofing manufacturer's service agent for use of drainage panels against and for waterproofing membrane protection.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, manufacturers specified.
2. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.2 PIPING MATERIALS

A. Refer to the "Piping Applications" Article in Part 3 for applications of pipe, tube, fitting, and joining materials.

2.3 PERFORATED-WALL PIPES AND FITTINGS

A. Perforated PE Pipe and Fittings:

1. NPS 6 and Smaller: ASTM F 405 or AASHTO M 252, Type CP; corrugated, for coupled joints.
2. Couplings: Manufacturer's standard, band type.

B. Perforated PVC Sewer Pipe and Fittings: ASTM D 2729, bell-and-spigot ends, for loose joints.

2.4 SOLID-WALL PIPES AND FITTINGS

A. PE Drainage Tubing and Fittings: AASHTO M 252, Type S, corrugated, with smooth waterway, for coupled joints.

1. Couplings: AASHTO M 252, corrugated, band type, matching tubing and fittings.

B. PE Pipe and Fittings: AASHTO M 294, Type S, corrugated, with smooth waterway, for coupled joints.

1. Couplings: AASHTO M 294, corrugated, band type, matching tubing and fittings.

C. PVC Sewer Pipe and Fittings: ASTM D 3034, SDR 35, bell-and-spigot ends, for gasketed joints.

1. Gaskets: ASTM F 477, elastomeric seal.

2.5 SOIL MATERIALS

A. Backfill, drainage course, impervious fill, and satisfactory soil materials are specified in Division 31 Section "Earth Moving."

2.6 GEOTEXTILE FILTER FABRICS

A. Description: Fabric of PP or polyester fibers or combination of both, with flow rate range from 110 to 330 gpm/sq. ft. when tested according to ASTM D 4491.

1. Structure Type: Nonwoven, needle-punched continuous filament.
2. Style(s): Flat.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces and areas for suitable conditions where subdrainage systems are to be installed.

B. If subdrainage is required for landscaping, locate and mark existing utilities, underground structures, and aboveground obstructions before beginning installation and avoid disruption and damage of services.

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

3.2 EARTHWORK

A. Excavating, trenching, and backfilling are specified in Division 31 Section "Earth Moving."

3.3 PIPING APPLICATIONS

A. Underground Subdrainage Piping:

1. Perforated PE pipe and fittings, couplings, and coupled joints.

B. Underslab Subdrainage Piping:

1. Perforated PE pipe and fittings, couplings, and coupled joints.

C. Header Piping:
1. PE drainage tubing and fittings, couplings, and coupled joints.
2. PVC sewer pipe and fittings, couplings, and coupled joints.

3.4 FOUNDATION DRAINAGE INSTALLATION

A. Place impervious fill material on subgrade adjacent to bottom of footing after concrete footing forms have been removed. Place and compact impervious fill to dimensions indicated, but not less than 6 inches deep and 12 inches wide.

B. Place impervious fill on subgrade adjacent to bottom of footing and compact to dimensions indicated, but not less than 6 inches deep and 12 inches wide after concrete footing forms have been removed.

C. Lay flat-style geotextile filter fabric in trench and overlap trench sides.

D. Place supporting layer of drainage course over compacted subgrade and geotextile filter fabric, to compacted depth of not less than 4 inches.

E. Install drainage piping as indicated in Part 3 "Piping Installation" Article for foundation subdrainage.

F. Add drainage course to width of at least 6 inches on side away from wall and to top of pipe to perform tests.

G. After satisfactory testing, cover drainage piping to width of at least 6 inches on side away from footing and above top of pipe to within 12 inches of finish grade.

H. Install drainage course and wrap top of drainage course with flat-style geotextile filter fabric.

I. Place layer of flat-style geotextile filter fabric over top of drainage course, overlapping edges at least 4 inches.

J. Place initial backfill material over compacted drainage course . Place material in loose-depth layers not exceeding 6 inches. Thoroughly compact each layer. Final backfill to finish elevations and slope away from building.

3.5 UNDERSLAB DRAINAGE INSTALLATION

A. Excavate for underslab drainage system after subgrade material has been compacted but before drainage course has been placed. Include horizontal distance of at least 6 inches between drainage pipe and trench walls. Grade bottom of trench excavations to required slope, and compact to firm, solid bed for drainage system.

B. Lay flat-style geotextile filter fabric in trench and overlap trench sides.

C. Place supporting layer of drainage course over compacted subgrade and geotextile filter fabric, to compacted depth of not less than 4 inches.

D. Install drainage piping as indicated in Part 3 "Piping Installation" Article for underslab subdrainage.

E. Add drainage course to width of at least 6 inches on side away from wall and to top of pipe to perform tests.

F. After satisfactory testing, cover drainage piping with drainage course to elevation of bottom of slab, and compact and wrap top of drainage course with flat-style geotextile filter fabric.

G. Install horizontal drainage panels as follows:

1. Coordinate placement with other drainage materials.
2. Lay perforated drainage pipe at inside edge of footings.
3. Place drainage panel over drainage pipe with core side up. Peel back fabric and wrap fabric around pipe. Locate top of core at bottom elevation of floor slab.
4. Butt additional panels against other installed panels. If panels have plastic flanges, overlap installed panel with flange.

3.6 RETAINING-WALL DRAINAGE INSTALLATION

A. Lay flat-style geotextile filter fabric in trench and overlap trench sides.

B. Place supporting layer of drainage course over compacted subgrade to compacted depth of not less than 4 inches.

C. Install drainage piping as indicated in Part 3 "Piping Installation" Article for retaining-wall subdrainage.

D. Add drainage course to width of at least 6 inches on side away from wall and to top of pipe to perform tests.

E. After satisfactory testing, cover drainage piping to width of at least 6 inches on side away from footing and above top of pipe to within 12 inches of finish grade.

F. Place drainage course in layers not exceeding 3 inches in loose depth; compact each layer placed and wrap top of drainage course with flat-style geotextile filter fabric.

G. Place layer of flat-style geotextile filter fabric over top of drainage course, overlapping edges at least 4 inches.

H. Fill to Grade: Place satisfactory soil fill material over compacted drainage course . Place material in loose-depth layers not exceeding 6 inches. Thoroughly compact each layer. Fill to finish grade.

3.7 LANDSCAPING DRAINAGE INSTALLATION

A. Provide trench width to allow installation of drainage conduit. Grade bottom of trench excavations to required slope, and compact to firm, solid bed for drainage system.

B. Lay flat-style geotextile filter fabric in trench and overlap trench sides.

C. Place supporting layer of drainage course over compacted subgrade and geotextile filter fabric, to compacted depth of not less than 4 inches.

D. Install drainage conduits as indicated in Part 3 "Piping Installation" Article for landscaping subdrainage with horizontal distance of at least 6 inches between conduit and trench walls. Wrap drainage conduits without integral geotextile filter fabric with flat-style geotextile filter fabric before installation. Connect fabric sections with tape.

E. Add drainage course to top of drainage conduits.

F. After satisfactory testing, cover drainage conduit to within 12 inches of finish grade.

G. Install drainage course and wrap top of drainage course with flat-style geotextile filter fabric.

H. Place layer of flat-style geotextile filter fabric over top of drainage course, overlapping edges at least 4 inches.

I. Fill to Grade: Place satisfactory soil fill material over drainage course. Place material in loose-depth layers not exceeding 6 inches. Thoroughly compact each layer. Fill to finish grade.

3.8 PIPING INSTALLATION

A. Install piping beginning at low points of system, true to grades and alignment indicated, with unbroken continuity of invert. Bed piping with full bearing in filtering material. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions and other requirements indicated.

1. Foundation Subdrainage: Install piping pitched down in direction of flow, at a minimum slope of 0.5 percent and with a minimum cover of 36 inches, unless otherwise indicated.
2. Underslab Subdrainage: Install piping pitched down in direction of flow, at a minimum slope of 0.5 percent.
3. Retaining-Wall Subdrainage: When water discharges at end of wall into stormwater piping system, install piping pitched down in direction of flow, at a

minimum slope of 0.5 percent and with a minimum cover of 36 inches, unless otherwise indicated. However, when water discharges through wall weep holes, pipe may be installed with a minimum slope of zero percent.

4. Landscaping Subdrainage: Install piping pitched down in direction of flow, at a minimum slope of 0.5 percent and with a minimum cover of 36 inches, unless otherwise indicated.
5. Lay perforated pipe with perforations down.
6. Lay pipe with bells facing upslope and with spigot end entered fully into adjacent bell.

B. Use increasers, reducers, and couplings made for different sizes or materials of pipes and fittings being connected. Reduction of pipe size in direction of flow is prohibited.

C. Install PE piping according to ASTM D 2321.

D. Install PVC piping according to ASTM D 2321.

3.9 PIPE JOINT CONSTRUCTION

A. Join PE pipe, tubing, and fittings with couplings for soil-tight joints according to AASHTO's "Standard Specifications for Highway Bridges," Division II, Section 26.4.2.4, "Joint Properties."

B. Join perforated, PE pipe and fittings with couplings for soil-tight joints according to AASHTO's "Standard Specifications for Highway Bridges," Division II, Section 26.4.2.4, "Joint Properties"; or according to ASTM D 2321.

C. Join PVC pipe and fittings according to ASTM D 3034 with elastomeric seal gaskets according to ASTM D 2321.

D. Join perforated PVC pipe and fittings according to ASTM D 2729, with loose bell-and-spigot joints.

E. Special Pipe Couplings: Join piping made of different materials and dimensions with special couplings made for this application. Use couplings that are compatible with and fit materials and dimensions of both pipes.

3.10 CONNECTIONS

A. Drawings indicate general arrangement of piping, fittings, and specialties.

B. Connect low elevations of subdrainage system to solid-wall-piping storm drainage system.

3.11 IDENTIFICATION

A. Materials and their installation are specified in Division 31 Section "Earth Moving." Arrange for installation of green warning tapes directly over piping.

1. Install PE warning tape or detectable warning tape over ferrous piping.
2. Install detectable warning tape over nonferrous piping and over edges of underground structures.

3.12 FIELD QUALITY CONTROL

A. Testing: After installing drainage course to top of piping, test drain piping with water to ensure free flow before backfilling. Remove obstructions, replace damaged components, and repeat test until results are satisfactory.

3.13 CLEANING

A. Clear interior of installed piping and structures of dirt and other superfluous material as work progresses. Maintain swab or drag in piping and pull past each joint as it is completed. Place plugs in ends of uncompleted pipe at end of each day or when work stops.

END OF SECTION 334600

SECTION 33 47 13

POND AND RESERVOIR LINERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes geomembrane liners and floating covers for ponds and reservoirs fabricated from the following:
   1. Polyvinyl chloride (PVC).

1.2 PREINSTALLATION MEETINGS

A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Include panel layout, seams, penetrations, perimeter anchorage, and methods of attachment and sealing to other construction. Differentiate between factory and field seams and joints.

C. Samples: For each exposed product and for each color specified.

1.4 INFORMATIONAL SUBMITTALS

A. Product certificates.

B. Product test reports.

C. Source quality-control reports.

D. Field quality-control reports.

E. Sample warranty.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance data.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer.

1.7 WARRANTY

A. Manufacturer's Special Warranty: Manufacturer agrees to repair or replace geomembrane liner that fail(s) in materials or workmanship within specified warranty period.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. Provide geomembrane liners that prevent the passage of water.

1. LH

2.2 PVC SHEET MATERIALS

A. PVC Sheet: Formulated from virgin PVC with plasticizers and other modifiers, compounded for use in hydraulic structures, and formed into uniform, flexible non-reinforced sheets with material properties complying with PGI 1104, "Specification for PVC Geomembranes," for nominal thickness indicated.
1. Nominal Thickness: 30 mils.
2. Sheet Texture: One side smooth; other side matte.

2.3 MISCELLANEOUS MATERIALS

A. Adhesives: Provide types of adhesive primers, compounds, solvents, and tapes recommended in writing by geomembrane liner manufacturer for bonding to structures (if required), for sealing of seams in geomembrane liner, and for sealing penetrations through geomembrane liner.

B. Penetration Assemblies: Provide manufacturer's standard factory-fabricated assemblies for sealing penetrations. Include joint sealant recommended in writing by geomembrane liner manufacturer and compatible with geomembrane liner, containment conditions, and materials.

2.4 FABRICATION

A. Fabricate geomembrane liner panels from sheets in sizes as large as possible with factory-sealed seams, consistent with limitations of weight and installation procedures. Minimize field seaming.

PART 3 - EXECUTION

3.1 PREPARATION

A. Provide temporary ballast, until edges are permanently secured, that does not damage geomembrane liner or substrate, to prevent uplift of geomembrane liner in areas with prevailing winds.

B. Prepare surfaces of construction penetrating through geomembrane liner according to geomembrane liner manufacturer's written instructions.

3.2 INSTALLATION

A. Examine anchor trench excavation, where geomembrane liner will be secured, for substrate conditions indicated above and for correct location and configuration.

B. General: Place geomembrane liner over prepared surfaces to ensure minimum handling. Install according to Shop Drawings and in compliance with geomembrane liner manufacturer's written instructions. Begin placing geomembrane liner at Project's upwind direction and proceed downwind. Install geomembrane liner in a relaxed condition, free from stress and with minimum wrinkles, and in full contact with subgrade. Do not bridge over voids or low areas in the subgrade. Fit closely and seal around inlets, outlets, and other projections through geomembrane liner. Permanently secure edges.

C. Field Seams: Comply with geomembrane liner manufacturer's written instructions. Form seams by lapping edges of panels 2 to 4 inches, unless instructions require a larger overlap. Wipe contact surfaces clean and free of dirt, dust, moisture, and other foreign materials. Use solvent-cleaning methods and grind geomembrane seam surfaces if recommended by geomembrane liner manufacturer. Proceed with seaming at required temperatures for materials and ambient conditions. Continuously bond sheet to sheet to construct single or double seams of width recommended for method of seaming used. Seal or fuse free seam edges. Inspect seams and reseal voids.

1. Thermal Bonding: Use thermal-welding technique recommended by geomembrane liner manufacturer. Apply pressure to smoothly bond surfaces together. Examine for and patch wrinkles and fishmouths.

D. Installation in Anchor Trench: Install geomembrane liner in trench according to manufacturer's written instructions. Backfill and compact to lock liner into trench.

E. Liner Repairs: Repair tears, punctures, and other imperfections in geomembrane liner field and seams using patches of geomembrane liner material, liner-to-liner bonding materials, and bonding methods according to geomembrane liner manufacturer's written instructions. Apply bonding solvent or weld to contact surfaces of both patch and geomembrane liner, and press together immediately. Roll to remove wrinkles.

3.3 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Nondestructive Testing: Visually inspect seams and patches. Comply with ASTM D 4437 for Air Lance Test, Vacuum Box Testing, or Ultrasonic (High Frequency) Pulse Echo Testing or with GRI Test Method GM6, as applicable to geomembrane liner and seam construction. Record locations of failed seams and patches. Individually number and date occurrences and details of leak and remedial action. Repair leaking seams and patches.

C. Prepare test and inspection reports.

3.4 DISINFECTION

A. Disinfect the complete installation according to procedures in AWWA C652.

3.5 PROTECTION

A. Protect installed geomembrane liner according to manufacturer's written instructions. Repair or replace areas of geomembrane liner damaged by scuffing, punctures, traffic, rough subgrade, or other unacceptable conditions.

B. Before initial filling of pond or placement of earth cover, inspect seams and patched areas to ensure tight, continuously bonded installation. Repair damaged geomembrane liner and seams and reinspect repaired work.

END OF SECTION 334713

225 Franklin Street, Suite 1100
Boston, Massachusetts 02110
t +1 (617) 478-0300
f +1 (617) 478-0321
@perkinswill_bos

PERKINS
+WILL

NORTH AMERICA | ASIA | MIDDLE EAST | AFRICA | EUROPE