

PROJECT MANUAL

PORT JERVIS CITY SCHOOL DISTRICT

9 Thompson Street
Port Jervis, New York 12771

Additions & Alterations to PJMS Re-Bid

SED Control No.
44-18-00-05-0-005-016

BCA Project No. 2019-011 PH1



**Bernier, Carr & Associates, Engineers,
Architects and Land Surveyors, P.C.**
798 Cascadilla Street, Suite C
Ithaca, New York 14850
(607) 319-4053 / Fax (315) 782-7192

Set # _____

VOLUME II OF III BIDDING DOCUMENTS AND TECHNICAL SPECIFICATIONS DIVISIONS 21 – 23 & 26 - 28

The above signed Architect/Engineer certifies that, to the best of his knowledge, information and belief, the plans and specifications are in accordance with applicable requirements of the New York State Uniform Fire Prevention and Building Code, the State Energy Conservation Code, construction standards of the State Education Department, and Part 56 of Title 12 of the Official Compilation of Codes, Rules and Regulations of the State of New York.

**TABLE OF CONTENTS TO
SPECIFICATION FOR**

**Port Jervis City School District
Additions & Alterations to PJMS
Re-Bid
Project No. 2019-011 PH1**

VOLUME I OF III

ALL CONTRACTORS:

Plan Deposit Policy
Notice to Bidders
Information for Bidders
Form of Proposal
Sample Agreement: AIA A132-2019 Standard Form of Agreement Between Owner and Contractor
General Conditions of the Contract for Construction: AIA A232-2019
Shop Drawing Submittal Form
Statement of Special Inspections – Architectural & MEP
Statement of Special Inspections – Structural
Wage Rate Schedules: Additions (PRC# 2021007719)
 Renovations (PRC# 2020012491)

DIVISION 00 – PROCUREMENT REQUIREMENTS

00 3113 Milestone Construction Schedule
00 3113.1 Site Staging Plans

DIVISION 01 – GENERAL REQUIREMENTS

01 0000 General Requirements
01 1200 Summary of Project
01 2000 Price and Payment Procedures
01 2100 Allowances
01 2200 Unit Prices
01 2300 Alternates
01 3000 Administrative Requirements
01 3216 Construction Progress Schedule
01 3300 Submittal Procedures
01 3529.10 Life Safety Requirements During School Construction
01 3553 Security Procedures
01 4000 Quality Requirements
01 4533 Code-Required Special Inspections
01 5000 Temporary Facilities and Controls
01 5100 Heat During Construction
01 5213 Field Offices
01 5500 Vehicular Access and Parking
01 5713 Erosion and Sediment Control
01 5721 Indoor Air Quality Controls
01 5813 Temporary Project Signage
01 6000 Product Requirements
01 6116 Volatile Organic Compound (VOC) Content Restrictions
01 6116.01 Material VOC Content Certification Form
01 7000 Execution Requirements
01 7329 Cutting and Patching
01 7800 Closeout Submittals
01 7900 Demonstration and Training
01 9113 General Commissioning Requirements

**TABLE OF CONTENTS TO
SPECIFICATION FOR**

**Port Jervis City School District
Additions & Alterations to PJMS
Re-Bid
Project No. 2019-011 PH1**

DIVISION 02 – EXISTING CONDITIONS

	Geotechnical Investigation – Elwyn & Palmer – July 31, 2021 (See Vol. 3)
	Geotechnical Engineering Report – WMA Engineering – September 2020 (See Vol. 3)
02 2600	Asbestos, Lead, and PCB Assessment
02 8213	Asbestos Abatement
02 8313	Lead Hazard Control Activities
	Limited Hazardous Materials Survey – Atlantic Testing Laboratories – July 15, 2021 (See Vol. 3)

DIVISION 03 – CONCRETE

03 0516	Underslab Vapor Barrier
03 1000	Concrete Forming and Accessories
03 2000	Concrete Reinforcing
03 3000	Cast-In-Place Concrete
03 3001	Concrete Sidewalks, Curbs and Exterior Concrete Flatwork
03 3533	Stamped Concrete Finishing
03 4100	Precast Structural Concrete

DIVISION 04 – MASONRY

04 0511	Mortar and Masonry Grout
04 2000	Unit Masonry
04 7200	Cast Stone Masonry

DIVISION 05 – METALS

05 1200	Structural Steel Framing
05 2100	Steel Joist Framing
05 3100	Steel Decking
05 4000	Cold-Formed Metal Framing
05 5000	Metal Fabrications
05 5100	Metal Stairs
05 5213	Pipe and Tube Railing
05 7500	Decorative Formed Metal

DIVISION 06 – WOOD, PLASTICS, & COMPOSITES

06 1000	Rough Carpentry
06 2000	Finish Carpentry
06 4100	Architectural Wood Casework
068000	Composite Fabrications

DIVISION 07 – THERMAL AND MOISTURE PROTECTION

07 0553	Fire and Smoke Assembly Identification
07 1113	Bituminous Damp Proofing
07 1400	Fluid Applied Waterproofing
07 2100	Thermal Insulation
07 2119	Foamed-in-place Insulation
07 2500	Weather Barriers
07 4213	Metal Wall Panels
07 4646	Fiber – Cement Siding
07 5323	Ethylene-Propylene-Diene-Monomer Roofing (EPDM)
07 6100	Sheet Metal Roofing
07 6200	Sheet Metal Flashing and Trim
07 7100	Roof Specialties
07 7200	Roof Accessories

**TABLE OF CONTENTS TO
SPECIFICATION FOR**

**Port Jervis City School District
Additions & Alterations to PJMS
Re-Bid
Project No. 2019-011 PH1**

DIVISION 07 – THERMAL AND MOISTURE PROTECTION (Continued)

07 8400	Firestopping
07 9200	Joint Sealants
07 9513	Expansion Joint Cover Assemblies

DIVISION 08 – OPENINGS

08 1116	Aluminum Doors and Frames
08 1213	Hollow Metal Frames
08 1416	Flush Wood Doors
08 3200	Sliding Glass Doors
08 3313	Coiling Counter Doors
08 3323	Overhead Coiling Doors
08 3327	Smoke and Fire Curtains
08 4313	Aluminum-Framed Storefronts
08 4523	Fiberglass Sandwich Panel Assemblies
08 5113	Aluminum Windows
08 5653	Security Windows
08 7100	Door Hardware
08 8000	Glazing
08 8723	Safety and Security Films
08 9100	Louvers

DIVISION 09 – FINISHES

09 0561	Common Work Results for Flooring Preparation
09 2116	Gypsum Board Assemblies
09 2216	Non-Structural Metal Framing
09 3000	Tiling
09 5100	Acoustical Ceilings
09 5400	Specialty Ceilings
09 6466	Wood Athletic Flooring
09 6500	Resilient Flooring
09 6566	Resilient Athletic Flooring
09 6700	Fluid-Applied Flooring
09 6813	Tile Carpeting
09 7200	Wall Coverings
09 7800	Interior Wall Paneling
09 8300	Acoustic Finishes
09 8430	Sound – Absorbing Wall and Ceiling Units
09 9000	Painting and Coating
09 9600	High-Performance Coatings
09 9723	Concrete and Masonry Coatings

**TABLE OF CONTENTS TO
SPECIFICATION FOR**

**Port Jervis City School District
Additions & Alterations to PJMS
Re-Bid
Project No. 2019-011 PH1**

DIVISION 10 – SPECIALTIES

10 1100	Visual Display Units
10 1200	Display Cases
10 1400	Signage
10 2113.17	Phenolic Toilet Compartments
10 2123	Cubicle Curtains and Track
10 2239	Folding Panel Partitions
10 2600	Wall and Door Protection
10 2800	Toilet Room Accessories
10 4400	Fire Protection Specialties
10 5113	Metal Lockers
10 7500	Flagpoles

DIVISION 11 – EQUIPMENT

11 4000	Foodservice Equipment
11 6143	Stage Curtains
11 6623	Gymnasium Equipment

DIVISION 12 – FURNISHINGS

12 2400	Window Shades
12 3200	Manufactured Wood Casework
12 3600	Countertops
12 4813	Entrance Floor Mats and Frames
12 6613	Telescoping Bleachers

DIVISION 14 – CONVEYING EQUIPMENT

14 2100	Electric Traction Elevators
---------	-----------------------------

DIVISION 31 – EARTHWORK

31 1000	Site Clearing
31 2200	Grading
31 2316	Excavation
31 2316.13	Trenching
31 2323	Fill
31 6615	Helical Foundations Piles

DIVISION 32 – EXTERIOR IMPROVEMENTS

32 1123	Aggregate Base Courses
32 1216	Asphalt Paving
32 1726	Tactile Warning Surfacing
32 1825	Infield Skinned Area
32 3113	Chain Link Fences and Gates
32 9219	Landscaping - Lawn
32 9300	Exterior Plants

DIVISION 33 – UTILITIES

33 0110.58	Disinfection of Water Utility Piping Systems
33 1416	Site Water Utility Distribution Piping
33 3113	Site Sanitary Sewerage Gravity Piping
33 4000	Storm Drainage Utilities
33 4923.10	Subsurface Storm Drainage Water Retention Structures

**TABLE OF CONTENTS TO
SPECIFICATION FOR**

**Port Jervis City School District
Additions & Alterations to PJMS
Re-Bid
Project No. 2019-011 PH1**

VOLUME II OF III

DIVISION 21 – FIRE SUPPRESSION

21 0524	Backflow Preventers
21 0529	Pipe Hangers and Supports
21 1300	Sprinkler Piping
21 1313	Sprinkler Systems

DIVISION 22 – PLUMBING

22 0510	Basic Plumbing Requirements
22 0516	Expansion Fittings and Loops for Plumbing Piping
22 0517	Sleeves and Sleeve Seals for Plumbing Piping
22 0519	Meters and Gauges for Plumbing Piping
22 0523	General-Duty Valves for Plumbing Piping
22 0529	Hangers and Supports for Plumbing Piping and Equipment
22 0553	Identification for Plumbing Piping and Equipment
22 0716	Plumbing Equipment Insulation
22 0719	Plumbing Piping Insulation
22 1005	Plumbing Piping
22 1006	Plumbing Piping Specialties
22 3000	Plumbing Equipment
22 4000	Plumbing Fixtures

DIVISION 23 – HEATING, VENTILATING, & AIR CONDITIONING

23 0510	Basic Mechanical Requirements
23 0516	Expansion Fittings and Flexible Connections
23 0517	Sleeves and Sleeve Seals for HVAC Piping
23 0519	Meters and Gauges for HVAC Piping
23 0523	General-Duty Valves for HVAC Piping
23 0529	Hangers and Supports for HVAC Piping and Equipment
23 0553	Identification for HVAC Piping and Equipment
23 0593	Testing, Adjusting, and Balancing for HVAC
23 0713	Duct Insulation
23 0716	HVAC Equipment Insulation
23 0719	HVAC Piping Insulation
23 0923	Direct-Digital Control System for HVAC
23 2113	Hydronic Piping
23 2114	Hydronic Specialties
23 2123	Hydronic Pumps
23 2300	Refrigerant Piping
23 2500	HVAC Water Treatment
23 3100	HVAC Ducts and Casings
23 3100.23	Textile Air Dispersion Ductwork
23 3300	Air Duct Accessories
23 3423	HVAC Power Ventilators
23 3700	Air Outlets and Inlets
23 4000	HVAC Air Cleaning Devices
23 5100	Breeching, Chimneys, and Stacks
23 5216	Condensing Boilers
23 6423	Scroll Water Chillers
23 7223	Packaged Air-to-Air Energy Recovery Units

**TABLE OF CONTENTS TO
SPECIFICATION FOR**

**Port Jervis City School District
Additions & Alterations to PJMS
Re-Bid
Project No. 2019-011 PH1**

DIVISION 23 – HEATING, VENTILATING, & AIR CONDITIONING (Continued)

23 7313	Air Handling Units
23 7423	Outdoor Make-Up Air Units
23 8126.13	Small Capacity Split System Air Conditioners
23 8200	Convection Heating and Cooling Units
23 8216	Air Coils

DIVISION 26 – ELECTRICAL

26 0010	Basic Electrical Work
26 0100	Basic Materials and Methods
26 0513	Medium-Voltage Cables
26 0519	Low-Voltage Cables
26 0526	Grounding
26 0533	Raceways
26 0543	Exterior Pathways
26 0573	Overcurrent Protective Device Coordination Study
26 0620	Wiring Devices
26 0800	Electrical Systems Commissioning
26 2116	Low-Voltage Underground Electrical Service Entrance
26 2213	Low Voltage Distribution Transformers
26 2400	Switchboards and Panelboards
26 2913	Switches, Contactors, and Motor Controllers
26 2923	Variable Frequency Drives
26 5100	Lighting

DIVISION 27 – COMMUNICATIONS

27 1000	Horizontal and Backbone Communication Cabling
27 1100	Communication Equipment Rooms and Spaces
27 5115	Audio Video Systems
27 5117	IP Public Address System
27 5313	Wireless Master Clock System

DIVISION 28 – ELECTRONIC SAFETY AND SECURITY

28 1300	Access Control System
28 1310	Video Intercom Control System
28 1610	Intrusion Detection System
28 2319	High-Definition IP Video Surveillance
28 3110	Fire Detection and Alarm System

**TABLE OF CONTENTS TO
SPECIFICATION FOR**

**Port Jervis City School District
Additions & Alterations to PJMS
Re-Bid
Project No. 2019-011 PH1**

VOLUME III OF III

REPORTS

- Geotechnical Investigation – Elwyn & Palmer – July 31, 2021
- Geotechnical Engineering Report – WMA Engineering – September 2020
- Limited Hazardous Materials Survey – Atlantic Testing Laboratories – July 15, 2021

This Page Intentionally Left Blank

**SECTION 21 0524
BACKFLOW PREVENTERS**

PART 1 GENERAL

1.01 SUBMITTALS

- A. Product Data:
 - 1. Manufacturer's catalog sheets, specifications, and installation instructions for each type backflow preventer and test kit.

1.02 QUALITY ASSURANCE

- A. Regulatory Requirements:
 - 1. Comply with the New York State Department of Health, and the other standards listed in Part 2 of this section.
 - 2. Where conflicts occur between the referenced standards, the most stringent requirements shall apply.

1.03 MAINTENANCE

- A. Special Tools (as furnished or recommended by the backflow preventer manufacturer). Deliver to the Owner's Representative:
 - 1. Test Kit B: Sight tube, of required length, for testing backflow preventer for proper operation, and printed procedure for conducting test.

PART 2 PRODUCTS

2.01 BACKFLOW PREVENTERS

- A. Type B: Double Check Valve device, conforming to ASSE Standard 1015, AWWA C-510, USC specifications manual for Cross Connection control, and listed as acceptable in the New York State Department of Health, Environmental Health manual.
 - 1. Performance: 150 psig, and 130 degrees F, maximum working conditions.
 - 2. Assembly: Strainer and gate valve on inlet side, gate valve on outlet side, and four test cocks, all as furnished or recommended by the backflow preventer manufacturer.

2.02 UL LISTED WATER METERS FOR FIRE PROTECTION SERVICE

- A. Contactor shall coordinate the requirement to install a water meter on the fire protection water entrance line with the local AHJ and water department prior to preparing a proposal. Where the AHJ or water department requires the installation of a water meter, the water shall be UL Listed for fire protection service.
- B. Contractor shall provide the manufacturer and model water meter as specified and required by the local AHJ or water department. Where local authorities do not specify the type of water meter, provide an OMNI Fireline (F2) Water Meter.
 - 1. Service:
 - a. Measurement of potable and reclaim water.
 - b. Storage temperature: -22F to 155F
 - c. Operating temperatures:
 - i. Air: -22F to 150F
 - ii. Water: 33F to 80F
 - 2. Operating Range (100% \pm 1.5%):
 - a. 4": 1.5 – 1050 GPM (0.34 – 227 m³/hr)
 - b. 6": 3 – 2000 GPM (0.68 – 454 m³/hr)
 - c. 8": 4 – 3500 GPM (0.91 – 795 m³/hr)
 - d. 10": 5 – 5500 GPM (1.1 – 1249 m³/hr)

3. Low flow (95% - 101.5%):
 - a. 4": 0.75 GPM (0.17 m³/hr)
 - b. 6": 1.5 GPM (0.34 m³/hr)
 - c. 8": 2.5 GPM (0.57 m³/hr)
 - d. 10": 3.5 GPM (.79 m³/hr)
4. UL Minimum Flow:
 - a. 8": 97% @ 3 GPM (0.68 m³/hr)
 - b. 10": 97% @ 4 GPM (0.91 m³/hr)
5. Maximum Continuous Operation:
 - a. 4": 1050 GPM (227 m³/hr)
 - b. 6": 2000 GPM (454 m³/hr)
 - c. 8": 3500 GPM (795 m³/hr)
 - d. 10": 5500 GPM (1249 m³/hr)
6. Maximum Operating Pressure:
 - a. 175 PSI
7. Flange Connections:
 - a. U.S. ANSI B16.1 / AWWA Class 125
8. Test Ports:
 - a. NPT
9. Register:
 - a. Fully electronic sealed register with programmable registration (Gal./Cu.Ft./Cu.Mtr./Imp.Gal./Acre Ft.)
 - b. Programmable to AMR/AMI reading and pulse outputs
 - c. Guaranteed 10-year battery life
10. NSF Approved Materials:
 - a. Maincase: Coated Ductile Iron
 - b. Measuring Chamber: Thermoplastic
 - c. Rotor "Floating Ball": Thermoplastic
 - d. Radial Bearings: Hybrid Thermoplastic
 - e. Thrust Bearings: Sapphire/Ceramic Jewel
 - f. Magnets: Ceramic
 - g. Strainer Screen: Stainless Steel
 - h. Strainer Cover: Coated Ductile Iron
 - i. Test Plug: Stainless Steel

203 BACKFLOW PREVENTER TEST CONNECTION

- A. Provide downstream of the main backflow prevention assembly UL 668 hose valves with 2.5 inch National Standard male hose threads with cap and chain. Provide one valve for each 250 gpm of system demand and round up to the next quantity where required. For example, a system with a flow demand of 251 gpm shall be provided with two hose valves.
- B. Provide Placard adjacent to test connection which states "BACKFLOW PREVENTER TEST VALVE." Placard text shall be red with a white background. Text height shall be 1".

PART 3 EXECUTION

301 INSTALLATION

- A. Install the Work of this section in accordance with the

manufacturer's printed installation instructions.

- B. Atmospheric Vent: Pipe vent to spill over closest point of drainage, as directed, maintaining a minimum 12 inch air gap above the drain.

302 BACKFLOW PREVENTION ASSEMBLY FORWARD FLOW TEST

- A. Each backflow prevention assembly shall be tested at system flow demand, including all applicable hose streams, as specified in NFPA 13. The Contractor shall provide all equipment and instruments necessary to conduct a complete forward flow test, including 2.5 inch diameter hoses, playpipe nozzles, calibrated pressure gauges, and pilot tube gauge. The Contractor shall provide all necessary supports to safely secure hoses and nozzles during ht test. At the system demand flow, the pressure readings and pressure drop (friction) across the assembly shall be recorded. A metal placard shall be provided on the backflow prevention assembly that lists the pressure readings both upstream and downstream of the assembly, total pressure drop, and the system test flow rate determined during the preliminary testing. The pressure drop shall be compared to the manufacturer's data and the readings observed during the final inspections and tests.

303 FIELD QUALITY CONTROL

- A. Operation Test: Test kit as specified under Part 1 of this section may be used. Conduct test in the presence of the Owner's Representative.
 - 1. Type B Backflow Preventer: Test the device with the test kit in accordance with the manufacturer's test procedure.
- B. Re-testing: Repair or replace any device failing the operation test, and repeat the test.

END OF SECTION

This Page Intentionally Left Blank

SECTION 21 0529
PIPE HANGERS AND SUPPORTS

PART 1 GENERAL

1.01 SUBMITTALS

- A. Shop Drawings:
 - 1. Details of trapeze hangers and upper hanger attachments for piping 4 inches in diameter and over. Include the number and size of pipe lines to be supported on each type of trapeze hanger.
- B. Product Data: Catalog sheets, specifications and installation instructions for each item specified except fasteners.

1.02 QUALITY ASSURANCE

- A. Regulatory Requirements:
 - 1. Comply with the applicable requirements of the ASME B31 Piping Codes.
 - 2. Unless otherwise shown or specified, comply with the requirements of the Manufacturer's Standardization Society of the Valve and Fittings Industry (MSS) Standards SP-58, and SP-69.
 - 3. Materials for use in Sprinkler Systems shall comply with the requirements of NFPA 13.

PART 2 PRODUCTS

2.01 PIPE HANGERS AND SUPPORTS

- A. Combination clevis hanger.
- B. Pipe hangers: Height adjustable standard duty clevis type, with cross bolt and nut.
 - 1. Swivel ring type hangers will be allowed for sprinkler piping up to a maximum of 2 inches in size.
- C. Adjustable Floor Rests and Base Flanges: Steel.
- D. Hanger Rods: Mild, low carbon steel, fully threaded or threaded at each end, with two nuts at each end for positioning rod and hanger, and locking each in place.
- E. Riser Clamps: Malleable iron or steel.

2.02 ANCHORS AND ATTACHMENTS

- A. Sleeve Anchors (Group II, Type 3, Class 3): Molly's Div./USM Corp. Parasleeve Series, Ramset's Dynabolt Series, or Red Head/Phillips AN, HN, or FS Series.
- B. Wedge Anchors (Zinc Plated, Group II, Type 4, Class 1): Hilti's Kwik Bolt Series, Molly's Div./USM Corp. Parabolt PB Series, Ramset's Trubolt T Series, or Red Head/Phillips WS Series.
- C. Self-Drilling Anchors (Group III, Type 1): Ramset's RD Series, or Red Head/Phillips S Series.
- D. Non-Drilling Anchors (Group VIII, Type 1): Ramset's Dynaset DS Series, Hilti's HDI Series, or Red Head/Phillips J Series.
- E. Stud Anchors (Group VIII, Type 2): Red Head/Phillips JS Series.
- F. Beam Clamps: Forged steel beam clamp, with weldless eye nut (right hand thread), steel tie rod, nuts, and washers, Grinnell's Fig No. 292 (size for load, beam flange width, and rod size required).
- G. Metal Deck Ceiling Bolts: B-Line Systems' Fig. B3019.
- H. Continuous Slotted Type Concrete Insert, Galvanized:
 - 1. Load Rating 800 lbs/ft: Kindorf's D-986.
 - 2. Load Rating 1500 lbs/ft: Kindorf's D-980.

3. Rating 3000 lbs/ft: Hohmann & Barnard's Inc. Type CS-H.
4. Load Rating 4500 lbs/ft: Hohmann & Barnard's Inc. Type CS-HD.
- I. Threaded Type Concrete Insert: Galvanized ferrous castings, internally threaded to receive 3/4 inch diameter machine bolts.
- J. Wedge Type Concrete Insert: Galvanized box-type ferrous castings, designed to accept 3/4 inch diameter bolts having special wedge shaped heads.

203 FASTENERS

- A. Bolts, Nuts, Washers, Lags, and Screws: Medium carbon steel; size and type to suit application; galvanized for high humidity locations, and treated wood; plain finish for other interior locations. Except where shown otherwise on the Drawings, furnish type, size, and grade required for proper installation of the Work.

204 SHOP PAINTING AND PLATING

- A. Hangers, supports, rods, inserts and accessories used for pipe supports, unless chromium plated, cadmium plated or galvanized shall be shop coated with metal primer paint.

PART 3 EXECUTION

301 PREPARATORY WORK

- A. Place inserts into construction form work expeditiously, so as not to delay the Work.

302 INSTALLATION

- A. Do not hang or support one pipe from another or from ductwork.
 1. Do not bend threaded rod.
- B. Support all insulated horizontal piping conveying fluids below ambient temperature, by means of hangers or supports with insulation shields installed outside of the insulation.
- C. Space hangers or supports for horizontal piping on maximum center distances as listed in the following hanger schedules, except as otherwise specified, or noted on the Drawings.
 1. For Steel Pipe:

PIPE SIZE (Inches)	MAXIMUM SPACING (Feet)
1 and under	8
1-1/4 and 1-1/2	9
2	10
2-1/2 and up	12

2. For Grooved End Steel Pipe:

PIPE SIZE (Inches)	MAXIMUM SPACING (Feet)
1-1/2 and under	7
2 through 4	10
5 and over	12

3. No pipe length shall be left unsupported between any two coupling joints.
4. For Directional Changes: Install a hanger or support close to the point of change of direction of all pipe runs in either a horizontal or vertical plane.

5. For Concentrated Loads: Install additional hangers or supports, spaced as required and directed, at locations where concentrated loads such as in-line pumps, valves, fittings or accessories occur, to support the concentrated loads.
 6. For Branch Piping Runs and Runouts Over 5 feet In Length: Install a minimum of one hanger, and additional hangers if required by the hanger spacing schedules.
 7. Parallel Piping Runs: Where several pipe lines run parallel in the same plane and in close proximity to each other, trapeze hangers may be submitted for approval. Base hanger spacing for trapeze type hangers on the smallest size of pipe being supported. Design the entire hanger assembly based on a safety factor of five, for the ultimate strength of the material being used.
- D. Minimum Hanger Rod Size: Increase hanger rod size as required to meet requirements of seismic restraint system.

PIPE OR TUBING SIZE (Inches)	SINGLE ROD HANGER SIZE (Inches)		DOUBLE ROD HANGER SIZE (Inches)	
	PIPE	TUBING	PIPE	TUBING
1/2 to 2	3/8	1/4	3/8	1/4
2-1/2 and 3	1/2	3/8	3/8	1/4
4 and 5	5/8	1/2	1/2	3/8
6	3/4	1/2	5/8	1/2
8, 10 and 12	7/8	5/8	3/4	5/8

1. Secure hanger rods as follows: Install one nut under clevis, angle or steel member; one nut on top of clevis, angle or steel member; one nut inside insert or on top of upper hanger attachment and one nut and washer against insert or on lower side of upper hanger attachment. A total of four nuts are required for each rod, two at upper hanger attachment and two at hanger.
- E. Vertical Piping:
1. Support vertical risers of piping systems, by means of heavy duty hangers installed close to base of pipe risers, and by riser clamps with extension arms at intermediate floors, with the distance between clamps not to exceed 25 feet, unless otherwise specified. Support pipe risers in vertical shafts equivalent to the aforementioned. Install riser clamps above floor slabs, with the extension arms resting on floor slabs. Provide adequate clearances for risers that are subject to appreciable expansion and contraction, caused by operating temperature ranges.
 2. Support extension arms of riser clamps, secured to risers to be insulated for cold service, 4 inches above floor slabs, to allow room for insulating and vapor sealing around riser clamps.
- F. Floor Supports: Install adjustable yoke rests with base flanges, for the support of piping, unless otherwise indicated on the Drawings. Install supports in a manner, which will not be detrimental to the building structure.

303 UPPER HANGER ATTACHMENTS

- A. General:
1. Secure upper hanger attachments to overhead structural steel, steel bar joists, or other suitable structural members.

2. Do not attach hangers to steel decks that are not to receive concrete fill.
 3. Do not attach hangers to precast concrete plank decks less than 2-3/4 inches thick.
 4. Do not use flat bars or bent rods as upper hanger attachments.
- B. Attachment to Steel Frame Construction: Provide intermediate structural steel members where required by pipe support spacing. Select steel members for use as intermediate supports based on a minimum safety factor of five.
1. Do not use drive-on beam clamps.
 2. Do not support piping over 4 inches in size from steel bar joists. Secure upper hanger attachments to steel bar joists at panel points of joists.
 3. Do not drill holes in main structural steel members.
 4. Beam clamps, with tie rods as specified, may be used as upper hanger attachments for the support of piping, subject to clamp manufacturer's recommended limits.
- C. Attachment to Concrete Filled Steel Decks:
1. New Construction: Install metal deck ceiling bolts.
 2. Existing Construction: Install welding studs (except at roof decks). Do not support a load in excess of 250 lbs from any single welded stud.
 3. Do not attach hangers to decks less than 2-1/2 inches thick.
- D. Attachment to Cast-In-Place Concrete: Secure to overhead construction by means of cast-in-place concrete inserts.
- E. Attachment to Existing Cast-In-Place Concrete:
1. For piping up to a maximum of 4 inches in size, secure hangers to overhead construction with self-drilling type expansion shields and machine bolts.
 2. Secure hangers to wall or floor construction with single unit expansion shields or self-drilling type expansion shields and machine bolts.
- F. Attachment to Cored Precast Concrete Decks (Flexicore, Dox Plank, Spancrete, etc.): Toggle bolts may be installed in cells for the support of piping up to a maximum of 2-1/2 inches in size.
- G. Attachment to Hollow Block or Hollow Tile Filled Concrete Decks:
1. New Construction: Omit block or tile and pour solid concrete with cast-in-place inserts.
 2. Existing Construction: Break out block or tile to access, and install machine bolt anchors at highest practical point on side of web.
- H. Attachment to Waffle Type Concrete Decks:
1. New Construction: Install cast-in-place inserts.
 2. Existing Construction: Install machine bolt expansion anchors at highest practical point on side of web.
- I. Attachment to Precast Concrete Tee Construction:
1. New Construction: Tee hanger inserts between adjacent flanges, except at roof deck without concrete fill.
 2. Existing Construction: Dual unit expansion shields in webs of tees. Install shields as high as possible in the webs.
 - a. Exercise extreme care in the field drilling of holes to avoid damage to reinforcing.
 - b. Do not use powder driven fasteners.
- J. Attachment to Wood Construction: Secure hangers to the sides (only) of wood members, by means of malleable iron side beam connectors, or malleable iron or

steel side beam brackets. Do not secure hanger attachments to nailing strips resting on top of steel beams.

1. Secure side beam connectors to wood members with two No. 18 x 1-1/2 inch long wood screws, or two No. 16 x 1-1/2 inch long drive screws. Do not support piping over 1-1/2 inches in size from side beam connectors. Do not hammer in wood screws.
2. Secure side beam brackets to wood members with steel bolts or lag screws. Do not use lag screws in wooden members having a nominal thickness (beam face) less than 2 inches in size. Install bolts or lag screws, in the sides of a timber or a joist, at the mid-point or above, not less than 2-1/2 inches from the lower edge when supporting branch lines and not less than 3 inches from the lower edge when supporting mains. Install heavy gage steel washers under all nuts.
3. Secure side beam brackets to wooden beams or joists, with lag screws or bolts of size as follows:

PIPE SIZE (Inches)	LAG SCREW SIZE (Inches)	BOLT DIAMETER (Inches)
2 and under	3/8 diameter x 1-3/4	3/8
2-1/2 and 3	1/2 diameter x 2	1/2
4 and 5	Use Bolt	5/8

- a. Do not support piping larger than 3 inches with lag screws. Pre-drill holes for lag screws 1/8 inch in diameter less than the root diameter of the lag screw thread.
- b. The minimum width of the lower face of wood beams or joints in which lag screws of size as specified may be used is as follows:

LAG SCREW DIAMETER (Inches)	NOMINAL WIDTH OF BEAM FACE (Inches)
3/8	2
1/2	3

4. Do not secure hanger attachment to the diagonals or vertical members of the trusses.

END OF SECTION

This Page Intentionally Left Blank

**SECTION 21 1300
SPRINKLER PIPING**

PART 1 GENERAL

1.01 REFERENCES

- A. NFPA 13 (2016)

1.02 SUBMITTALS

- A. Product Data:
1. Catalog sheets and specifications indicating manufacturer name, type, applicable reference standard, schedule, or class for specified pipe and fittings.
- B. Material Schedule: Itemize pipe and fitting materials for each specified application in Pipe and Fittings Schedule in Part 3 of this Section. Where optional materials are specified indicate option selected.

PART 2 GENERAL

2.01 STEEL PIPE AND FITTINGS

- A. Steel Pipe for Threading: Standard weight, Schedule 40, black or galvanized; ASTM A 53 or ASTM A 135.
- B. Steel Pipe for Roll Grooving: Standard weight, Schedule 10 or 40, black or galvanized; ASTM A 53, Grade B, Type F for sizes 1-1/4 inch to 1-1/2 inch, and Type E or S for sizes 2 inch to 24 inch, or ASTM A 135.
- C. Cast Iron Fittings:
1. Drainage Pattern, Threaded: ASME B16.12.
 2. Steam Pattern, Threaded: ASME B16.4.
 - a. Standard Weight: Class 125.
 - b. Extra Heavy Weight: Class 250.
 3. Flanged Fittings and Threaded Flanges: ASME B16.1.
 - a. Standard Weight: Class 125.
 - b. Extra Heavy: Class 250.
- D. Unions: Malleable iron, 250 lb class, brass to iron or brass to brass seats.
- E. Couplings: Same material and pressure rating as adjoining pipe, conforming to standards for fittings in such pipe. Use taper tapped threaded type in screwed pipe systems operating in excess of 15 psig.
- F. Nipples: Same material and strength as adjoining pipe, except nipples having a length of less than one inch between threads shall be extra heavy.
- G. Steel Press-Connect Flanges:
1. Pressure Rating: UL 213, FM Global-approved, 175 psig.
 2. Flanges: Steel housing, rubber EPDM O-rings, and pipe stop; for use with fitting manufacturer's pressure-seal tools.
 3. Class 150, carbon steel; raised-face flanged with full-face gaskets.

2.02 DUCTILE IRON PIPE AND FITTINGS

- A. Water Pipe: Bitumin coated and cement-mortar lined; AWWA C151.
1. 3 and 4 Inch Sizes: Class 51.
 2. 6 inch Size and Over: Class 50.
- B. Fittings: Bitumin coated and cement-mortar lined; AWWA C110.
- C. Victaulic Under Ground Ductile Iron Pipe: Pipe: AWWA ductile iron pipe, minimum Class 53, grooved in accordance with AWWA C606. Rigid radius groove dimensions shall be utilized where flexibility is neither required nor desired. Pipe ends shall be factory grooved.

1. Victaulic Couplings: [UL, ULC, FM] Manufactured in two or more segments of cast ductile iron, conforming to A-536, Grade 65-45-12. Gaskets shall be pressure-responsive synthetic rubber, FlushSeal® type. Mechanical coupling bolts shall be stainless steel conforming to physical properties of ASTM A-193, minimum tensile strength 110,000 psi (758450 kPa). Victaulic Style 31.
2. Transition Couplings: [UL, ULC, FM] For transition between IPS steel and AWWA ductile iron sized pipe. Housings cast with offsetting, angle-pattern, bolt pads. Victaulic Style 307.
3. Coupling Gaskets: Synthetic rubber, FlushSeal® configuration, conforming to AWWA pipe outside diameter and coupling housing, manufactured of elastomers as designated in ASTM D-2000.
 - a. Reference shall always be made to the latest published Selection Guide for Victaulic Gaskets for proper gasket selection for the intended service.
4. Flange Adapters: [UL, FM] For use with AWWA grooved end pipe and fittings, for mating to ANSI Class 125 flanged components. Victaulic Style 341.
5. Victaulic Grooved End Fittings for AWWA Ductile Iron Pipe: [UL, ULC] Fittings shall be cast of ductile iron conforming to A-536, Grade 65-45-12. Fittings conform to ANSI A21.10/AWWA C-110 for center-to-end dimensions and wall thickness, and AWWA C-153 for wall thickness. Grooved ends shall conform to AWWA C606.

203 COUPLINGS AND FITTINGS FOR GROOVED END PIPE

- A. Couplings: Victaulic Co.'s FireLock EZ Style 009N or equal.
- B. Fittings: By same manufacturer as couplings, having pressure ratings equal to or greater than couplings. Comply with the following standards:
 1. Steel: ASTM A 53 or A 106, Grade B.
 2. Malleable Iron: ASTM A 47.
 3. Ductile Iron: ASTM A 536.

204 VICTAULIC MECHANICAL COUPLINGS FOR JOINING CARBON STEEL PIPE

- A. Victaulic Mechanical Couplings: Manufactured in two segments of cast ductile iron, conforming to ASTM A-536, Grade 65-45-12. Gaskets shall be pressure-responsive synthetic rubber, grade to suit the intended service, conforming to ASTM D-2000. Mechanical Coupling bolts shall be zinc plated (ASTM B-633) heat treated carbon steel track head conforming to ASTM A-449 and A-183, minimum tensile strength 110,000 psi (758450 kPa) as provided standard Victaulic.
 1. Rigid Type:
 - a. "Installation Ready" rigid joints shall be Victaulic FireLock® EZ Style 109 [cULus, FM] and 107N [cULus], in sizes 1-1/4"(DN32) through 4" Style 009N in sizes 5" through 12" (DN300.). Designed for direct "stab" installation onto grooved pipe without prior disassembly of the coupling.
 - b. Coupling housing 1 1/4" through 4" shall consist of one bolt and one linkage. Linkage shall be constructed of CrMo Alloy Steel, zinc electroplated per ASTM B633 Fe/Zn 5, Type III Finish
 - c. Coupling housings 5" through 12" shall be cast with offsetting, angle-pattern bolt pads to provide system rigidity and support and hanging in accordance with NFPA 13.
 - d. Rigid couplings shall require visual pad-to-pad verification of complete installation. Tongue and recess type couplings which require the use of a

torque wrench to achieve the exact required gap between housings are not permitted.

2. Flexible Type: Use in seismic areas where required by NFPA 13.
 - a. "Installation Ready" flexible joints shall be Victaulic Style 177N QuickVic™ [cULus, FM], in sizes 2"(DN50) through 8"(DN200), which shall be designed for direct "stab" installation onto grooved pipe without prior disassembly of the coupling.
 - b. Standard flexible couplings shall be Victaulic Style 77 [UL, ULC, FM].
- B. Mechanical Coupling Gaskets: Pressure-responsive, synthetic rubber listed for use with the housings.
- C. Flange Adapters: For use with grooved end pipe and fittings, for mating to ANSI Class 125 / 150 flanges. Victaulic Style 741 or 744 [UL, ULC, FM]. For mating to ANSI Class 300 flanges use Victaulic Style 743 [UL, ULC, FM].

205 INSTALLATION-READY™ FITTINGS FOR FIRE PROTECTION SYSTEMS

- A. Installation-Ready™ fittings for grooved end steel piping in fire protection applications sizes NPS 1-¼ thru 2½ (DN 32 thru DN 65). Fittings shall consist of a ductile iron housing conforming to ASTM A-536, Grade 65-45-12, with Installation-Ready™ ends, [orange enamel coated] [red enamel coated] [galvanized]. Fittings complete with prelubricated Grade "E" EPDM Type 'A' gasket; and ASTM A449 electroplated steel bolts and nuts. System shall be UL listed for a working pressure of 300 psi (2065 kPa) and FM approved for working pressure 365 psi (2517kPa).
 1. Fittings shall have a shorter center-to-end dimensions for installation in tight spaces.
 2. Fittings are rigid, for direct stab installation without field disassembly.
 3. Installation-Ready™ Fittings shall be Victaulic FireLock® Style 101, Style 102, and style 103, which shall be designed for direct "stab" installation onto grooved pipe without prior disassembly of the fitting.
 4. Fittings shall require visual pad-to-pad verification of complete installation.
 5. Fitting Gaskets: Pressure-responsive, synthetic rubber listed for use with the housings.
- B. In lieu of threaded steel piping systems, the Victaulic FireLock IGS System with "Installation-Ready™ fittings and couplings may be used for NPS 1 (DN 25) Schedule 10 and Schedule 40 carbon steel pipe in fire protection applications. System rated for a working pressure to 365 psi (2517 kPa).
 1. Groove: IGS "Innovative Groove System" groove with shortened "A" dimension and tapered groove backside for ease of installation.
 2. Grooving Tool: Victaulic RG2100, with IGS Confirmation Gauge.
 3. Fittings: Ductile iron housing conforming to ASTM A-536, Grade 65-45-12. Orange enamel coated or galvanized.
 - a. Victaulic Style 101 (90-degree elbow), Style 102 (tee), and Style 108 (coupling) with Installation-Ready™ ends.
 - b. Style 108 single-bolt coupling provided with EPDM Type A pressure responsive gasket with Vic-Plus lubricant, and ASTM A449 compliant electroplated steel bolt and nut. CrMo alloy steel coupling linkage.
- C. UL listed and FM approved rigid coupling to join sprinklers with IGS profile grooved ends to matching 1" IGS outlets; Coupling consists of two cast copper-alloy housing segments for connection of ½", ¾", and 1" sprinklers. Coupling includes an EPDM Type A gasket, with zinc-plated cap screws conforming to ASTM F835, and nylon

insert locknut. Installation-ready, for direct push installation without field disassembly.
Rated for a working pressure to 175 psi (1205 kPa).

1. Fully installed at visual pad-to-pad contact with no required torque rating.

206 COUPLINGS AND FITTINGS FOR 1 INCH NOMINAL DIAMETER GROOVED END PIPE

- A. Manufacturer: Vitaulic® FireLock™ Innovative Groove System (IGS)
 - 1. No. 142 Welded Outlet
 - 2. Style 922 Outlet-T
 - 3. Style 920N Mechanical-T Outlet
 - 4. No. 101 Installation-Ready™ 90o Elbow
 - 5. Style 108 Installation-Ready™ Rigid Coupling
 - 6. No. 102 Installation-Ready™ Tee
 - 7. No. 148 Sprinkler Reducer, NPT or BSPT sprinkler outlet
 - 8. No. 143 Close Nipple
 - 9. No. 145 Female NPT or BSPT Threaded x Groove 90o Elbow
 - 10. No. 146 Cap
 - 11. No. 140 Male NPT or BSPT Threaded x Groove Adapter
 - 12. No. 141 Female NPT or BSPT Threaded x Groove Adapter
 - 13. RG2100 Roll Grooving Tool
 - 14. VicFlex™ Series AH2-CC Braided Flexible Hose with Captured Coupling
- B. Available Sizes: 1 inch
- C. Pipe Material:
 - 1. Carbon steel, Schedule 40.
- D. Maximum Working Pressure:
 - 1. Up to 365 psi.
- E. Pipe Preparation:
 - 1. Cut or roll grooved in accordance with publication: Vitaulic IGS Specifications.
- F. Product shall be UL Listed and FM Approved.
- G. Housing: Ductile iron conforming to ASTM A536, Grade 65-42-12
- H. Grade "E" EPDM Type A Vic-Plus™ Gasket System
 - 1. EPDM (Violet color code). FireLock products have been Listed by UL LLC and Approved by FM Approvals LLC for fire sprinkler services up to the rated working pressure using the Grade "E" Type A Vic-Plus™ Gasket System, requiring no field lubrication for most installation conditions.
- I. Bolts/Nuts:
 - 1. Standard: Carbon steel oval neck track bolts meeting the mechanical property requirements of ASTM A449 (imperial) and ISO 898-1 Class 9.8 (metric). Carbon steel hex nuts meeting the mechanical property requirements of ASTM A563 Grade B (imperial – heavy hex nuts) and ASTM A563M Class 9 (metric – hex nuts). Track bolts and hex nuts are zinc electroplated per ASTM B633 FE/Zn 5, finish Type III (imperial) or Type II (metric).
- J. Coupling Linkage: CrMo Alloy Steel zinc electroplated per ASTM B633 Re/Zn 5, Type III Finish.
- K. No. 140, 141, 142, 143, 148: Carbon Steel meeting the chemical and mechanical property requirements of ASTM A53 Grade A.
- L. No. 145, 146: Ductile iron conforming to ASTM A536, Grade 65-45-12
- M. Victaulic FireLock™ IGS Installation-Ready™ Style V9 Coupling

1. UL listed and FM approved rigid coupling to join sprinklers with IGS profile grooved ends to matching 1" IGS outlets; Coupling consists of two cast copper-alloy housing segments for connection of 1/2", 3/4", and 1" sprinklers. Coupling includes an EPDM Type A gasket, with zinc-plated cap screws conforming to ASTM F835, and nylon insert locknut. Installation-ready, for direct push installation without field disassembly. Rated for a working pressure to 175 psi (1205 kPa).
 - a. Groove: IGS "Innovative Groove System" groove with shortened "A" dimension and tapered groove backside for ease of installation.
 - i. Grooving Tool: Victaulic RG2100, with IGS Confirmation Gauge.
 - b. Fully installed at visual pad-to-pad contact with no required torque rating.

207 BOLTED MECHANICAL BRANCH CONNECTION

- A. Victaulic Co.'s 920 Mechanical T.

208 JOINING AND SEALANT MATERIALS

- A. Thread Sealant:
 1. LA-CO Industries' Slic-Tite Paste with Teflon.
 2. Loctite Corp.'s No. 565 Thread Sealant.
 3. Thread sealants for potable water shall be NSF approved.
- B. Joint Packing:
 1. Oiled Oakum: Manufactured by Nupak of New Orleans, Inc., 931 Daniel St., Kenner, LA 70062, (504) 466-1484.
- C. Gaskets For Use With Ductile Iron Water Pipe: Synthetic rubber rings (molded or tubular): Clow Corp.'s Belltite, Tyler Pipe Industries Inc.'s Ty-Seal, or U.S. Pipe and Foundry Co.'s Tyton.
- D. Flange Gasket Material:
 1. For Use With Cold Water: 1/16 inch thick rubber.
- E. Gaskets For Use With Grooved End Pipe and Fittings: Type and materials as recommended and furnished by the fitting manufacturer, for the service of piping system in which installed
- F. Anti-Seize Lubricant: Bostik Inc.'s Never Seez or Dow Corning Corp.'s Molykote 1000.

209 PIPE SLEEVES

- A. Type A: Schedule 40 steel pipe.
- B. Type B: No. 16 gage galvanized sheet steel.
- C. Type D: No. 16 gage galvanized sheet steel with 16 gage sheet steel metal collar rigidly secured to sleeve. Size metal collars as required to span a minimum of one cell or corrugation, on all sides of the rough opening thru the metal deck.

210 FLOOR, WALL AND CEILING PLATES

- A. Cast Brass: Solid type with polished chrome plated finish, and set screw.
 1. Series Z89 by Zurn, 929 Riverside Drive, Grovesnorale, CT 06255, (800) 243-1830.
 2. Model 127XXXX by Maguire Mfg., Cheshire CT 06410, (203) 699-1801.
- B. Stamped Steel: Split type, polished chrome plated finish, with set screw.
 1. Figures 2 and 13 by Anvil International, Portsmouth, NH 03802, (603) 422-8000.
- C. Cast Iron or Malleable Iron : Solid type, galvanized finish, with set screw:
 1. Model 395 by Anvil International, Portsmouth, NH 03802, (603) 422-8000.
 2. Model 900-016XX by Landsdale International, Westville, NJ 08093, (800) 908-0523.

PART 3 EXECUTION

301 INSTALLATION

- A. Install piping at approximate locations indicated, and at maximum height.
- B. Install piping clear of door swings, and above sash heads.
- C. Make allowances for expansion and contraction.
- D. Allow for a minimum of one inch free air space around pipe or pipe covering, unless otherwise specified.
- E. Install horizontal piping with a constant pitch, and without sags or humps.
- F. Install vertical piping plumb.
- G. Use fittings for offsets and direction changes.
- H. Cut pipe and tubing ends square; ream before joining.
- I. Threading: Use American Standard Taper Pipe Thread Dies.

302 FIRE SPRINKLER AND FIRE STANDPIPE PIPING SYSTEM

- A. Install piping to be completely drainable.

303 PIPE JOINT MAKE-UP

- A. Threaded Joint: Make up joint with a pipe thread compound applied in accordance with manufacturer's printed application instructions for the intended service.
- B. Flanged Pipe Joint:
 - 1. Install threaded companion flanges on steel pipe; flanges on galvanized pipe are not required to be galvanized.
 - 2. Provide a gasket for each joint.
 - 3. Coat bolt threads and nuts with anti-seize lubricant before making up joint.
- C. Grooved Pipe Joint: Roll groove pipe ends, make up joint with grooved end fittings and couplings, in conformance with the manufacturer's printed installation instructions.
 - 1. Cut grooved end piping is not acceptable.
- D. Mechanical Joint: Make up joint in conformance with the manufacturer's printed installation instructions, with particular reference to tightening of bolts.
- E. Dissimilar Pipe Joint:
 - 1. Joining Bell and Spigot and Threaded Pipe: Install a half coupling on the pipe or tube end to form a spigot, and calk into the cast iron bell.
 - 2. Joining Dissimilar Threaded Piping: Make up connection with a threaded coupling or with companion flanges.
 - 3. Joining Dissimilar Non-Threaded Piping: Make up connection with adapters recommended by the manufacturers of the piping to be joined.
 - 4. Joining Galvanized Steel Pipe and Copper Tubing: Make up connection with a dielectric connector.

304 PIPING PENETRATIONS

- A. Diameter of Sleeves and Core Drilled Holes:
 - 1. Unless otherwise specified, size holes thru floors and walls in accordance with the through penetration fire stopping system being used.
 - 2. Size holes thru exterior walls or waterproofed walls above inside earth or finished floors, and exterior concrete slabs in accordance with the following:
 - a. Uninsulated (Bare) Pipe: Inside diameter of sleeve or core drilled hole 1/2 inch greater than outside diameter of pipe, unless otherwise specified.
 - b. Insulated Pipe: Inside diameter of sleeve or core drilled hole 1/2 inch greater than outside diameter of insulation, unless otherwise specified.

- c. Mechanical Modular Seals: Size holes in accordance with the manufacturer's recommendations.
 - 3. Size holes for sprinkler and fire standpipe piping in accordance with NFPA 13.
- B. Length of Sleeves (except as shown otherwise on Drawings):
 - 1. Walls and Partitions: Equal in length to total finished thickness of wall or partition.
 - 2. Floors, Finished: Equal in length to total finished thickness of floor and extending 1/2 inch above the finished floor level, except as follows:
 - a. In furred spaces at exterior walls, extend sleeve one inch above the finished floor level.
 - 3. Exterior Concrete Slabs: Equal in length to total thickness of slab and extending 1/2 inch above the concrete slab.
 - 4. Roofs: Equal in length to the total thickness of roof construction, including insulation and roofing materials, and extending one inch above the finished roof level.
- C. Packing of Sleeves and Core Drilled Holes:
 - 1. Unless otherwise specified, pack sleeves or cored drilled holes in accordance with Section 078400 - FIRESTOPPING.
 - 2. Pack sleeves in exterior walls or waterproofed walls above inside earth or finished floors with oakum to within 1/2 inch of each wall face, and finish both sides with Type 1C (one part) sealant. See Section 079200.
 - a. Mechanical modular seals may be used in lieu of packing and sealant for sleeves and core drilled holes.
 - 3. Pack sleeves in exterior concrete slabs with oakum to full depth, and within 1/2 inch of top of sleeve and finish the remainder with sealant. See Section 079200.
 - a. Sealant Types:
 - i. Piping Conveying Materials up to 140 degrees F other than Motor Fuel Dispensing System Piping: Type 1C (one part).
 - b. Mechanical modular seals may be used in lieu of packing and sealant for sleeves and core drilled holes.
- D. Weld metal collars of Type C and D sleeves to the upper surface of the metal deck. Seal voids under the metal collar as recommended by the manufacturer of the metal deck.

305 FLOOR, WALL AND CEILING PLATES

- A. Install plates for exposed uninsulated piping passing thru floors, walls, ceilings, and exterior concrete slabs as follows:
 - 1. Piping 2 Inch Size and Smaller In Finished Spaces:
 - a. Solid Type: Chrome plated cast brass construction with set screw.
 - b. Split Type: Chrome plated stamped steel construction with set screw.
 - 2. Piping over 2 inch size In Finished Spaces, and Piping in Unfinished Spaces:
 - a. Solid Type: Galvanized cast iron construction with set screw.
 - b. Split Type: Chrome plated stamped steel construction with set screw.
 - 3. Piping in Unfinished Spaces (Including Exterior Concrete Slabs): Solid type, galvanized, cast iron or malleable iron construction.
 - 4. Fasten plates with set screws.
 - 5. Plates are not required in pipe shafts or furred spaces.

306 FIELD QUALITY CONTROL

- A. Perform the following tests and inspections with the assistance of a factory-authorized service representative:
 - 1. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.
 - 2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
 - 3. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance Chapter."
 - 4. Energize circuits to electrical equipment and devices.
 - 5. Coordinate with fire-alarm tests. Operate as required.
 - 6. Coordinate with fire-pump tests. Operate as required.
 - 7. Verify that equipment hose threads are same as local fire department equipment.
- B. Sprinkler piping system will be considered defective if it does not pass tests and inspections.
- C. Prepare test and inspection reports.

END OF SECTION

**SECTION 21 1313
SPRINKLER SYSTEMS**

PART 1 GENERAL

1.01 RELATED WORK SPECIFIED ELSEWHERE

- A. Backflow Preventers: Section 210524.
- B. Hangers and Supports: Section 210529.
- C. Sprinkler Piping: Section 211300.

1.02 REFERENCES

- A. NFPA 13 - National Fire Protection Association Standard for the Installation of Sprinkler Systems.

1.03 SYSTEM DESCRIPTION

- A. Type of System:
 - 1. Wet System – Hydraulically Designed System.
- B. Occupancy Classification:
 - 1. Light Hazard Occupancy.
 - 2. Ordinary Hazard Occupancy.

1.04 SUBMITTALS

- A. Fire Protection Engineer Qualification:
 - 1. Where required by this specification or the project drawings to provide the services of a professional engineer, the professional engineer shall be a licensed Fire Protection Engineer, who is actively licensed in the State which the work is being performed in.
 - 2. A licensed Fire Protection Engineer shall be defined as a registered professional engineer (P.E.) who has passed the fire protection engineering written examination administered by the National Council of Examiners for Engineering and Surveys (NCEES). No substitutions or alternates shall be accepted.
- B. Shop Drawings:
 - 1. Complete sprinkler system layout in accordance with NFPA-14.
 - 2. Hydraulic calculations shall be complete and cross referenced to the appropriate drawing sheets. Hydraulic calculations shall be prepared using one of the following programs (NO EXCEPTIONS):
 - a. HydraCAD
 - b. AutoSprink
 - c. SprinkCAD
 - 3. The shop drawings shall be developed by and the hydraulic calculations shall be performed by person(s) meeting one of the following minimum qualification levels (without substitution):
 - a. National Institute for Certification in Engineering Technologies (NICET) Level IV for Water-Based Fire Protection Systems certified technicians, OR
 - b. A licensed Professional Engineer, licensed in the State of New York, who has licensed by exam (Principles of Practice of Fire Protection Engineering Exam).
- C. Product Data: Catalog sheets, specifications, and installation instructions. Indicate UL or FM approval for each product. Include the following additional information:
 - 1. Electrical Devices: Complete description of intended use, wiring diagrams, data plate information and, in the case of

- switching devices, whether normally on, or normally off. Include motor test data.
- 2. Mechanical Devices: Complete description of intended use, including normal operating capacities and working pressures.
- 3. Enclosures: Dimensions, materials, gages of metals; type of door hinges and locks, and methods of securing the enclosure members to the building construction.
- 4. Hose Threads: Verify that hose threads on fire department connections match threads on equipment used by the local or servicing fire department.
- D. Quality Control Submittals:
 - 1. Design Data: The portions of the sprinkler system not sized on the Contract Drawings shall be sized in accordance with NFPA requirements for Hydraulically Designed Systems. Submit drawings and hydraulic calculations for approval.
 - 2. Certificates: As required under Quality Assurance Article.
 - 3. Company Field Advisor Data: Include:
 - a. Name, business address and telephone number of Company Field Advisor secured for the required services.
 - b. Certified statement from the Company listing the qualifications of the Company Field Advisor.
 - c. Services and each product for which authorization is given by the Company, listed specifically for this project.
 - d. Copy of:
 - i. NICET Letter of Approval of supervisor indicating Level IV for Water-Based Fire Protection Systems certification OR
 - ii. Licensure certificate for Professional Engineering in the State of New York, AND National Council of Examiners for Engineering and Surveying (NCEES) record/certificate for verification of completion of the Principles of Practice of Fire Protection Engineering Exam.
 - 4. Contractor's Qualifications Data:
 - a. Contractor's name, business address and telephone number.
 - b. Names and addresses of 3 similar projects that each person has worked on during the past 5 years.
 - c. Name of Project Manager for the project that is National Institute for Certification in Engineering Technologies (NICET) certified as Level IV for Water-Based Fire Protection Systems, or is a registered Professional Engineer in the State of New York. Provide a copy of Project Manager's:
 - i. NICET Letter of Approval indicating Level IV for Water-Based Fire Protection Systems certification, OR
 - ii. Licensure certificate for Professional Engineering in the State of New York, AND National Council of Examiners for Engineering and Surveying (NCEES) record/certificate for verification of completion of the Principles of Practice of Fire Protection Engineering Exam.
 - 5. Installer's Qualifications Data:
 - a. Name of each person who will be performing the Work and their employer's name, business address and telephone number.
 - b. Names and addresses of 3 similar projects that each person has worked on during the past 5 years.
 - 6. Working Drawing/Hydraulic Calculation Preparer Qualification Data:

- a. Working drawings and hydraulic calculations shall be prepared by either a:
 - i. National Institute for Certification in Engineering Technologies (NICET) certified as Level IV for Water-Based Fire Protection Systems technician.
 - ii. A licensed Professional Engineer, licensed in the State of New York, who has licensed by exam (Principles of Practice of Fire Protection Engineering Exam).
- b. Name of each person who will be preparing working drawings/hydraulic calculations required for the Work.
- c. Upon request, furnish names and addresses of the required number of similar projects that each person has worked on which meet the experience criteria.
- d. Copy of:
 - i. NICET Letter of Approval indicating Level IV for Water-Based Fire Protection Systems certification, OR
 - ii. Licensure certificate for Professional Engineering in the State of New York, AND National Council of Examiners for Engineering and Surveying (NCEES) record/certificate for verification of completion of the Principles of Practice of Fire Protection Engineering Exam.
- 7. All of the above Qualifications Data shall be submitted with Contractor's bid package and with shop drawings.
- E. Contract Closeout Submittals:
 - 1. Operation and Maintenance Data. Deliver 2 copies to the Owner's Representative:
 - a. Instruction manual describing the operation and maintenance of the system.
 - b. Parts list for each mechanical and electrical device.
 - c. Publication NFPA 25, Inspection, Testing, and Maintenance of Water Based Fire Protection Systems.

1.05 QUALITY ASSURANCE

- A. Company Field Advisor with qualifications identified above. Secure the services of a Company Field Advisor for the following:
 - 1. Observe installation of fire protection systems on a regular basis (minimum of once per every two weeks) throughout the duration of construction. Maintain a log/report of items noted, progress completed and adjustments made during each site observation. Maintain this log/report so that it can be furnished to the Owner's representative and/or the Engineer at any time throughout construction. Log/report shall be provided in the O+M Manual upon project closeout.
 - 2. Render advice regarding installation and final adjustment of the system.
 - 3. Witness final system test and then certify with an affidavit that the system is installed in accordance with the contract documents and is operating properly.
 - 4. Train facility personnel in operation, and routine maintenance of the system.
 - 5. The Company Field Advisor shall be:
 - a. National Institute for Certification in Engineering Technologies (NICET) Level IV for Water-Based Fire Protection Systems certified technicians, OR
 - b. A licensed Professional Engineer, licensed in the State of New York, who has licensed by exam (Principles of Practice of Fire Protection Engineering

Exam).

- B. Contractor Qualifications: The Contractor performing the Work of this Section shall be experienced in sprinkler Work and shall have been regularly engaged in the installation of sprinkler systems for a minimum of 10 years and shall, upon request, furnish to the Owner's Representative the names and addresses of 5 similar projects which the Contractor worked on during the last 5 years.
1. The Project Manager employed to supervise the Work shall be National Institute for Certification in Engineering Technologies (NICET) certified as Level IV for Water-Based Fire Protection Systems, OR shall be a Professional Engineer licensed in the State of New York who has licensed by exam (Principles of Practice of Fire Protection Engineering Exam). The services of a Project Manager shall include but not limited to the following:
 - a. Attendance at meetings during construction.
 - b. Render advice regarding installation and final adjustment of the system.
 - c. Witness final system test and then certify with an affidavit that the system is installed in accordance with the contract documents and is operating properly.
 - d. Performance of hydraulic calculations and development of Working Drawings.
 - e. Visit the site at a minimum on a bi-weekly basis during active installation of the fire protection systems. During each site observation, the Project Manager shall document the progress of the sprinkler system, fire pump system and standpipe system installation, and shall document all items which have been modified/adjusted in the field for NFPA-13 compliance.
 - f. The Project Manager is permitted to be the same personnel as the Company Field Advisor, and shall perform all the duties as the Company Field Advisor and the Project Manager if one person is serving both roles.
- C. Installer Qualifications: The workers and supervisors performing the Work of this Section shall be personally experienced in sprinkler systems Work and shall have been regularly employed by a company engaging in the installation of sprinkler systems for a minimum of 5 years and shall, upon request, furnish to the Owner's Representative the names and addresses of 5 similar projects which they have worked on during the last 5 years.
- D. Working Drawing/Hydraulic Calculation Preparer Qualifications:
1. The persons employed to prepare these documents for the Work shall be personally experienced in sprinkler work and shall have been regularly performing such work for a minimum of 5 years while in the employ of a company or companies engaged in the installation of fire protection systems.
 - a. Upon request, furnish to the Owner's Representative the names and addresses of five similar projects which the foregoing people have prepared working drawings/hydraulic calculations on during the past 3 years.
 - b. The persons employed to prepare these documents for the Work shall be performed by person(s) meeting one of the following minimum qualification levels (without substitution):
 - i. National Institute for Certification in Engineering Technologies (NICET) Level IV for Water-Based Fire Protection Systems certified technicians, OR

- ii. A licensed Professional Engineer, licensed in the State of New York, who has licensed by exam (Principles of Practice of Fire Protection Engineering Exam).
- E. System Acceptance:
 - 1. Comply with NFPA 13 requirements.
 - 2. Complete and sign the Contractor's Material and Test Certifications and provide copies to Owner's Representative.
 - 3. Tests shall be witnessed by the Owner's Representative.
- F. Regulatory Requirements:
 - 1. Materials for the Work of this Section shall be Underwriter's Laboratories listed, and/or Factory Mutual approved.
- G. Certification: NFPA Contractor's Material and Test Certificate.

1.06 MAINTENANCE

- A. Spare Parts: Furnish the following items and deliver to the Owner's Representative for storage in spare sprinkler head cabinets:
 - 1. Spare sprinkler heads per NFPA-13.
 - 2. One sprinkler head wrench to fit each type sprinkler head listed above.

PART 2 PRODUCTS

2.01 VALVES AND ACCESSORIES

- A. Gate Valves (175 psig non-shock working pressure):
 - 1. 3/4 inch to 2 inch: Bronze body, OS & Y indicating type; double or wedge disc with threaded ends.
 - 2. 2-1/2 inch and larger: IBBM, OS & Y indicating type; double or wedge disc with end connections as required to suit the piping system.
- B. Alarm Check Valve:
 - 1. Two piece cast iron body, bolted and gasketed.
 - 2. Moving parts brass, bronze, or stainless steel with replaceable rubber clapper facing.
 - 3. Right or left hand trimming as required.
 - 4. Suitable for horizontal or vertical installation.
 - 5. Two pressure gages.
 - 6. Main drain tap.
 - 7. Alarm retarding chamber for water motor alarm device and electric alarm pressure switch.
 - 8. Pressure switch: Equip with spst or spdt contacts rated 10 Amps at 110 V ac, adjustable differential, range as required; NEMA Type 12 enclosure.
 - 9. Factory finish with corrosion resistant red paint.
 - 10. Trim Package: Angle valve, globe valve, alarm line strainer, orifice restriction, pipe nipples and fittings.
- C. Check Valves: IBBM, single clapper swing check with metal to metal or rubber faced checks, suitable for horizontal and vertical installation; end connections as required to suit the piping system; 175 psig non-shock working pressure.
 - 1. Ball Drip (where shown on Drawings): Brass, automatic; threaded on both ends.
- D. Check Valves (250 and 350 psig non-shock working pressure)
 - 1. 2-1/2 inch and larger: Iron body, bronze mounted, single clapper swing check with metal to metal or rubber faced

checks, suitable for horizontal and vertical installation; end connections as required to suit the piping system.

- E. Butterfly Valves: UL/FM approved, 300 psi grooved ends, polyphenylene sulfide coated ductile iron body (ASTM A-536). Ductile iron disc, synthetic rubber encapsulated suited for intended service, with integrally cast stem. Complete with waterproof actuator and pre-wired supervisory switches. Victaulic Series 705 W Fire Lock or approved equal.

202 FIRE SPRINKLERS AND APPURTENANCES

- A. Fire Sprinklers: Provide sprinkler types as listed on the Construction Drawings.
 - 1. Acceptable Manufacturers:
 - a. Victaulic
 - b. Reliable
 - c. Viking
 - d. Tyco
- B. Sprinkler Guards For Exposed Piping: Welded steel wire cage with cast or pressed steel base plate and suitable retaining clamps.
 - 1. Finish: Paint to match sprinkler piping.
- C. Spare Sprinkler Head Cabinet: Steel, with hinged cover, constructed of minimum 20 gage material and fitted with 16 gage steel racks designed to hold quantities and types of spare sprinkler heads and sprinkler head wrenches.
 - 1. Finish: Bright red, baked on enamel.
- D. Where concealed pendent or sidewall sprinklers are provided, Contractor shall provide cover plates which are factory painted to match the ceiling or wall color in which the sprinkler is installed. Contractor shall confirm the colors of all walls and ceilings with Architect and Owner's Representative prior to submitting proposal.
- E. Victaulic VicFlex™ Multiple-Use Flexible Stainless Steel Sprinkler Drop System [with captured coupling Style 108] shall be used to locate sprinklers as required by final finished ceiling tiles and walls. The factory tested drop system shall consist of a braided type 304 stainless steel flexible tube, zinc plated steel Male threaded nipple or Victaulic FireLock IGS Groove Style 108 coupling for connection to branch-line piping, and a zinc plated steel reducer with a female thread with installed sprinkler head.
 - 1. Captured Coupling IGS Groove Style 108 single-bolt coupling provided with EPDM Type A pressure responsive gasket with Vic-Plus lubricant, and ASTM A449 compliant electroplated steel bolt and nut. CrMo alloy steel coupling linkage.
 - 2. The drop shall include a UL approved Series AH1 with 3" bend radius; AH2 or AH2-CC braided hose with a bend radius to 2" to allow for proper installation in confined spaces. The hose shall be listed for [(4) bends at 31" length, (5) bends at 36" length, (8) bends at 48" length, (10) bends at 60" length, and (12) bends at 72" length.
 - 3. Union joints shall be provided for ease of installation. The flexible drop shall attach to the ceiling grid using a one-piece open gate Series AB1 or AB2 bracket. The bracket shall allow installation before the ceiling tile is in place. The braided drop system is UL listed for sprinkler services to 175 psi (1206 kPa) and FM Approved to 200 psi (1380 kPa).
 - a. All hoses shall be factory-pressure tested to 400 psi.

- (2760 kPa).
- b. AB6 Bracket Assembly, for use in cold storage applications with Victaulic Model V36 dry sprinklers.
- c. Approvals:
 - i. FM-1637
 - ii. UL 2443
- d. Refer to the Victaulic I-VICFLEX installation manual and the Victaulic VicFlex™ Design Guide, as shown in product submittal 10.85 to ensure proper installation.
- F. Victaulic VicFlex™ Dry Sprinkler:
 - 1. In lieu of rigid connections to dry sprinkler heads, a Victaulic VicFlex™ dry sprinkler, Model VS1, may be used. The sprinkler shall provide a vertical or horizontal flexible connection with a bend radius to 2", and allow for up to 4 bends.
 - 2. The sprinkler body shall be die cast brass with brass deflector, supplied chrome plated, and glass bulb with glycerin solution. The product shall consist of a braided type 300 stainless steel flexible hose with a swivel type branch line threaded connection, EPDM gasket seal, with PTFE-coated Beryllium Nickel and stainless-steel spring-seal assembly. The bracket shall be metal strap to provide for sprinkler placement and alignment. The flexible dry sprinkler and bracket system is UL listed for sprinkler services to 175 psi (1206 kPa).

203 FIRE DEPARTMENT CONNECTIONS

- A. Contractor shall coordinate final type and location of fire department connection with the local fire department prior to installation.
- B. Fire Department Connections shall be constructed of cast brass with a polished finish and matching caps and chain.
- C. Storz Connection: Projecting wall type, brass with polished finish; plugs and chains, and escutcheon. 45 degree angle down. Coordinate size with the local fire department.
- D. Identification: Cast the word "STANDPIPE AND AUTOSPKR" on escutcheon.

204 WATER FLOW ALARM DEVICE

- A. Vane-Type Waterflow Switch
 - 1. UL, CUL Listed / FM, LPCB, VdS Approved and CE Marked vane type waterflow switches shall be furnished and installed at each sprinkler system connection to the wet pipe main where indicated on the drawings and plans and as required by applicable local and national codes and standards.
 - 2. The device shall consist of a saddle with factory installed non-corrosive insert, gasket and non-corrosive vane and trip stem assembly as well as a field replaceable adjustable time delay / switch mechanism to prevent false alarms from water surges. All wetted parts of the waterflow switch shall be non-metallic to resist being affected by or contributing to corrosion. The waterflow switch enclosures shall be NEMA 4 rated and the cover shall be held captive by tamper resistant screws. It shall be possible to install an optional cover tamper switch to detect removal of the enclosure.
 - 3. The field replaceable instantly recycling adjustable pneumatic retard shall provide a 0-90 second time delay and visual indication of activation. Expiration of the retard time shall result in the simultaneous operation of two sets

of single pole double throw (SPDT) switch contacts rated at 10A, 125VAC and 2A, 30VDC. Each switch contact shall have a separate wiring chamber and separate conduit entrance to comply with the NEC requirements for separation of power limited and non power limited conductors without the need for special wire or wire methods.

4. The device shall be listed for pressures up to 450 psi, maximum water surges of 18 fps and alarm activation by a continuous flow of 10gpm. The device shall be Listed for installation on pipe schedules from 5-40 for 2" – 6" and schedule 10-40 for 8" through 10" size.
5. The waterflow switch shall be a model VSR manufactured by Potter Electric Signal Company LLC or equivalent.

205 ELECTRIC ALARM GONG

- A. 6 inch diameter vibrating bell; 120 V ac. Sound rating 92 db at 10 feet minimum; Viking's 03115BA or Edward's 438-6N5 or Potter PBA-AC.
 1. Markings: The words FIRE ALARM in block lettering on a contrasting background.
 2. Mounting: Suitable for both wall and ceiling mounting.

206 VALVE SUPERVISORY SWITCHES

- A. Mechanically actuated, designed to close contacts and sound an alarm when supervised valve is closed and when switch cover removed.
- B. For OS&Y Valves
 1. UL, CUL Listed / FM Approved and CE Marked valve supervisory switches shall be furnished and installed on all OS&Y type valves that can be used to shut off the flow of water to any portion of the fire sprinkler system, where indicated on the drawings and plans and as required by applicable local and national codes and standards.
 2. The supervisory switch shall be NEMA 4X and 6P rated and capable of being mounted in any position indoors or out or be completely submerged without allowing water to enter the enclosure. The enclosure shall be held captive by tamper resistant screws. The device shall contain two conduit entrances and one or two Single Pole Double Throw (SPDT) switches. There shall be a visual indicator to display the status of the switches.
 3. To aid in installation, the device shall contain a micro-adjust feature making it possible to make fine adjustments to the position of the device on the valve without loosening the mounting bracket. The mounting bracket shall be knurled to prevent slippage on the valve yoke. The device shall contain an adjustable length trip rod, the trip rod shall be held captive by a set screw accessible upon removal of the cover. The switch contacts shall be rated at 10.0A, 125/250VAC and 2.0A, 30VDC.
 4. OS&Y Valve Supervisory Switch shall be model OSYSU-1 for the single switch model and OSYSU-2 for the two switch model manufactured by Potter Electric Signal Company LLC or equivalent.
- C. For Post Indicator and Butterfly Valves
 1. UL, CUL Listed / FM Approved and CE Marked valve supervisory switches shall be furnished and installed on all Post Indicator and Butterfly type valves that can be used to shut off the flow of water to any portion of the fire sprinkler system, where indicated on the drawings and plans and as

- required by applicable local and national codes and standards.
2. The supervisory switch shall be NEMA 4X and 6P rated and capable of being mounted in any position indoors or out or be completely submerged without allowing water to enter the enclosure. The enclosure shall be held captive by tamper resistant screws. The device shall contain two conduit entrances and two Single Pole Double Throw (SPDT) switches. The device shall contain a removable ½" NPT nipple and an adjustable length trip rod, the trip rod shall be held captive by a set screw accessible upon removal of the cover.
 - a. The switch contacts shall be rated at 10A, 125/250VAC and 2A, 30VDC.
 3. Post Indicator and Butterfly Valve Supervisory Switch shall be model PCVS-2 manufactured by Potter Electric Signal Company LLC or equivalent.
- D. For Ball Valve Supervisory Switch
1. UL, cUL Listed and FM Approved supervisory switch specifically manufactured for monitoring ball valves shall be furnished and installed on ¼ turn ball valves that can be used to shut off the flow of water to a portion of the sprinkler system including the trim piping on alarm check, dry pipe or preaction valves. Locations shall be as indicated on drawings and plans and as required by applicable local and national codes and standards.
 2. The supervisory switch shall monitor the position of the handle on the valve and be capable of monitoring a valve in the open or closed position. Movement of the valve handle from normal shall activate the supervisory switch. Restoration of the valve handle shall cause the supervisory switch to automatically restore to normal. There shall not be any tools or extra steps required to restore the supervisory switch to normal. The enclosure shall be corrosion resistant and rated NEMA 4. The cover of the device shall be secured by the use of a tamper proof screw.
 3. All mounting hardware necessary for the installation on valves ranging in sizes from ½" – 2" including backflow preventors shall be included. Each ball valve switch shall contain 1 SPDT contact rated 10A at 125/250 VAC and 2A at 30 VDC.
 4. Ball Valve Supervisory Switch shall be model RBVS as manufactured by Potter Electric Signal Company LLC or equivalent.

207 AIR VENTS

- A. Air vents shall be installed on all wet pipe sprinkler systems in locations required by NFPA-13 (2016) and where indicated on the Contract Drawings.
- B. Potter Air Vent (Model PAV)
 1. Furnish and install air release valve(s) at the high point(s) on the fire sprinkler system piping determined by the sprinkler system designer or engineer to assure evacuation of air from the system during and after filling. The automatic air release valve shall consist of a 40 mesh "Y" type strainer connected to an automatic air vent valve. The output of the air vent valve shall be a ½" NPT male connection which allows a drain attachment for safely draining inadvertent discharge of water that is inherent in the operation of the automatic air vent. Install drain pipe to appropriate location. The air vent assembly shall be field replaceable without disabling the sprinkler system by the installation of a ½" ball valve installed before the Y strainer for isolation purposes. The automatic air release valve shall be mounted in a vertical

position and shall require a minimum of 8 " of clearance above the fire sprinkler main or branch line piping. The Automatic Air Release Valve shall be a model PAV manufactured by Potter Electric Signal Company LLC

2. Furnish and install a ball valve prior to the "Y" type strainer to isolate the automatic air release valve and strainer from the system for replacement of the automatic air vent or WAGS or strainer maintenance.

208 ENCLOSURE

- A. Size: Length and width as indicated; full ceiling height, but not to exceed 8'-0".
- B. Construction and Materials: 1-1/2 inch diamond pattern woven mesh, with No. 10 W&M (0.135 inch) steel wire forming a panel framed with minimum 1 x 1/2 x 1/8 inch steel channel.
 1. Panel width: 5'-0" wide panels with odd size fill-in sections as required.
 2. Door Panel: Include one panel containing a 3'-0" wide door set in a steel frame. Hang door on not less than 3 butt hinges; equip door with mortise cylinder lock and 2 keys.
- C. Accessories:
 1. Cast iron floor sockets with set screws and means of anchoring.
 2. Door Panel: Include one panel containing a 3'-0" wide door set in a steel frame. Hang door on not less than 3 butt hinges; equip door with mortise cylinder lock and 2 keys.
 3. Wall clips, bolts for fastening sections together and bolts, shields and hardware for fastening the enclosure to floor, walls and ceiling.
 4. Finish: Factory applied light green enamel.

209 SIGNS

- A. Steel with vitreous enamel finish, lettering on contrasting background to identify and indicate the function of:
 1. Control valves.
 2. Drain, test, air supply and alarm check valves.
 3. Alarm gong.
 4. Drain and test valves.
 5. Hydraulic Design Nameplate Data: Size approx. 9 x 12 inches, inscribed with the following:
 - a. SPRINKLER SYSTEM HYDRAULICALLY DESIGNED (in block letters).
 - b. Location and area of hydraulically designed section.
 - c. Discharge density over designed area in gallons per minute.
 - d. Residual pressure at base of riser supplying water to designed section.

210 AUXILIARY DRAINS

- A. Provide auxiliary drains on all dry pipe sprinkler and standpipe systems in accordance with the edition of NFPA-13 adopted by the Local Authorities. At a minimum provide Auxiliary drains in the following locations.
 1. Auxiliary Drains for Wet Pipe Systems and Preaction Systems in Areas Not Subject to Freezing.
 - a. Where the capacity of isolated trapped sections of pipe is 50 gallons or more, the auxiliary drain shall consist of a valve not smaller than 1 inch, piped to an accessible location.
 - b. Where the capacity of isolated trapped sections of pipe is more than 5 gallons and less than 50 gallons, the auxiliary drain shall consist of a valve 3/4 inch or

- larger and a plug or a nipple and cap.
- c. Where the capacity of trapped sections of pipes in wet systems is less than 5 gallons, one of the following shall be provided:
 - i. An auxiliary drain shall consist of a nipple and cap or plug not less than ½ inch in size.
 - ii. An auxiliary drain shall not be required for trapped sections less than 5 gallons where the system piping can be drained by removing a single pendent sprinkler.
 - iii. Where flexible couplings or other easily separated connections are used, the nipple and cap or plug shall be permitted to be omitted.
- d. Tie-in drains shall not be required on wet systems and preaction systems processing nonfreezing environments.

PART 3 EXECUTION

301 PREPARATION

- A. Existing Sprinkler System Shutdown:
 - 1. Before shutting down the sprinkler system to perform the Work, notify the Owner's Representative in writing, and the local fire department that the system is to be shut down temporarily. Give schedule which states date and time of proposed shut down and the approximate length of time that the system will be out of service. Request instructions for precautions that should be taken during the shut down period.
 - 2. Do not shut down the system until schedule is approved by the Owner's Representative.
 - 3. Return the existing system to pre-shutdown operation immediately after the Work has been completed. Give written notice to the Owner's

302 INSTALLATION

- A. Unless otherwise shown or specified, install the Work of this section in accordance with NFPA 13, and the item manufacturer's installation instructions.
- B. Locking Valves:
 - 1. Lock gate valves in open position with chain looped through handwheel and around adjacent sprinkler pipe. Secure with padlock.
 - 2. Lock test outlet valve in closed position with padlock.
- C. Spare Sprinkler Head Cabinet: Secure to building wall or other permanent structure in vicinity of main valve controlling sprinkler system, unless otherwise directed.
- D. Signs: Install signs identifying the following:
 - 1. Valves: One for each size, type and function.
 - 2. Water Motor Alarm.
 - 3. Hydraulically Designed System.

303 FIELD QUALITY CONTROL

- A. Tests: Unless otherwise shown or specified, perform tests in accordance with NFPA 13.
 - 1. Flushing: In addition to the requirements of the Standard, flush new piping before making final connection to existing systems and before performing hydrostatic test. Flush at rates of flow prescribed in the Contractor's Material and Test Certificate. After making final connections, flush entire system and assure that debris is removed from piping and there are no

stoppages or obstructions in the system.

2. System Tests:

- a. Test all new Work.
- b. Notify the Owner's Representative when the Work of this Section is ready for testing.
- c. Perform the tests when directed, and in the Owner's Representatives presence.

END OF SECTION

**SECTION 22 0510
BASIC PLUMBING REQUIREMENTS**

PART 1 GENERAL

1.01 WORK INCLUDED

- A. Provide all labor, tools, materials, accessories, parts, transportation, taxes, and related items, essential for installation of the work and necessary to make work, complete, and operational. Provide new equipment and material unless otherwise called for. References to codes, specifications and standards called for in the specification sections and on the drawings mean, the latest edition, amendment and revision of such referenced standard in effect on the date of these Contract Documents.

1.02 LICENSING

- A. The Contractor shall hold a license to perform the work as issued by the local jurisdiction.
- B. Plumbing work shall be performed by, or under, the direct supervision of a licensed master plumber if so required by the local jurisdiction.
- C. The Contractor shall be responsible for reviewing the local jurisdiction requirements prior to bidding.

1.03 PERMITS

- A. Apply for and obtain all required permits and inspections, pay all fees and charges including all service charges.

1.04 CODE COMPLIANCE

- A. Provide work in compliance with the following:
 - 1. The Building Code of New York State including The Fire Code; Property Maintenance Code; Plumbing Code, Mechanical Code and Fuel Gas Code; and The Energy Code of New York.
 - 2. New York State Department of Labor Rules and Regulations.
 - 3. Occupational Safety and Health Administration (OSHA).
 - 4. National Fuel Gas Code, NFPA 54.
 - 5. National Electrical Code, NFPA 70.
 - 6. Local Codes and Ordinances.
 - 7. Life Safety Codes, NFPA 101 (2000).
 - 8. New York Board of Fire Underwriters.
 - 9. New York State Education Department "Manual of Planning Standards".

1.05 GLOSSARY

- A. ACI American Concrete Institute
- B. AGA American Gas Association
- C. AGCA Associated General Contractors of America, Inc.
- D. AIA American Institute of Architects
- E. AISC American Institute of Steel Construction
- F. AFBMA Anti-Friction Bearing Manufacturer's Association
- G. AMCA Air Moving and Conditioning Association, Inc.
- H. ANSI American National Standards Institute
- I. ARI Air Conditioning and Refrigeration Institute
- J. ASHRAE American Society of Heating, Refrigeration, and Air Conditioning Engineers, Inc.
- K. ASME American Society of Mechanical Engineers
- L. ASPE American Society of Plumbing Engineers
- M. ASTM American Society for Testing Materials

N.	FM	Factory Mutual Insurance Company
O.	IBR	Institute of Boiler & Radiation Manufacturers
P.	IEEE	Institute of Electrical and Electronics Engineers
Q.	IRI	Industrial Risk Insurers
R.	NYBFU	New York Board of Fire Underwriters
S.	NEC	National Electrical Code
T.	NEMA	National Electrical Manufacturer's Association
U.	NESC	National Electrical Safety Code
V.	NFPA	National Fire Protection Association
W.	NYS/DEC	New York State Department of Environmental Conservation
X.	NYSDOH	New York State Department of Health
Y.	NYS/UFPBC	New York State Uniform Fire Prevention and Building Code
Z.	OSHA	Occupational Safety and Health Administration
AA.	SBI	Steel Boiler Institute
BB.	SMACNA	Sheet Metal and Air Conditioning Contractors National Association
CC.	UFPO	Underground Facilities Protective Organization
DD.	UL	Underwriter's Laboratories, Inc.

1.06 DEFINITIONS

A.	Acceptance	Owner acceptance of the project from Contractor upon certification by Owner's Representative.
B.	Approval/Approved	Written permission to use a material or system.
C.	As Called For	Materials, equipment including the execution specified/shown in the Contract Documents.
D.	Code Requirements	Minimum requirements.
E.	Concealed	Work installed in pipe and duct shafts, chases or recesses, inside walls, above ceilings, in slabs or below grade.
F.	Design Equipment	Refer to the article, Equipment Arrangements, and the article, Substitutions.
G.	Design Make	Refer to the articles, Equipment Arrangements, and the article, Substitutions.
H.	Exposed	Work not identified as concealed.
I.	Equal or Equivalent	Equally acceptable as determined by Owner's Representative.
J.	Furnish	Supply and deliver to installed location.
K.	Furnished by Others	Receive delivery at job site or where called for and install.
L.	Inspection	Visual observations by Owner's site Representative.
M.	Install	Mount and connect equipment and associated materials ready for use.
N.	Labeled	Refers to classification by a standards agency.
O.	Make	Refers to the article, Equipment Arrangements, and the article, Substitutions.
P.	Or Approved Equal	Approved equal or equivalent as determined by Owner's Representative.
Q.	Owner's Representative	The Prime Professional.

- R. Prime Professional Architect or Engineer having a contract directly with the Owner for professional services.
- S. Provide Furnish, install, and connect ready for use.
- T. Relocate Disassemble, disconnect, and transport equipment to new locations, then clean, test, and install ready for use.
- U. Replace Remove and provide new item.
- V. Review A general contractual conformance check of specified products.
- W. Roughing Pipe, duct, conduit, equipment layout and installation.
- X. Satisfactory As specified in contract documents.
- Y. Site Representative Owner's inspector or "Clerk of Works" at the work site.

1.07 SHOP DRAWINGS/PRODUCT DATA/SAMPLES

- A. Submit Shop Drawings on all items of equipment and materials to be furnished and installed. Submission of Shop Drawings and samples shall be accompanied by a transmittal letter, stating name of Project and Contractor, number of drawings, titles, and other pertinent data called for in individual sections. Shop Drawings shall be dated and contain: Name of Project; name of Prime Professional; name of Prime Contractor; description or names of equipment, materials and items; and complete identification of locations at which materials or equipment are to be installed. Individual piecemeal or incomplete submittals will not be accepted. Similar items, (all types specified) shall be submitted at one time. Number each submittal by trade. Indicate deviations from contract requirements on Letter of Transmittal. Shop Drawings will be given a general review only. Corrections or comments made on the Shop Drawings during the review do not relieve Contractor from compliance with requirements of the drawings and specifications. The Contractor is responsible for: confirming and correcting all quantities; checking electrical characteristics and dimensions; selecting fabrication processes and techniques of construction; coordinating his work with that of all other trades; and performing his work in a safe and satisfactory manner.

1.08 PROTECTION OF PERSONS AND PROPERTY

- A. Contractor shall assume responsibility for construction safety at all times and provide, as part of contract, all trench or building shoring, scaffolding, shielding, dust/fume protection, mechanical/electrical protection, special grounding, safety railings, barriers, and other safety feature required to provide safe conditions for all workmen and site visitors.

1.09 EQUIPMENT ARRANGMENTS

- A. The Contract Documents are prepared on basis of one manufacturer as "design equipment," even though other manufacturer's names are listed as acceptable makes. If Contractor elects to use one (1) of the listed makes other than "design equipment," submit detailed drawings, indicating proposed installation of equipment. Show maintenance arrangement. Make required changes in the work of other trades, at no increase in any contract. Provide larger motors, feeders, breakers, and equipment, additional control devices, valves, fittings and other miscellaneous equipment required for proper operation, and assume responsibility for proper location of roughing and connections by other trades. Remove and replace door frames, access doors, walls, ceilings, or floors required to install other than design make equipment. If revised arrangement submittal is rejected, revise and resubmit specified "design equipment" item which conforms to contract documents.

1.10 CONTINUITY OF SERVICES

- A. The building will be in use during construction operations. Maintain existing systems in operation within all rooms of building at all times. Refer to "General Conditions of the Contract for Construction" for temporary facilities for additional contract requirements. Schedules for various phases of contract work shall be coordinated with all other trades and with Owner's Representative. Provide, as part of contract, temporary mechanical and plumbing connections and relocations as required to accomplish the above. Obtain approval in writing as to date, time, and location for shutdown of existing mechanical/plumbing facilities or services.

1.11 UTILITY COMPANY SERVICES

- A. Make arrangements with the Owner's gas supplier for relocation of existing gas lines. Provide service to the building as required. Coordinate all activities between the Owner and supplier. The installation of the gas service shall comply with the published standards, including but not limited to NFPA 54 and NFPA 58. PAY ALL UTILITY SUPPLIER CHARGES; INCLUDE CHARGES IN THE BASE BID.

1.12 ROUGHING

- A. Due to small scale of Drawings, it's not possible to indicate all offsets, fittings, changes in elevation, interferences, etc. Make necessary changes in Contract Work, equipment locations, etc., as part of a contract to accommodate work to obstacles and interferences encountered. Before installing, verify exact location and elevations at work site. DO NOT SCALE plans. If field conditions, details, changes in equipment or shop drawing information require an important rearrangement, report same to Owner's Representative for review. Obtain written approval for all major changes before installing.
- B. Install work so that items both existing and new are operable and serviceable. Eliminate interference with removal of coils, motors, filters, belt guards and/or operation of doors. Provide easy, safe, and code mandated clearances at controllers, motor starters, valve access, and other equipment requiring maintenance and operation. Where Contractor could not reasonably be expected to find such trade interferences due to concealment in walls, ceiling or floors, such relocations will be done by Change Order, if not, included in contract work. Contractor shall relocate existing work in way of new construction. VISIT SITE BEFORE BIDDING TO DETERMINE SCOPE OF WORK SINCE FEW OF SUCH ITEMS CAN BE SHOWN. Provide new materials, including new piping and insulation for relocated work.
- C. Coordinate work with other trades and determine exact route or location of each duct, pipe, conduit, etc., before fabrication and installation. Coordinate with Architectural Drawings. Obtain from Owner's Representative exact location of all equipment in finished areas (i.e., thermostat, fixture, and switch mounting heights, and equipment mounting heights). Coordinate all work with the architectural reflected ceiling plans and/or existing Architecture. Mechanical and plumbing drawings show design arrangement only for diffusers, grilles, registers, air terminals, lighting fixtures, speakers, and other items. Do not rough-in contract work without reflected ceiling location plans.
- D. Before roughing for equipment furnished by Owner or in other Contracts, obtain from Owner and other Contractors, approved roughing drawings giving exact location for each piece of equipment. Do not "rough in" services without final layout drawings approved for construction. Cooperate with other trades to insure proper location and size of connections to insure proper functioning of all systems and equipment. For equipment and connections provided in this contract, prepare roughing drawing as follows:
 - 1. Existing Equipment: Measure the existing equipment and prepare for installation in new location.
 - 2. New Equipment: Obtain equipment roughing drawings and dimensions, then prepare roughing-in-drawings. If such information is not available in time, obtain an acknowledgement in writing, then make space arrangements as required with Owner's Representative.

1.13 COORDINATION DRAWINGS

- A. Before construction work commences, Contractors for all trades shall submit coordination drawings in the form of reproducible transparencies drawn at not less than 3/8 inch scale. Such drawings will be required throughout all areas for all trades. These drawings shall show resolutions of trade conflicts in congested areas. Mechanical equipment rooms shall be drawn early in coordination drawing process simultaneous with all other congested areas. Prepare Coordination Drawings as follows:
 - 1. The HVAC Trade shall prepare the base plan Coordination Drawings showing all ductwork, all pertinent heating piping, and equipment. These drawings may be sepia of the required ductwork Shop Drawings. The drawings shall be coordinated with lighting fixtures, air diffusers, other ceiling mounted items, ceiling heights, structural work,

maintenance clearances, electric code clearance, reflected ceiling plans, and other contract requirements. Reposition proposed locations of work after coordination drawing review by the Owner's Representative. Provide adjustments to exact size, location, and offsets of ducts, pipes, conduit, etc., to achieve reasonable appearance objectives.

Provide these adjustments as part of contract. Minor revisions need not be re-drawn.

2. HVAC Contractor shall provide sepia transparencies and/or prints and submit the base plan to all major trades' Contractors.
 3. The Plumbing Trade shall draft location of piping and equipment on the base plan, indicating areas of conflict and suggested resolutions.
 4. The Electrical Trade shall draft location of lighting fixtures, cable trays, and feeders over 1-1/2 inches on the base plan, indicating areas of conflict and suggested resolution.
 5. The General Contractor shall indicate areas of architectural/structural conflicts or obstacles and coordinate to suit the overall construction schedule.
 6. The General Contractor shall expedite all drawing work and coordinate to suit the overall construction schedule. He shall then review these drawings and compare them with the architectural, structural, equipment, and other drawings and determine that all of the work can be installed without interference. In the case of unresolved interferences, he shall notify the Owner's Representative. The Owner's Representative will then direct the various Contractors as to how to revise their drawings as required to eliminate installation interferences.
 7. If a given trade proceeds to resolving conflicts, then if necessary, that Trade shall change its work at no extra cost in order to permit others to proceed with a coordinated installation. Coordination approval will be given by areas after special site meetings involving all Trades.
- B. Coordination Drawings are intended for the respective Contractor's use during construction and shall not replace any Shop Drawings, or record drawings required elsewhere in these Contract Documents.

1.14 REMOVAL WORK

- A. Where existing equipment removals are called for, submit to Owner's Representative a complete list of all items that Owner wishes to retain that do not contain asbestos or PCB material shall be delivered to location directed by Owner. Items that Owner does not wish to retain shall be removed from site and legally disposed of. Removal and disposal of material containing asbestos and/or PCB's shall be in accordance with Federal, State, and Local laws requirements. Where equipment is called for to be relocated, contractor shall carefully remove, clean and recondition, then reinstall. Removal all abandoned piping, wiring, equipment, lighting, ductwork, tubing, supports, fixtures, etc. Visit each room, crawl space, and roof to determine the total Scope of Work. The disturbance or dislocation of asbestos-containing materials causes asbestos fibers to be released into the building's atmosphere, thereby creating a health hazard to workmen and building occupants. Consistent with Industrial Code Rule 56 and the content of recognized asbestos-control work, the Contractor shall apprise all of his workers, supervisory personnel, subcontractors, Owner and Consultants who will be at the job site of the seriousness of the hazard and of proper safeguards and work procedures which must be followed, as described in New York State Department of Labor Industrial Code Rule 56.

1.15 EQUIPMENT AND MATERIAL INSTALLATION

- A. Provide materials that meet the following minimum requirements:
1. Materials shall have a flame spread rating of 25 or less and smoke developed rating of 50 or less, in accordance with NFPA 255.
 2. All equipment and material for which there is a listing service shall bear a UL label.
 3. Potable water systems and equipment shall be built according to AWWA Standards.
 4. Gas-fired equipment and system shall meet AGA Regulations and shall have AGA label.
 5. Electrical equipment and systems shall meet UL Standards and requirements of the NEC.

1.16 CUTTING AND PATCHING

- A. Each trade shall include their required cutting and patching work unless shown as part of the General Construction work on the architectural drawings. Refer to "General Conditions of the Contract for Construction," for additional requirements. Cut and drill from both sides of walls and/or floors to eliminate splaying. Patch any cut or abandoned holes left by removals of equipment, fixtures, etc. Patch adjacent existing work disturbed by installation of new work including insulation, walls and wall covering, ceiling and floor covering, other finished surfaces. Patch openings and damaged areas equal to existing surface finish. Cut openings in prefabricated construction units in accordance with manufacturer's instructions.

1.17 PAINTING

- A. Include painting for patchwork with color to match adjacent surfaces. Where color cannot be adequately matched, paint entire surface. Provide one (1) coat of primer and two (2) finish coats or as called for in the mechanical and electrical specifications. Refer to General Construction Specifications for additional information.

1.18 CONCEALMENT

- A. Conceal all Contract Work above ceilings and in walls, below slabs, and elsewhere throughout building. If concealment is impossible or impractical, notify Owner's Representative before starting that part of the work and install only after his review. In areas with no ceilings, install only after Owner's Representative reviews and comments on arrangement and appearance.

1.19 CHASES

- A. New Construction:
 - 1. Certain chases, recessed, openings, shafts, and wall pockets will be provided as part of "General Building Construction Plans and Specifications." Mechanical and electrical trades work shall provide all other openings required for their Contract Work.
 - 2. Check Architectural and Structural Design and Shop Drawings to verify correct size and location for all openings, recesses and chases in general building construction work.
 - 3. Assume responsibility for correct and final location and size of such openings.
 - 4. Rectify improperly sized, improperly located or omitted chases or openings due to faulty or late information or failure to check final location.
 - 5. Provide 18 gauge galvanized sleeves and inserts. Extend all sleeves 2 inch above finished floor. Set sleeves and inserts in place ahead of new construction, securely fastened during concrete pouring. Correct, by drilling, omitted or improperly located sleeves. Assume responsibility for all work and equipment damaged during course of drilling. Firestop all unused sleeves.
 - 6. Provide angle iron frame where openings are required for Contract Work, unless provided by General Contractor.
- B. In Existing Buildings:
 - 1. Drill holes for floor and/or roof slab openings.
 - 2. Multiple pipes smaller than 1 inch properly spaced and supported may pass through one (1) 6 inch or smaller diameter opening.
 - 3. Seal voids in fire rated assemblies with a fire-stopping seal system to maintain the fire resistance of the assembly. Provide 18 gauge galvanized sleeves at fire rated assemblies. Extend sleeves 2 inches above floors.
 - 4. In wall openings, drill or cut holes to suit. Provide 18 gauge galvanized sleeves at shafts and fire rated assemblies. Provide fire-stopping seal between sleeves and wall in drywall construction. Provide fire-stopping similar to that for floor openings.

1.20 FLASHING, SEALING, FIRE-STOPPING

- A. See Specification Section 22 0515 - Plumbing Firestopping.

1.21 SUPPORTS

- A. Provide required supports, beams, angles, hangers, rods, bases, braces, and other items to properly support contract work. Supports shall meet the approval of the Owner's Representative. Modify studs, add studs, add framing, or otherwise reinforce studs in metal

stud walls and partitions as required to suit contract work. If necessary, in stud walls, provide special supports from floor to structure above. For precast panels/planks and metal decks, support Mechanical/Electrical Work as determined by manufacturer and Owner's Representative. Provide heavy gauge steel mounting plates for mounting contract work. Mounting plates shall span two (2) or more studs. Size, gauge, and strength of mounting plates shall be sufficient for equipment size, weight, and desired rigidity.

1.22 ACCESS PANELS

- A. Access panels shall be furnished by the Mechanical and Plumbing Trades and installed by General Contractor. Location and size shall be the responsibility of each trade. Bear cost of construction changes necessary due to improper information or failure to provide proper information in ample time. Access panels over 324 square inches shall have two (2) cam locks. Contractor shall provide proper frame and door type for various wall or ceiling finishes. Access panels shall be manufactured by Milcor, or approved equal. Provide General Contractor with a set of architectural black and white prints with size and approximate locations of access panels shown.

1.23 CONCRETE BASES

- A. Provide concrete bases for all floor-mounted equipment (unless otherwise noted). Provide 3,000 pound concrete, chamfer edges, trowel finish, and securely bond to floor by roughening slab and coating with cement grout. Bases 4 inches high (unless otherwise indicated); shape and size to accommodate equipment. Set anchor bolts in sleeves before pouring and after anchoring and leveling, fill equipment bases with grout.

1.24 PLUMBING EQUIPMENT CONNECTIONS

- A. Contractor is responsible for draining, filling, venting, chemically treating and restarting any systems which are affected by work shown on the Contract Documents unless specifically noted otherwise.
- B. Provide roughing and final water, waste, vent, propane, etc., connections to all equipment. Provide loose key stops, sanitary "P" traps, tailpiece, adapters, gas cocks, and all necessary piping and fittings from roughing point to equipment. Provide installation of sinks, faucets, traps, tailpiece furnished by others. Provide continuation of piping and connection to equipment that is furnished by others. Provide relief valve discharge piping from equipment relief valves to point(s) of safe discharge.
- C. Provide as part of Plumbing Work valved water outlet adjacent to equipment requiring same. Provide equipment type floor drains, or drain hubs, adjacent to equipment.
- D. Install controls and devices furnished by others.
- E. Refer to Contract Documents for roughing schedules and equipment lists indicating scope of connections required.
- F. Provide for Owner furnished and Contractor furnished equipment all valves, piping, piping accessories, traps, pressure reducing valves, gauges, relief valves, vents, drains, insulation, sheet metal work, controls, dampers, and wiring as required.
- G. Refer to Manufacturer drawings and specifications for requirements of kitchen equipment, laboratory equipment and special equipment. Verify connection requirements before bidding.

1.25 STORAGE AND PROTECTION OF MATERIALS

- A. Store materials on dry base, at least 6 inches above-ground or floor. Store so as not to interfere with other work or obstruct access to buildings or facilities. Provide waterproof/windproof covering. Remove and provide special storage for items subject to moisture damage. Protect against theft or damage from any cause. Replace items stolen or damaged, at no cost to Owner.
- B. Refer to "General Conditions of the Contract for Construction."

1.26 FREEZING AND WATER DAMAGE

- A. Take all necessary precautions with equipment, systems and building to prevent damage due to freezing and/or water damage. Repair or replace, at no charge in Contract, any such

damage to equipment, systems, and building. Perform first season's winterizing in presence of Owner's operating staff.

1.27 LUBRICATION CHART

- A. Provide lubrication chart, 8-1/2 inch x 11 inch minimum size, typed in capital letters, mounted under clear laminated plastic; secure to wall in area of equipment. List all motors and equipment in Contract. Obtain and list necessary information by name/location of equipment, manufacturer recommended types of lubrication and schedule. Lubricate motors as soon as installed and perform lubrication maintenance until final acceptance. Plumbing Trade shall add Contract items to the chart provided by the heating trade or provide separate charts.

1.28 OWNER INSTRUCTIONS

- A. Before final acceptance of the work, furnish necessary skilled labor to operate all systems by seasons. Instruct designated person on proper operation, and care of systems/equipment. Repeat instructions, if necessary. Obtain written acknowledgement from person instructed prior to final payment. Contractor is fully responsible for system until final acceptance, even though operated by Owner's personnel, unless otherwise agreed in writing. List under clear plastic, operating, maintenance, and starting precautions procedures to be followed by Owner for operating systems and equipment.

1.29 MAINTENANCE MANUALS

- A. Prepare Instructions and Maintenance Portfolios. Include one copy of each of approved Shop Drawings, wiring diagrams, piping diagrams spare parts lists, as-built drawings and manufacturer's instructions. Include typewritten instructions, describing equipment, starting/operating procedures, emergency operating instructions, summer-winter changeover, freeze protection, precautions and recommended maintenance procedures. Include name, address, and telephone number of supplier manufacturer representative and service agency for all major equipment items in a three ring binder with name of project on the cover. Deliver to Owner's Representative before request for final acceptance.

1.30 RECORD DRAWINGS

- A. The Contractor shall obtain at his expense one (1) set of Construction Contract Drawings including non-reproducible black and white prints and one (1) set of reproducible mylars for the purpose of recording record conditions.
- B. The Contractor shall perform all survey work required for the location and construction of the work and to record information necessary for completion of the record drawings. Record drawings shall show the actual location of the constructed facilities in the same manner as was shown on the bid drawings. All elevations and dimensions shown on the drawings shall be verified or corrected so as to provide a complete and accurate record of the facilities as constructed.
- C. It shall be the responsibility of the Contractor to mark each sheet of the non-reproducible drawings in pencil and to record thereon in a legible manner, any and all approved field changes and conditions as they occur. A complete file of approved field sketches, diagrams, and other changes shall also be maintained. At completion of the Work, each sheet of record prints, plus all approved field sketches and diagrams, shall be used in preparation of the mylar reproducible record drawings.
- D. Completed reproducible mylar drawings shall be certified as reflecting record conditions and submitted to the Engineer for approval.

1.31 ADDITIONAL ENGINEERING SERVICES

- A. In the event that the Consultant is required to provide additional engineering services as a result of substitution of equivalent materials or equipment by the Contractor or changes by the Contractor in dimension, weight, power requirements, etc., of the equipment and accessories furnished, or if the Consultant is required to examine and evaluate any changes proposed by the Contractor for the convenience of the Contractor, then the Consultant's expenses in connection with such additional services shall be paid by the Contractor and may be deducted from any monies owed to the Contractor.

1.32 FINAL INSPECTION

- A. Upon completion of all punch list items, the Contractor shall provide a copy of the punch list back to the Engineer with each items noted as completed or the current status of the item. Upon receipt, the Engineer will schedule a final inspection.

1.33 ALL TRADES TEMPORARY HEAT

- A. Refer to the Standard General Conditions of the Contract for Construction and Supplementary Conditions.

1.34 PLUMBING TEMPORARY FACILITIES

- A. Refer to the Standard General Conditions of the Contract for Construction and Supplementary Conditions.

1.35 CLEANING

- A. It is the Contractor's responsibility to keep clean all equipment and fixtures provided under this contract for the duration of the project. Each Trade shall keep the premises free from an accumulation of waste material or rubbish caused by his operations. The facilities require an environment of extreme cleanliness, and it is the Contractor's responsibility to adhere to the strict regulations regarding procedures on the existing premises. After all tests are made and installations completed satisfactorily:
- B. Thoroughly clean entire installation, both exposed surfaces and interiors.
- C. Remove all debris caused by work.
- D. Remove tools, surplus, materials, when work is finally accepted.

PART 2 PRODUCT - NOT USED

PART 3 EXECUTION - NOT USED

END OF SECTION

This Page Intentionally Left Blank

**SECTION 22 0516
EXPANSION FITTINGS AND LOOPS FOR PLUMBING PIPING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Flexible pipe connectors.

1.02 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data:
 - 1. Flexible Pipe Connectors: Indicate maximum temperature and pressure rating, face-to-face length, live length, hose wall thickness, hose convolutions per foot and per assembly, fundamental frequency of assembly, braid structure, and total number of wires in braid.
 - 2. Expansion Joints: Indicate maximum temperature and pressure rating, and maximum expansion compensation.

PART 2 PRODUCTS

2.01 FLEXIBLE PIPE CONNECTORS - STEEL PIPING

- A. Inner Hose: Carbon steel.
- B. Exterior Sleeve: Single braided, stainless steel.
- C. Pressure Rating: 125 psi and 450 degrees F.
- D. Joint: Flanged.
- E. Size: Use pipe sized units.
- F. Maximum offset: 3/4 inch on each side of installed center line.

2.02 FLEXIBLE PIPE CONNECTORS - COPPER PIPING

- A. Inner Hose: Bronze.
- B. Exterior Sleeve: Braided bronze.
- C. Pressure Rating: 125 psi and 450 degrees F.
- D. Joint: Flanged.
- E. Size: Use pipe sized units.
- F. Maximum offset: 3/4 inch on each side of installed center line.
- G. Application: Copper piping.

2.03 ACCESSORIES

- A. Pipe Alignment Guides:
 - 1. Two piece welded steel with enamel paint, bolted, with spider to fit standard pipe, frame with four mounting holes, clearance for minimum 1 inch thick insulation, minimum 3 inches travel.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Anchor pipe to building structure where indicated. Provide pipe guides so movement is directed along axis of pipe only. Erect piping such that strain and weight is not on cast connections or apparatus.
- C. Provide support and equipment required to control expansion and contraction of piping. Provide loops, pipe offsets, and swing joints, or expansion joints where required.

- D. Substitute grooved piping for vibration isolated equipment instead of flexible connectors.
Grooved piping need not be anchored.

END OF SECTION

**SECTION 22 0517
SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Pipe sleeves.
- B. Manufactured sleeve-seal systems.

1.02 REFERENCE STANDARDS

- A. ASTM E814 - Standard Test Method for Fire Tests of Penetration Firestop Systems 2013a (Reapproved 2017).

1.03 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 6000 - Product Requirements, for additional provisions.

1.04 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

1.05 WARRANTY

- A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.

PART 2 PRODUCTS

2.01 PIPE SLEEVES

- A. Vertical Piping:
 - 1. Sleeve Length: 1 inch above finished floor.
 - 2. Provide sealant for watertight joint.
 - 3. Blocked Out Floor Openings: Provide 1-1/2 inch angle set in silicon adhesive around opening.
 - 4. Drilled Penetrations: Provide 1-1/2 inch angle ring or square set in silicone adhesive around penetration.
- B. Pipe Passing Through Below Grade Exterior Walls:
 - 1. Zinc coated or cast iron pipe.
 - 2. Provide watertight space with link rubber or modular seal between sleeve and pipe on both pipe ends.
- C. Pipe Passing Through Mechanical, Laundry, and Animal Room Floors above Basement:
 - 1. Galvanized steel pipe or black iron pipe with asphalt coating.
 - 2. Connect sleeve with floor plate except in mechanical rooms.
- D. Clearances:
 - 1. Provide allowance for insulated piping.
 - 2. Wall, Floor, Floor, Partitions, and Beam Flanges: 1 inch greater than external; pipe diameter.
 - 3. All Rated Openings: Caulked tight with fire stopping material complying with ASTM E814 in accordance with Section 07 8400 to prevent the spread of fire, smoke, and gases.

2.02 MANUFACTURED SLEEVE-SEAL SYSTEMS

- A. Modular/Mechanical Seal:
 - 1. Synthetic rubber interlocking links continuously fill annular space between pipe and wall/casing opening.
 - 2. Provide watertight seal between pipe and wall/casing opening.
 - 3. Elastomer element size and material in accordance with manufacturer's recommendations.

4. Glass reinforced plastic pressure end plates.

PART 3 EXECUTION

3.01 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Remove scale and foreign material, from inside and outside, before assembly.

3.02 INSTALLATION

- A. Route piping in orderly manner, plumb and parallel to building structure. Maintain gradient.
- B. Install piping to conserve building space, to not interfere with use of space and other work.
- C. Install piping and pipe sleeves to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- D. Provide sleeves when penetrating footings, floors, walls, and partitions. Seal pipe including sleeve penetrations to achieve fire resistance equivalent to fire separation required.
- E. Manufactured Sleeve-Seal Systems:
 1. Install manufactured sleeve-seal systems in sleeves located in grade slabs and exterior concrete walls at piping entrances into building.
 2. Provide sealing elements of the size, quantity, and type required for the piping and sleeve inner diameter or penetration diameter.
 3. Locate piping in center of sleeve or penetration.
 4. Install field assembled sleeve-seal system components in annular space between sleeve and piping.
 5. Tighten bolting for a water-tight seal.
 6. Install in accordance with manufacturer's recommendations.
- F. When installing more than one piping system material, ensure system components are compatible and joined to ensure the integrity of the system. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.

END OF SECTION

**SECTION 22 0519
METERS AND GAUGES FOR PLUMBING PIPING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Pressure gauges and pressure gauge taps.
- B. Thermometers and thermometer wells.
- C. Static pressure gauges.

1.02 REFERENCE STANDARDS

- A. ASME B40.100 - Pressure Gauges and Gauge Attachments 2013.
- B. ASTM E1 - Standard Specification for ASTM Liquid-in-Glass Thermometers 2014 (Reapproved 2020).
- C. ASTM E77 - Standard Test Method for Inspection and Verification of Thermometers 2014 (Reapproved 2021).
- D. UL 393 - Indicating Pressure Gauges for Fire-Protection Service Current Edition, Including All Revisions.

1.03 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide list that indicates use, operating range, total range and location for manufactured components.

PART 2 PRODUCTS

2.01 PRESSURE GAUGES

- A. Pressure Gauges: ASME B40.100, UL 393 drawn steel case, phosphor bronze bourdon tube, rotary brass movement, brass socket, with front recalibration adjustment, black scale on white background.
 - 1. Case: Steel with brass bourdon tube.
 - 2. Size: 4-1/2 inch diameter.
 - 3. Mid-Scale Accuracy: One percent.
 - 4. Scale: Psi and kPa.

2.02 PRESSURE GAUGE TAPPINGS

- A. Gauge Cock: Tee or lever handle, brass for maximum 150 psi.

2.03 STEM TYPE THERMOMETERS

- A. Thermometers - Adjustable Angle: Red- or blue-appearing non-toxic liquid in glass; ASTM E1; lens front tube, cast aluminum case with enamel finish, cast aluminum adjustable joint with positive locking device; adjustable 360 degrees in horizontal plane, 180 degrees in vertical plane.
 - 1. Size: 9 inch scale.
 - 2. Window: Clear Lexan.
 - 3. Accuracy: 2 percent, per ASTM E77.
 - 4. Calibration: Degrees F.

2.04 STATIC PRESSURE GAUGES

- A. 3-1/2 inch diameter dial in metal case, diaphragm actuated, black figures on white background, front recalibration adjustment, 2 percent of full scale accuracy.
- B. Accessories: Static pressure tips with compression fittings for bulkhead mounting, 1/4 inch diameter tubing.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Provide one pressure gauge per pump, installing taps before strainers and on suction and discharge of pump. Pipe to gauge.
- C. Install thermometers in piping systems in sockets in short couplings. Enlarge pipes smaller than 2-1/2 inch for installation of thermometer sockets. Ensure sockets allow clearance from insulation.

END OF SECTION

**SECTION 22 0523
GENERAL-DUTY VALVES FOR PLUMBING PIPING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Applications.
- B. Ball valves.
- C. Butterfly valves.
- D. Check valves.
- E. Globe valves.

1.02 REFERENCE STANDARDS

- A. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250 2020.
- B. ASME B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard 2020.
- C. ASME B16.10 - Face-to-Face and End-to-End Dimensions of Valves 2017.
- D. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings 2018.
- E. ASME B16.34 - Valves — Flanged, Threaded, and Welding End 2020.
- F. ASME B31.9 - Building Services Piping 2020.
- G. ASTM A126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings 2004 (Reapproved 2019).
- H. ASTM A536 - Standard Specification for Ductile Iron Castings 1984 (Reapproved 2019)e1.
- I. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings 2017.
- J. AWWA C606 - Grooved and Shouldered Joints 2015.
- K. MSS SP-67 - Butterfly Valves 2017, with Errata.
- L. MSS SP-71 - Gray Iron Swing Check Valves, Flanged and Threaded Ends 2018.
- M. MSS SP-72 - Ball Valves with Flanged or Butt-Welding Ends for General Service 2010a.
- N. MSS SP-80 - Bronze Gate, Globe, Angle, and Check Valves 2019.
- O. MSS SP-85 - Gray Iron Globe and Angle Valves, Flanged and Threaded Ends 2011.
- P. MSS SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends 2010, with Errata .
- Q. NSF 61 - Drinking Water System Components - Health Effects 2020.
- R. NSF 372 - Drinking Water System Components - Lead Content 2020.

1.03 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on valves including manufacturers catalog information. Submit performance ratings, rough-in details, weights, support requirements, and piping connections.

PART 2 PRODUCTS

2.01 APPLICATIONS

- A. Provide the following valves for the applications if not indicated on drawings:
 - 1. Shutoff: Ball, butterfly, plug.
 - 2. Throttling: Provide globe, angle, ball, or butterfly.
- B. Domestic, Hot and Cold Water Valves:
 - 1. 2 NPS and Smaller:
 - a. Bronze and Brass: Provide with solder-joint ends.

- b. Ball: One piece, full port, brass with brass trim.
 - c. Bronze Swing Check: Class 125, bronze disc.
 - d. Bronze Globe: Class 125, bronze disc.
- 2. 2-1/2 NPS and Larger:
 - a. Iron, 2-1/2 NPS to 4 NPS: Provide with threaded ends.
 - b. Iron Ball: Class 150.
 - c. Iron Single-Flange Butterfly: 200 CWP, EPDM seat, aluminum-bronze disc.
 - d. Iron Grooved-End Butterfly: 175 CWP.
 - e. Iron Swing Check: Class 125, metal seats.
 - f. Iron Grooved-End Swing Check: 300 CWP.
 - g. Iron Globe: Class 125.

2.02 GENERAL REQUIREMENTS

- A. Valve Pressure and Temperature Ratings: No less than rating indicated; as required for system pressures and temperatures.
- B. Valve Sizes: Match upstream piping unless otherwise indicated.
- C. Valve Actuator Types:
 - 1. Hand Lever: Quarter-turn valves 6 NPS and smaller except plug valves.
- D. Valve-End Connections:
 - 1. Flanges on Iron Valves: ASME B16.1 for flanges on iron valves.
 - 2. Pipe Flanges and Flanged Fittings 1/2 NPS through 24 NPS: ASME B16.5.
 - 3. Solder Joint Connections: ASME B16.18.
 - 4. Grooved End Connections: AWWA C606.
- E. General ASME Compliance:
 - 1. Ferrous Valve Dimensions and Design Criteria: ASME B16.10 and ASME B16.34.
 - 2. Solder-joint Connections: ASME B16.18.
 - 3. Building Services Piping Valves: ASME B31.9.
- F. Potable Water Use:
 - 1. Certified: Approved for use in compliance with NSF 61 and NSF 372.
 - 2. Lead-Free Certified: Wetted surface material includes less than 0.25 percent lead content.

2.03 BRASS, BALL VALVES

- A. Two Piece, Full Port with Brass Trim and Soldered Connections:
 - 1. Comply with MSS SP-110.
 - 2. SWP Rating: 150 psig.
 - 3. CWP Rating: 600 psig, WOG.
 - 4. Body: Forged brass.
 - 5. Seats: PTFE.
 - 6. Ball: Chrome-plated brass.
- B. Two Piece, Full Port with Press Connection:
 - 1. CWP Rating: 250 psig, WOG.
 - 2. Body: Forged brass.
 - 3. Seats: EPDM.
 - 4. Ball: Chrome-plated brass.
 - 5. Blow-out Proof Stem: Forged brass.
 - 6. Maximum Service Temperature: 250 deg F.

2.04 IRON, BALL VALVES

- A. Class 125, Full Port, Stainless Steel Trim:
 - 1. Comply with MSS SP-72.
 - 2. CWP Rating: 200 psig.

3. Body: ASTM A536 Grade 65-45-12, ductile iron.
4. Ends: Flanged.
5. Seats: PTFE.
6. Operator: Lever, with locking handle.

2.05 IRON, SINGLE FLANGE BUTTERFLY VALVES

- A. Lug Style: Bi-directional dead-end service without use of downstream flange.
 1. Comply with MSS SP-67, Type I.
 2. CWP Rating: 200 psig.
 3. Body: ASTM A126, cast iron or ASTM A536, ductile iron.
 4. Stem: One or two-piece stainless steel.
 5. Seat: EPDM.
 6. Disc: Stainless steel.

2.06 IRON, GROOVED-END BUTTERFLY VALVES

- A. CWP Rating: 175 psig (1200 kPa).
 1. Comply with MSS SP-67, Type I.
 2. Body: Coated ductile iron.
 3. Stem: Two-piece stainless steel.
 4. Disc: Coated ductile iron.
 5. Disc Seal: EPDM.

2.07 BRONZE, SWING CHECK VALVES

- A. General:
 1. Fabricate from dezincification resistant material.
 2. Copper alloys containing more than 15 percent zinc are not permitted.
- B. Class 125 CWP Rating; 200 psig (1,380 kPa) WOG:
 1. Comply with MSS SP-80, Type 3.
 2. Design: Y-pattern, horizontal or vertical flow.
 3. Body: Bronze, ASTM B62.
 4. Ends: Threaded.
 5. Disc: Bronze.

2.08 IRON, HORIZONTAL SWING CHECK VALVES

- A. Class 125:
 1. Comply with MSS SP-71, Type I.
 2. CWP Rating: 200 psig.
 3. Design: Clear or full waterway.
 4. Body: ASTM A126, gray cast iron with bolted bonnet.
 5. Ends: Flanged.
 6. Trim: Composition.
 7. Seat Ring and Disc Holder: Bronze.
 8. Disc: PTFE.
 9. Gasket: Asbestos free.

2.09 IRON, GROOVED-END SWING CHECK VALVES

- A. 300 CWP:
 1. CWP Rating: 300 psig.
 2. Body: ASTM A536, Grade 65-45-12 ductile iron.
 3. Seal: EPDM.
 4. Disc: Ductile iron.
 5. Coating: Black, non-lead paint.

2.10 BRONZE, GLOBE VALVES

- A. General:

1. Fabricate from dezincification resistant material.
 2. Copper alloys containing more than 15 percent zinc are not permitted.
- B. Class 125: CWP Rating 200 psig:
1. Comply with MSS SP-80, Type 1.
 2. Body: ASTM B62, bronze with integral seat and screw-in bonnet.
 3. Ends: Threaded joint.
 4. Stem: Bronze.
 5. Disc: PTFE.
 6. Packing: Asbestos free.
 7. Handwheel: Malleable Iron.

2.11 IRON, GLOBE VALVES

- A. Class 125: CWP Rating: 200 psig:
1. Comply with MSS SP-85, Type I.
 2. Body: Gray iron; ASTM A126, with bolted bonnet.
 3. Ends: Flanged.
 4. Trim: Bronze.
 5. Packing and Gasket: Asbestos free.
 6. Operator: Handwheel or chainwheel.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Provide unions or flanges with valves to facilitate equipment removal and maintenance while maintaining system operation and full accessibility for servicing.
- B. Provide separate valve support as required and locate valve with stem at or above center of piping, maintaining unimpeded stem movement.

END OF SECTION

**SECTION 22 0529
HANGERS AND SUPPORTS FOR PLUMBING PIPING AND EQUIPMENT**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Support and attachment components for equipment, piping, and other plumbing work.

1.02 REFERENCE STANDARDS

- A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products 2017.
- B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware 2016a.
- C. ASTM A181/A181M - Standard Specification for Carbon Steel Forgings, for General - Purpose Piping 2014 (Reapproved 2020).
- D. ASTM A36/A36M - Standard Specification for Carbon Structural Steel 2019.
- E. ASTM A47/A47M - Standard Specification for Ferritic Malleable Iron Castings 1999, with Editorial Revision (2018).
- F. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel 2019.
- G. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2021a.
- H. MFMA-4 - Metal Framing Standards Publication 2004.
- I. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials Current Edition, Including All Revisions.

1.03 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for metal channel (strut) framing systems, nonpenetrating rooftop supports, post-installed concrete and masonry anchors, and thermal insulated pipe supports.

1.04 QUALITY ASSURANCE

- A. Comply with applicable building code.

PART 2 PRODUCTS

2.01 SUPPORT AND ATTACHMENT COMPONENTS

- A. General Requirements:
 - 1. Provide all required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for the complete installation of plumbing work.
 - 2. Provide products listed, classified, and labeled as suitable for the purpose intended, where applicable.
 - 3. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for the load to be supported with a minimum safety factor of [____]. Include consideration for vibration, equipment operation, and shock loads where applicable.
 - 4. Steel Components: Use corrosion resistant materials suitable for the environment where installed.
 - a. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.
 - b. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.
- B. Metal Channel (Strut) Framing Systems:
 - 1. Comply with MFMA-4.

- C. Hanger Rods: Threaded zinc-plated steel unless otherwise indicated.
 - 1. Minimum Size, Unless Otherwise Indicated or Required:
 - a. Piping up to 1 inch (27 mm) nominal: 3/8 inch diameter.
 - b. Piping larger than 1 inch (27 mm) nominal: 3/8 inch diameter.
- D. Pipe Stanchions: For pipe runs, use stanchions of same type and material where vertical adjustment is required for stationary pipe.
 - 1. Material: Malleable iron, ASTM A47/A47M; or carbon steel, ASTM A36/A36M.
 - 2. Provide coated or plated saddles to isolate steel hangers from dissimilar metal tube or pipe.
- E. Beam Clamps: MSS SP-58 Types 19 through 23, 25 or 27 through 30 based on required load.
 - 1. Material: ASTM A36/A36M carbon steel or ASTM A181/A181M forged steel.
 - 2. Provide clamps with hardened steel cup-point set screws and lock-nuts for anchoring in place.
- F. Riser Clamps:
 - 1. Provide copper plated clamps for copper tubing support.
 - 2. For insulated pipe runs, provide two bolt-type clamps designed for installation under insulation.
- G. Pipe Hangers: For a given pipe run, use hangers of the same type and material.
 - 1. Material: Malleable iron, ASTM A47/A47M; or carbon steel, ASTM A36/A36M.
 - 2. Provide coated or plated hangers to isolate steel hangers from dissimilar metal tube or pipe.
- H. Pipe Shields for Insulated Piping:
 - 1. General Construction and Requirements:
 - a. Surface Burning Characteristics: Comply with ASTM E84 or UL 723.
 - b. Shields Material: UV-resistant polypropylene with glass fill.
 - c. Maximum Insulated Pipe Outer Diameter: 12-5/8 inch.
 - d. Minimum Service Temperature: Minus 40 degrees F.
 - e. Maximum Service Temperature: 178 degrees F.
 - f. Pipe shields to be provided at hanger, support, and guide locations on pipe requiring insulation or additional support.
- I. Anchors and Fasteners:
 - 1. Unless otherwise indicated and where not otherwise restricted, use the anchor and fastener types indicated for the specified applications.
 - 2. Concrete: Use preset concrete inserts, expansion anchors, or screw anchors.
 - 3. Solid or Grout-Filled Masonry: Use expansion anchors or screw anchors.
 - 4. Hollow Masonry: Use toggle bolts.
 - 5. Hollow Stud Walls: Use toggle bolts.
 - 6. Steel: Use beam clamps, machine bolts, or welded threaded studs.
 - 7. Sheet Metal: Use sheet metal screws.
 - 8. Wood: Use wood screws.
 - 9. Plastic and lead anchors are not permitted.
 - 10. Preset Concrete Inserts: Continuous metal channel (strut) and spot inserts specifically designed to be cast in concrete ceilings, walls, and floors.
 - a. Comply with MFMA-4.
 - b. Channel Material: Use galvanized steel.
 - c. Manufacturer: Same as manufacturer of metal channel (strut) framing system.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.

- B. Provide independent support from building structure. Do not provide support from piping, ductwork, conduit, or other systems.
- C. Unless specifically indicated or approved by Architect, do not provide support from suspended ceiling support system or ceiling grid.
- D. Unless specifically indicated or approved by Architect, do not provide support from roof deck.
- E. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.
- F. Equipment Support and Attachment:
 - 1. Use metal fabricated supports or supports assembled from metal channel (strut) to support equipment as required.
 - 2. Use metal channel (strut) secured to studs to support equipment surface-mounted on hollow stud walls when wall strength is not sufficient to resist pull-out.
 - 3. Use metal channel (strut) to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.
 - 4. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.
- G. Preset Concrete Inserts: Use manufacturer-provided closure strips to inhibit concrete seepage during concrete pour.
- H. Secure fasteners according to manufacturer's recommended torque settings.
- I. Remove temporary supports.

END OF SECTION

This Page Intentionally Left Blank

**SECTION 22 0553
IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Nameplates.
- B. Tags.
- C. Pipe markers.
- D. Ceiling tacks.

1.02 REFERENCE STANDARDS

- A. ASME A13.1 - Scheme for the Identification of Piping Systems 2020.

1.03 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Chart and Schedule: Submit valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.
- C. Product Data: Provide manufacturers catalog literature for each product required.

PART 2 PRODUCTS

2.01 IDENTIFICATION APPLICATIONS

- A. Piping: Pipe markers.
- B. Pumps: Nameplates.
- C. Tanks: Nameplates.
- D. Valves: Tags and ceiling tacks where located above lay-in ceiling.

2.02 NAMEPLATES

- A. Description: Laminated three-layer plastic with engraved letters.
 - 1. Letter Color: White.
 - 2. Letter Height: 1/4 inch.
 - 3. Background Color: Black.
 - 4. Plastic: Comply with ASTM D709.

2.03 TAGS

- A. Metal Tags: Brass with stamped letters; tag size minimum 1-1/2 inch diameter with smooth edges.
- B. Valve Tag Chart: Typewritten letter size list in anodized aluminum frame.

2.04 PIPE MARKERS

- A. Comply with ASME A13.1.
- B. Plastic Pipe Markers: Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and identification of fluid being conveyed.
- C. Plastic Tape Pipe Markers: Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings.
- D. Underground Plastic Pipe Markers: Bright colored continuously printed plastic ribbon tape, minimum 6 inches wide by 4 mil thick, manufactured for direct burial service.
- E. Color code as follows:
 - 1. Potable, Cooling, Boiler, Feed, Other Water: Green with white letters.

2.05 CEILING TACKS

- A. Description: Steel with 3/4 inch diameter color coded head.
- B. Color code as follows:
 - 1. Plumbing Valves: Green.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install plastic nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.
- B. Install tags with corrosion resistant chain.
- C. Install plastic pipe markers in accordance with manufacturer's instructions.
- D. Install plastic tape pipe markers complete around pipe in accordance with manufacturer's instructions.
- E. Install underground plastic pipe markers 6 to 8 inches below finished grade, directly above buried pipe.
- F. Locate ceiling tacks to locate valves or dampers above lay-in panel ceilings. Locate in corner of panel closest to equipment.

END OF SECTION

**SECTION 22 0716
PLUMBING EQUIPMENT INSULATION**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Covering.

1.02 REFERENCE STANDARDS

- A. ASTM C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus 2019.
- B. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus 2021.
- C. ASTM C534/C534M - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form 2020a.
- D. ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications 2013 (Reapproved 2019).
- E. ASTM C1410 - Standard Specification for Cellular Melamine Thermal and Sound-Absorbing Insulation 2017.
- F. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2021a.
- G. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials Current Edition, Including All Revisions.

1.03 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide product description, thermal characteristics, list of materials and thickness for equipment scheduled.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Accept materials on site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.
- B. Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original wrapping.

1.05 FIELD CONDITIONS

- A. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.
- B. Maintain temperature during and after installation for minimum period of 24 hours.

PART 2 PRODUCTS

2.01 REGULATORY REQUIREMENTS

- A. Surface Burning Characteristics: Flame spread index/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84 or UL 723.

2.02 CELLULAR MELAMINE

- A. Insulation: Flexible preformed open-cell polymeric foam tubing, slit lengthwise for installation, complying with applicable requirements of ASTM C1410.
 - 1. K Value: ASTM C177; 0.25 at 75 degrees F.
 - 2. Minimum Service Temperature: Minus 40 degrees F.
 - 3. Maximum Service Temperature: 350 degrees F.
 - 4. Density: 0.56 lb/cu ft.

2.03 GLASS FIBER, FLEXIBLE

- A. Insulation: ASTM C553; flexible, noncombustible.

1. K Value: 0.36 at 75 degrees F, when tested in accordance with ASTM C177 or ASTM C518.
 2. Maximum Service Temperature: 450 degrees F.
 3. Maximum Water Vapor Absorption: 5.0 percent by weight.
- B. Vapor Barrier Jacket: Kraft paper reinforced with glass fiber yarn and bonded to aluminized film.
1. Secure with self-sealing longitudinal laps and butt strips.

2.04 FLEXIBLE ELASTOMERIC CELLULAR INSULATION

- A. Insulation: Preformed flexible elastomeric cellular rubber insulation complying with ASTM C534/C534M Grade 1, in sheet form.
1. Minimum Service Temperature: Minus 40 degrees F.
 2. Maximum Service Temperature: 220 degrees F.
 3. Connection: Waterproof vapor barrier adhesive.

2.05 JACKETS

- A. PVC Plastic:
1. Jacket: Sheet material, off-white color.
 - a. Minimum Service Temperature: Minus 40 degrees F.
 - b. Maximum Service Temperature: 150 degrees F.
 - c. Thickness: 10 mil.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install cellular melamine with factory-applied jackets with a manufacturer-approved adhesive along seams, both straight lap joints and circumferential lap joints.
- C. Inserts and Shields:
1. Application: Equipment 1-1/2 inches diameter or larger.
 2. Shields: Galvanized steel between hangers and inserts.
 3. Insert location: Between support shield and equipment and under the finish jacket.
 4. Insert configuration: Minimum 6 inches long, of same thickness and contour as adjoining insulation; may be factory fabricated.
 5. Insert material: Hydrous calcium silicate insulation or other heavy density insulating material suitable for the planned temperature range.
- D. Cover glass fiber insulation with metal mesh and finish with heavy coat of insulating cement.

END OF SECTION

**SECTION 22 0719
PLUMBING PIPING INSULATION**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Piping insulation.
- B. Jackets and accessories.

1.02 RELATED REQUIREMENTS

- A. Section 07 8400 - Firestopping.
- B. Section 22 1005 - Plumbing Piping: Placement of hangers and hanger inserts.

1.03 REFERENCE STANDARDS

- A. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate 2014.
- B. ASTM B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric) 2014.
- C. ASTM C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus 2019.
- D. ASTM C547 - Standard Specification for Mineral Fiber Pipe Insulation 2019.
- E. ASTM C795 - Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel 2008 (Reapproved 2018).
- F. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2021a.
- G. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials 2021.
- H. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials Current Edition, Including All Revisions.

1.04 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.

PART 2 PRODUCTS

2.01 REGULATORY REQUIREMENTS

- A. Surface Burning Characteristics: Flame spread index/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84 or UL 723.

2.02 GLASS FIBER

- A. Insulation: ASTM C547 and ASTM C795; rigid molded, noncombustible, with wicking material to transport condensed water to the outside of the system for evaporation to the atmosphere.
 - 1. K Value: ASTM C177, 0.23 at 75 degrees F.
 - 2. Maximum Service Temperature: 220 degrees F.
 - 3. Maximum Moisture Absorption: 0.2 percent by volume.

2.03 JACKETS

- A. PVC Plastic.
 - 1. Jacket: One piece molded type fitting covers and sheet material, off-white color.
 - a. Minimum Service Temperature: 0 degrees F.
 - b. Maximum Service Temperature: 150 degrees F.
 - c. Moisture Vapor Permeability: 0.002 perm inch, maximum, when tested in accordance with ASTM E96/E96M.
 - d. Thickness: 10 mil.

- e. Connections: Brush on welding adhesive.
- B. Canvas Jacket: UL listed 6 oz/sq yd plain weave cotton fabric treated with dilute fire retardant lagging adhesive.
- C. Aluminum Jacket: ASTM B209 (ASTM B209M) formed aluminum sheet.
 - 1. Thickness: 0.016 inch sheet.
 - 2. Finish: Smooth.
 - 3. Joining: Longitudinal slip joints and 2 inch laps.
 - 4. Fittings: 0.016 inch thick die shaped fitting covers with factory attached protective liner.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Exposed Piping: Locate insulation and cover seams in least visible locations.
- C. Insulated pipes conveying fluids below ambient temperature: Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, and expansion joints.
- D. Glass fiber insulated pipes conveying fluids below ambient temperature:
 - 1. Provide vapor barrier jackets, factory-applied or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure sensitive adhesive. Secure with outward clinch expanding staples and vapor barrier mastic.
 - 2. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe. Finish with glass cloth and vapor barrier adhesive or PVC fitting covers.
- E. For hot piping conveying fluids 140 degrees F or less, do not insulate flanges and unions at equipment, but bevel and seal ends of insulation.
- F. Glass fiber insulated pipes conveying fluids above ambient temperature:
 - 1. Provide standard jackets, with or without vapor barrier, factory-applied or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure sensitive adhesive. Secure with outward clinch expanding staples.
 - 2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Finish with glass cloth and adhesive or PVC fitting covers.
- G. Inserts and Shields:
 - 1. Application: Piping 1-1/2 inches diameter or larger.
 - 2. Shields: Galvanized steel between pipe hangers or pipe hanger rolls and inserts.
 - 3. Insert Location: Between support shield and piping and under the finish jacket.
 - 4. Insert Configuration: Minimum 6 inches long, of same thickness and contour as adjoining insulation; may be factory fabricated.
 - 5. Insert Material: Hydrous calcium silicate insulation or other heavy density insulating material suitable for the planned temperature range.
- H. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations. Finish at supports, protrusions, and interruptions. At fire separations, refer to Section 07 8400.
- I. Pipe Exposed in Mechanical Equipment Rooms or Finished Spaces (less than 10 feet above finished floor): Finish with canvas jacket sized for finish painting.
- J. Buried Piping: Provide factory fabricated assembly with inner all-purpose service jacket with self-sealing lap, and asphalt impregnated open mesh glass fabric, with one mil thick aluminum foil sandwiched between three layers of bituminous compound; outer surface faced with a polyester film.
- K. Heat Traced Piping: Insulate fittings, joints, and valves with insulation of like material, thickness, and finish as adjoining pipe. Size large enough to enclose pipe and heat tracer. Cover with aluminum jacket with seams located on bottom side of horizontal piping.

END OF SECTION

**SECTION 22 1005
PLUMBING PIPING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Pipe, pipe fittings, specialties, and connections for piping systems.
 - 1. Sanitary sewer.
 - 2. Domestic water.
 - 3. Storm water.
 - 4. Flanges, unions, and couplings.
 - 5. Pipe hangers and supports.
 - 6. Ball valves.
 - 7. Balancing valves.

1.02 RELATED REQUIREMENTS

- A. Section 08 3100 - Access Doors and Panels.
- B. Section 22 0516 - Expansion Fittings and Loops for Plumbing Piping.

1.03 REFERENCE STANDARDS

- A. ASME B16.3 - Malleable Iron Threaded Fittings: Classes 150 and 300 2016.
- B. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings 2018.
- C. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings 2018.
- D. ASME B31.1 - Power Piping 2020.
- E. ASME BPVC-IX - Boiler and Pressure Vessel Code, Section IX - Qualification Standard for Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing, and Fusing Operators 2021.
- F. ASTM A47/A47M - Standard Specification for Ferritic Malleable Iron Castings 1999, with Editorial Revision (2018).
- G. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless 2020.
- H. ASTM A74 - Standard Specification for Cast Iron Soil Pipe and Fittings 2021.
- I. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service 2019.
- J. ASTM B32 - Standard Specification for Solder Metal 2020.
- K. ASTM B42 - Standard Specification for Seamless Copper Pipe, Standard Sizes 2020.
- L. ASTM B88 - Standard Specification for Seamless Copper Water Tube 2020.
- M. ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric) 2020.
- N. ASTM B813 - Standard Specification for Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube 2016.
- O. ASTM B828 - Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings 2016.
- P. ASTM C564 - Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings 2020a.
- Q. ASTM D2564 - Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems 2020.
- R. ASTM D2665 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Drain, Waste, and Vent Pipe and Fittings 2020.
- S. ASTM D2729 - Standard Specification for Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings 2021.

- T. ASTM D2855 - Standard Practice for the Two-Step (Primer and Solvent Cement) Method of Joining Poly (Vinyl Chloride) (PVC) or Chlorinated Poly (Vinyl Chloride) (CPVC) Pipe and Piping Components with Tapered Sockets 2020.
- U. ASTM D3034 - Standard Specification for Type PSM Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings 2016.
- V. AWWA C105/A21.5 - Polyethylene Encasement for Ductile-Iron Pipe Systems 2018.
- W. AWWA C606 - Grooved and Shouldered Joints 2015.
- X. AWWA C651 - Disinfecting Water Mains 2014, with Addendum (2020).
- Y. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation 2018 (Amendment 2019).
- Z. MSS SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends 2010, with Errata .
- AA. NSF 61 - Drinking Water System Components - Health Effects 2020.
- BB. NSF 372 - Drinking Water System Components - Lead Content 2020.

1.04 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide data on pipe materials, pipe fittings, valves, and accessories. Provide manufacturers catalog information. Indicate valve data and ratings.
- C. Welders' Certificates: Submit certification of welders' compliance with ASME BPVC-IX.
- D. Project Record Documents: Record actual locations of valves.

1.05 QUALITY ASSURANCE

- A. Perform work in accordance with applicable codes.
- B. Valves: Manufacturer's name and pressure rating marked on valve body.
- C. Identify pipe with marking including size, ASTM material classification, ASTM specification, potable water certification, water pressure rating.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- B. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- C. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.07 FIELD CONDITIONS

- A. Do not install underground piping when bedding is wet or frozen.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

- A. Potable Water Supply Systems: Provide piping, pipe fittings, and solder and flux (if used), that comply with NSF 61 and NSF 372 for maximum lead content; label pipe and fittings.

2.02 SANITARY SEWER PIPING, BURIED WITHIN 5 FEET OF BUILDING

- A. Cast Iron Pipe: ASTM A74 extra heavy weight.
 - 1. Fittings: Cast iron.
 - 2. Joints: Hub-and-spigot, CISPI HSN compression type with ASTM C564 neoprene gaskets or lead and oakum.
- B. PVC Pipe: ASTM D2665 or ASTM D3034.
 - 1. Fittings: PVC.
 - 2. Joints: Solvent welded, with ASTM D2564 solvent cement.

2.03 SANITARY SEWER PIPING, ABOVE GRADE

- A. Cast Iron Pipe: ASTM A74, service weight.
 - 1. Fittings: Cast iron.
 - 2. Joint Seals: ASTM C564 neoprene gaskets, or lead and oakum.
- B. PVC Pipe: ASTM D2729.
 - 1. Fittings: PVC.
 - 2. Joints: Solvent welded, with ASTM D2564 solvent cement.

2.04 DOMESTIC WATER PIPING, BURIED WITHIN 5 FEET OF BUILDING

- A. Copper Pipe: ASTM B42, hard drawn.
 - 1. Fittings: ASME B16.18, cast copper alloy or ASME B16.22 wrought copper and bronze.
 - 2. Joints: ASTM B32, alloy Sn95 solder.

2.05 DOMESTIC WATER PIPING, ABOVE GRADE

- A. Copper Tube: ASTM B88 (ASTM B88M), Type L (B), Drawn (H).
 - 1. Fittings: ASME B16.18, cast copper alloy or ASME B16.22, wrought copper and bronze.
 - 2. Joints: ASTM B32, alloy Sn95 solder.
 - 3. Mechanical Press Sealed Fittings: Double-pressed type, NSF 61 and NSF 372 approved or certified, utilizing EPDM, nontoxic, synthetic rubber sealing elements.

2.06 STORM WATER PIPING, BURIED WITHIN 5 FEET OF BUILDING

- A. Cast Iron Pipe: ASTM A74 extra heavy weight.
 - 1. Fittings: Cast iron.
 - 2. Joint Seals: ASTM C564 neoprene gaskets, or lead and oakum.
- B. PVC Pipe: ASTM D2665 or ASTM D3034.
 - 1. Fittings: PVC.
 - 2. Joints: Solvent welded, with ASTM D2564 solvent cement.

2.07 STORM WATER PIPING, ABOVE GRADE

- A. Cast Iron Pipe: ASTM A74 extra heavy weight.
 - 1. Fittings: Cast iron.
 - 2. Joint Seals: ASTM C564 neoprene gaskets, or lead and oakum.
- B. PVC Pipe: ASTM D2665 or ASTM D3034.
 - 1. Fittings: PVC.
 - 2. Joints: Solvent welded, with ASTM D2564 solvent cement.

2.08 NATURAL GAS PIPING, BURIED WITHIN 5 FEET OF BUILDING

- A. Steel Pipe: ASTM A53/A53M Schedule 40 black.
 - 1. Fittings: ASTM A234/A234M, wrought steel welding type.
 - 2. Joints: ASME B31.1, welded.
 - 3. Jacket: AWWA C105/A21.5 polyethylene jacket or double layer, half-lapped 10 mil polyethylene tape.

2.09 NATURAL GAS PIPING, ABOVE GRADE

- A. Steel Pipe: ASTM A53/A53M Schedule 40 black.
 - 1. Fittings: ASME B16.3, malleable iron, or ASTM A234/A234M, wrought steel welding type.
 - 2. Joints: Threaded or welded to ASME B31.1.

2.10 FLANGES, UNIONS, AND COUPLINGS

- A. Unions for Pipe Sizes 3 inch and Under:
 - 1. Ferrous Pipe: Class 150 malleable iron threaded unions.
 - 2. Copper Tube and Pipe: Class 150 bronze unions with soldered joints.
- B. Mechanical Couplings for Grooved and Shouldered Joints: Two or more curved housing segments with continuous key to engage pipe groove, circular C-profile gasket, and bolts to secure and compress gasket.

1. Dimensions and Testing: In accordance with AWWA C606.
2. Housing Material: Provide ASTM A47/A47M malleable iron or ductile iron.
3. Gasket Material: EPDM suitable for operating temperature range from minus 30 degrees F to 230 degrees F.
4. Bolts and Nuts: Hot dipped galvanized or zinc-electroplated steel.
5. When pipe is field grooved, provide coupling manufacturer's grooving tools.

2.11 PIPE HANGERS AND SUPPORTS

- A. Provide hangers and supports that comply with MSS SP-58.
 1. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.
 2. Overhead Supports: Individual steel rod hangers attached to structure or to trapeze hangers.
 3. Trapeze Hangers: Welded steel channel frames attached to structure.
 4. Vertical Pipe Support: Steel riser clamp.
- B. Plumbing Piping - Drain, Waste, and Vent:
 1. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Malleable iron, adjustable swivel, split ring.
 2. Hangers for Pipe Sizes 2 inch and Over: Carbon steel, adjustable, clevis.
 3. Wall Support for Pipe Sizes to 3 inch: Cast iron hook.
 4. Wall Support for Pipe Sizes 4 inch and Over: Welded steel bracket and wrought steel clamp.
- C. Plumbing Piping - Water:
 1. Hangers for Pipe Sizes 1/2 to 1-1/2 inch: Malleable iron, adjustable swivel, split ring.
 2. Hangers for Cold Pipe Sizes 2 inch and Over: Carbon steel, adjustable, clevis.
 3. Hangers for Hot Pipe Sizes 2 to 4 inch: Carbon steel, adjustable, clevis.

2.12 BALL VALVES

- A. Construction, 4 inch and Smaller: MSS SP-110, Class 150, 400 psi CWP, bronze body, 304 stainless steel or chrome plated brass ball, regular port, teflon seats and stuffing box ring, blow-out proof stem, lever handle with balancing stops, threaded or grooved ends with union.

2.13 BALANCING VALVES

- A. Construction: Class 125, brass or bronze body with union on inlet and outlet, temperature and pressure test plug on inlet and outlet, blowdown/backflush drain.
- B. Automatic Flow Limiting Cartridge with Ball Valve, Size 1/2 to 1 inch:
 1. Class 125, brass or bronze body, stainless steel cartridge, leak-proof stem, threaded or soldered connections with built-in union, dual PT (hot and cold pressure-temperature) test ports for 400 psi, 0.25 to 1.5 gpm WOG service.
- C. Calibration: Control flow within five percent of selected rating, over operating pressure range of 10 times minimum pressure required for control, maximum minimum pressure 3.5 psi.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that excavations are to required grade, dry, and not over-excavated.

3.02 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Remove scale and dirt, on inside and outside, before assembly.
- C. Prepare piping connections to equipment with flanges or unions.

3.03 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Provide non-conducting dielectric connections wherever jointing dissimilar metals.

- C. Route piping in orderly manner and maintain gradient. Route parallel and perpendicular to walls.
- D. Install piping to maintain headroom, conserve space, and not interfere with use of space.
- E. Group piping whenever practical at common elevations.
- F. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. See Section 22 0516.
- G. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings.
- H. Provide access where valves and fittings are not exposed.
 - 1. Coordinate size and location of access doors with Section 08 3100.
- I. Provide support for utility meters in accordance with requirements of utility companies.
- J. Install bell and spigot pipe with bell end upstream.
- K. Copper Pipe and Tube: Make soldered joints in accordance with ASTM B828, using specified solder, and flux meeting ASTM B813; in potable water systems use flux also complying with NSF 61 and NSF 372.
- L. PVC Pipe: Make solvent-welded joints in accordance with ASTM D2855.

3.04 APPLICATION

- A. Install unions downstream of valves and at equipment or apparatus connections.
- B. Install ball valves for shut-off and to isolate equipment, part of systems, or vertical risers.
- C. Install globe valves for throttling, bypass, or manual flow control services.

3.05 TOLERANCES

- A. Drainage Piping: Establish invert elevations within 1/2 inch vertically of location indicated and slope to drain at minimum of 1/8 inch per foot slope.
- B. Water Piping: Slope at minimum of 1/32 inch per foot and arrange to drain at low points.

3.06 DISINFECTION OF DOMESTIC WATER PIPING SYSTEM

- A. Prior to starting work, verify system is complete, flushed, and clean.
- B. Ensure acidity (pH) of water to be treated is between 7.4 and 7.6 by adding alkali (caustic soda or soda ash) or acid (hydrochloric).
- C. Inject disinfectant, free chlorine in liquid, powder, tablet, or gas form throughout system to obtain 50 to 80 mg/L residual.
- D. Bleed water from outlets to ensure distribution and test for disinfectant residual at minimum 15 percent of outlets.
- E. Maintain disinfectant in system for 24 hours.
- F. If final disinfectant residual tests less than 25 mg/L, repeat treatment.
- G. Flush disinfectant from system until residual equal to that of incoming water or 1.0 mg/L.
- H. Take samples no sooner than 24 hours after flushing, from 10 percent of outlets and from water entry, and analyze in accordance with AWWA C651.

3.07 SERVICE CONNECTIONS

- A. Provide new sanitary sewer services. Before commencing work, check invert elevations required for sewer connections, confirm inverts and ensure that these can be properly connected with slope for drainage and cover to avoid freezing.

3.08 SCHEDULES

- A. Pipe Hanger Spacing:
 - 1. Metal Piping:
 - a. Pipe Size: 1/2 inch to 1-1/4 inch:

- 1) Maximum Hanger Spacing: 6.5 ft.
 - 2) Hanger Rod Diameter: 3/8 inches.
 - b. Pipe Size: 1-1/2 inch to 2 inch:
 - 1) Maximum Hanger Spacing: 10 ft.
 - 2) Hanger Rod Diameter: 3/8 inch.
 - c. Pipe Size: 2-1/2 inch to 3 inch:
 - 1) Maximum Hanger Spacing: 10 ft.
 - 2) Hanger Rod Diameter: 1/2 inch.
 - d. Pipe Size: 4 inch to 6 inch:
 - 1) Maximum Hanger Spacing: 10 ft.
 - 2) Hanger Rod Diameter: 5/8 inch.
- 2. Plastic Piping:
 - a. All Sizes:
 - 1) Maximum Hanger Spacing: 6 ft.
 - 2) Hanger Rod Diameter: 3/8 inch.

END OF SECTION

**SECTION 22 1006
PLUMBING PIPING SPECIALTIES**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Drains.
- B. Cleanouts.
- C. Hose bibbs.
- D. Hydrants.
- E. Double check valve assemblies.
- F. Water hammer arrestors.
- G. Exterior penetration accessories.

1.02 REFERENCE STANDARDS

- A. ASME A112.6.3 - Floor and Trench Drains 2019.
- B. ASME A112.6.4 - Roof, Deck, and Balcony Drains 2003 (Reaffirmed 2012).
- C. ASSE 1012 - Performance Requirements for Backflow Preventers with an Intermediate Atmospheric Vent 2021.
- D. NSF 61 - Drinking Water System Components - Health Effects 2020.
- E. NSF 372 - Drinking Water System Components - Lead Content 2020.
- F. PDI-WH 201 - Water Hammer Arresters 2017.

1.03 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide component sizes, rough-in requirements, service sizes, and finishes.

1.04 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with not less than three years documented experience.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

- A. Specialties in Potable Water Supply Systems: Provide products that comply with NSF 61 and NSF 372 for maximum lead content.

2.02 DRAINS

- A. Roof Drains:
 - 1. Assembly: ASME A112.6.4.
 - 2. Body: Lacquered cast iron with sump.
 - 3. Strainer: Removable cast iron dome with vandal proof screws.
 - 4. Manufacturers:
 - a. Jay R. Smith Manufacturing Company: www.jrsmith.com
 - b. MIFAB, Inc: www.mifab.com
 - c. Zurn Industries, LLC; Z100: www.zurn.com
 - d. Substitutions: See Section 01 6000 - Product Requirements.
- B. Linear Drains:
 - 1. Body: Provide PVC, ABS, or stainless-steel with sloped channel to vertical waste pipe.
 - 2. Clamping Ring: Stainless steel mechanism to clamp waterproof membrane to linear drain body.
 - 3. Strainer: Removable brushed stainless steel or tile top strainer furnished by manufacturer.

4. Additional Components: Manufacturer's standard membrane, sealant, fasteners, and anchors.
- C. Floor Drains:
 1. Manufacturers:
 - a. Jay R. Smith Manufacturing Company: www.jrsmith.com
 - b. Zurn Industries, LLC: www.zurn.com
 - c. Watts; Model FD-100-A: www.watts.com.
 - d. Substitutions: See Section 01 6000 - Product Requirements.
- D. Floor Drain (FD-A):
 1. ASME A112.6.3; epoxy coated cast iron floor drain with anchor flange, weep holes, reversible clamping collar, and round, adjustable round heel proof nickel-bronze strainer.
- E. Shower Channel Drain (LS-A): Factory fabricated channel and grate with built in outlet pipe.
 1. Basis of Design: Quick Drain: www.quickdrain.com Model PLD-N.
 2. Channel Edge: Flange edge.
 3. Plumbing Connector Type: Stainless steel.
 4. Channel Length: 34 inches.
 5. Substrate Construction: Concrete slab.
 6. Material: Electropolished stainless steel.
 7. Outlet Pipe: 2 inch diameter.
- F. Floor Sink (FS-A):
 1. Type 304 Stainless Steel sanitary floor sink with loose set cast stainless steel grate, dome bottom strainer and no hub outlet.
 2. Manufacturers:
 - a. Watts: Model FS-780 www.watts.com.
 - b. Substitutions: See Section 01 6000 - Product Requirements.

2.03 CLEANOUTS

- A. Cleanouts at Interior Finished Floor Areas (CO-A):
 1. Lacquered cast iron body with anchor flange, reversible clamping collar, threaded top assembly, and round gasketed scored cover in service areas and round gasketed depressed cover to accept floor finish in finished floor areas.

2.04 INTERIOR HOSE BIBBS

- A. Manufacturers:
 1. Jay R. Smith Manufacturing Company: www.jayrsmith.com/
 2. Watts Company: www.watts.com/
 3. Zurn Industries, LLC; Model Z1330-C: www.zurn.com/
 4. Substitutions: See Section 01 6000 - Product Requirements.
- B. Interior Hose Bibbs (HYD-A):
 1. Anti-siphon, automatic draining, wall hydrant for moderate climate and interior wall installation, complete with integral backflow preventer, all bronze interior parts, non-turning operating coupling with free-floating compression closure valve, and combination 3/4 female solder and 3/4 male pipe threaded inlet connection standard. Regularly furnished with 3/4 hose connection. Chrome-plated rough cast bronze box and hinged cover. Includes operating key.

2.05 EXTERIOR HOSE BIBBS

- A. Manufacturers:
 1. Jay R. Smith Manufacturing Company: www.jayrsmith.com/
 2. Watts Company[<>]: www.watts.com/
 3. Zurn Industries, LLC; Model Z1300: www.zurn.com/
 4. Substitutions: See Section 01 6000 - Product Requirements.
- B. Exterior Hose Bibbs (HYD-B):

1. Encased anti-siphon automatic draining wall hydrant for flush installation. Complete with non-freeze type integral backflow preventer, bronze casing, all bronze interior parts, non-turning operating rod with free-floating compression closure valve, replaceable bronze seat and seat washer, and combination 3/4" female or 1" male straight IP inlet. Nickel bronze box and hinged cover with operating key lock and "WATER" cast on cover.

2.06 DOUBLE CHECK VALVE ASSEMBLIES

- A. Double Check Valve Assembly:
 1. ASSE 1012; cast bronze body with corrosion resistant internal parts and stainless steel springs; two independently operating check valves with intermediate atmospheric vent.
 2. Size: 3/4 to 2 inch, NPS assembly with threaded full port ball valves.

2.07 WATER HAMMER ARRESTORS

- A. Water Hammer Arrestors:
 1. Stainless steel construction, bellows type sized in accordance with PDI-WH 201, precharged suitable for operation in temperature range minus 100 to 300 degrees F and maximum 250 psi working pressure.

2.08 AIR VENTS

- A. Manual Type: Short vertical sections of 2 inch diameter pipe to form air chamber, with 1/8 inch brass needle valve at top of chamber.
- B. Float Type:
 1. Brass or semi-steel body, copper, polypropylene, or solid non-metallic float, stainless steel valve and valve seat; suitable for system operating temperature and pressure; with isolating valve.

2.09 FLOOR DRAIN TRAP SEALS

- A. Manufacturers:
 1. Green Drains; GD4: www.greendrains.com
 2. Substitutions: See Section 01 6000 - Product Requirements.
- B. Description: Push-fit EPDM or silicone fitting with a one-way membrane.

2.10 EXTERIOR PENETRATION ACCESSORIES

- A. Flashing Panels for Exterior Wall Penetrations: Premanufactured components and accessories as required to preserve integrity of building envelope; suitable for conduits and facade materials to be installed.
- B. Sealing Systems for Roof Penetrations: Premanufactured components and accessories as required to preserve integrity of roofing system and maintain roof warranty; suitable for piping, cables, and roofing system to be installed; designed to accommodate existing penetrations where applicable.
- C. Plumbing Ventilation Thru Roof Accessories - Retrofit:
 1. Plumbing Pipe Extension Kit: Extends roof plumbing pipes above minimum clearance from roof surface per local codes and Authority Having Jurisdiction (AHJ).

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Extend cleanouts to finished floor or wall surface. Lubricate threaded cleanout plugs with mixture of graphite and linseed oil. Ensure clearance at cleanout for rodding of drainage system.
- C. Encase exterior cleanouts in concrete flush with grade.
- D. Install floor cleanouts at elevation to accommodate finished floor.
- E. Install approved potable water protection devices on plumbing lines where contamination of domestic water may occur; on boiler feed water lines, janitor rooms, fire sprinkler systems, premise isolation, irrigation systems, flush valves, interior and exterior hose bibbs.

- F. Pipe relief from backflow preventer to nearest drain.
- G. Install water hammer arrestors complete with accessible isolation valve on hot and cold water supply piping to lavatory sinks, washing machine outlets, or water closets.

END OF SECTION

**SECTION 22 3000
PLUMBING EQUIPMENT**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Water Heaters:
 - 1. Commercial electric.
- B. In-line circulator pumps.

1.02 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements for submittals procedures.
- B. Product Data:
 - 1. Provide dimension drawings of water heaters indicating components and connections to other equipment and piping.
 - 2. Indicate pump type, capacity, power requirements.
 - 3. Provide certified pump curves showing pump performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable.
 - 4. Provide electrical characteristics and connection requirements.

1.03 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

PART 2 PRODUCTS

2.01 WATER HEATERS

- A. Manufacturers:
 - 1. A.O. Smith Water Products Co; Model DEN-120: www.hotwater.com/
 - 2. Bock Water Heaters, Inc: www.bockwaterheaters.com/
 - 3. Rheem Manufacturing Company: www.rheem.com/
 - 4. Substitutions: See Section 01 6000 - Product Requirements.
- B. Commercial Electric:
 - 1. Type: Factory-assembled and wired, electric, vertical storage.
 - 2. Performance:
 - a. Storage Capacity: 119 gal.
 - b. Heating Element Size: 9 kW.
 - c. Number of Heating Elements: 2.
 - d. Maximum Working Pressure: 150 psig.
 - 3. Electrical Characteristics:
 - a. 480 volts, single phase, 60 Hz.
 - 4. Tank: Welded steel ASME labeled pressure vessel; glass lining, mounted on steel channel base with lifting lugs, insulated with 2 inch glass fiber; enclosed with 16 gauge, 0.0598 inch steel jacket; baked enamel finish.
 - 5. Controls: Ventilated control cabinet, factory-wired with solid state progressive sequencing step controller, fuses, magnetic contactors, control transformer, pilot lights indicating main power and heating steps, control circuit toggle switch, electronic low-water (probe-type) cut-off, high temperature limit thermostat, flush-mounted temperature and pressure gauges.
 - 6. Heating Elements: Flange-mounted immersion elements; individual elements sheathed with Incoloy corrosion-resistant metal alloy, rated less than 75 W/sq in.

2.02 IN-LINE CIRCULATOR PUMPS

- A. Manufacturers:
 - 1. Armstrong Fluid Technology: www.armstrongfluidtechnology.com/
 - 2. Bell & Gossett, a brand of Xylem, Inc; Model: ecocirc 19-16: www.bellgossett.com/
 - 3. Substitutions: See Section 01 6000 - Product Requirements.

- B. Casing: Bronze, rated for 125 psig working pressure, with stainless steel rotor assembly.
- C. Impeller: Bronze.
- D. Shaft: Alloy steel with integral thrust collar and two oil lubricated bronze sleeve bearings.
- E. Seal: Carbon rotating against a stationary ceramic seat.
- F. Drive: Flexible coupling.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install plumbing equipment in accordance with manufacturer's instructions, as required by code, and complying with conditions of certification, if any.
- B. Coordinate with plumbing piping and related fuel piping work to achieve operating system.
- C. Pumps:
 - 1. Provide line sized isolating valve and strainer on suction and line sized soft seated check valve and balancing valve on discharge.
 - 2. Ensure pumps operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation, and operate within 25 percent of midpoint of published maximum efficiency curve.

END OF SECTION

**SECTION 22 4000
PLUMBING FIXTURES**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Urinals.
- B. Lavatories.
- C. Sinks.
- D. Service sinks.
- E. Mop sinks.
- F. Drinking fountains.
- G. Showers.

1.02 REFERENCE STANDARDS

- A. ASME A112.6.1M - Floor-Affixed Supports for Off-the-Floor Plumbing Fixtures for Public Use 1997 (Reaffirmed 2017).
- B. ASME A112.18.1 - Plumbing Supply Fittings 2018, with Errata.
- C. ASME A112.19.2 - Ceramic Plumbing Fixtures 2018, with Errata.
- D. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2021a.
- E. IAPMO Z124 - Plastic Plumbing Fixtures 2017, with Errata.
- F. NSF 61 - Drinking Water System Components - Health Effects 2020.
- G. NSF 372 - Drinking Water System Components - Lead Content 2020.
- H. UL (DIR) - Online Certifications Directory Current Edition.

1.03 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide catalog illustrations of fixtures, sizes, rough-in dimensions, utility sizes, trim, and finishes.
- C. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Accept fixtures on site in factory packaging. Inspect for damage.
- B. Protect installed fixtures from damage by securing areas and by leaving factory packaging in place to protect fixtures and prevent use.

1.05 WARRANTY

- A. Provide five year manufacturer warranty for electric water cooler.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS

- A. Potable Water Systems: Provide plumbing fittings and faucets that comply with NSF 61 and NSF 372 for maximum lead content; label pipe and fittings.
- B. Water Efficiency: EPA WaterSense label is required for all water closets, urinals, lavatory faucets, and showerheads.

2.02 REGULATORY REQUIREMENTS

- A. Comply with applicable codes for installation of plumbing systems.
- B. Comply with UL (DIR) requirements.

- C. Perform work in accordance with local health department regulations.
- D. Provide certificate of compliance from Authority Having Jurisdiction indicating approval of installation.

2.03 FLUSH VALVE WATER CLOSETS

- A. Water Closets (WC-A (ADA height) and WC-B): Vitreous china, ASME A112.19.2, wall hung, siphon jet flush action, china bolt caps.
 - 1. Flush Valve: Exposed (top spud).
 - 2. Flush Operation: Sensor operated.
 - 3. Color: White.
 - 4. Manufacturers:
 - a. American Standard, Inc; Model 2257.101: www.americanstandard-us.com/
 - b. Kohler Company: www.kohler.com/
 - c. Zurn Industries, Inc: www.zurn.com/
 - d. Substitutions: See Section 01 6000 - Product Requirements.
- B. Water Closets (WC-C): Vitreous china, ASNE A112.19.2, floor mount, siphon jet flush action, china bolt caps.
 - 1. Flush Valve: Exposed (top spud)
 - 2. Flush Operation: Sensor operated
 - 3. Color: White
 - 4. Manufacturers
 - a. American Standard, Inc; Model Baby DeVoro: www.americanstandard-us.com/
 - b. Kohler Company: www.kohler.com/
 - c. Zurn Industries, Inc: www.zurn.com/
 - d. Substitutions: See Section 01 6000 - Product Requirements.
- C. Flush Valves: ASME A112.18.1, piston with debris screen and solenoid with self cleaning mechanism , complete with vacuum breaker stops and accessories.
 - 1. Sensor-Operated Type: Solenoid operator, battery powered, infrared sensor with mechanical over-ride or over-ride push button.
 - 2. Manufacturers:
 - a. Sloan Valve Company: www.sloanvalve.com/
 - b. Zurn Industries, Inc: www.zurn.com/
 - c. Toto; Model TET1LA: www.totousa.com.
 - d. Substitutions: See Section 01 6000 - Product Requirements.
- D. Seats:
 - 1. Manufacturers:
 - a. American Standard, Inc: www.americanstandard-us.com/
 - b. Bemis Manufacturing Company: www.bemismfg.com/
 - c. Church Seat Company; 295CT: www.churchseats.com/
 - d. Substitutions: See Section 01 6000 - Product Requirements.
 - 2. Solid white plastic, open front, extended back, self-sustaining hinge, brass bolts, with cover.
- E. Water Closet Carriers:
 - 1. Manufacturers:
 - a. Jay R. Smith MFG. Co: www.jrsmith.com/
 - b. Zurn Industries, Inc: www.zurn.com/
 - c. Substitutions: See Section 01 6000 - Product Requirements.
 - 2. ASME A112.6.1M; adjustable cast iron frame, integral drain hub and vent, adjustable spud, lugs for floor and wall attachment, threaded fixture studs with nuts and washers.

2.04 WALL HUNG URINALS (UR-A)

- A. Wall Hung Urinal Manufacturers:
 - 1. American Standard, Inc; Model: 6590.001: www.americanstandard-us.com/#sle.

2. Kohler Company: www.kohler.com/
 3. Zurn Industries, Inc: www.zurn.com/
 4. Substitutions: See Section 01 6000 - Product Requirements.
- B. Urinals: Vitreous china, ASME A112.19.2, wall hung with side shields and concealed carrier.
1. Flush Valve: Exposed (top spud).
 2. Flush Operation: Sensor operated.
 3. Trap: Integral.
- C. Flush Valves: ASME A112.18.1, solenoid piston with debris screen , complete with vacuum breaker stops and accessories.
1. Sensor-Operated Type: Solenoid operator, battery powered, infrared sensor with mechanical over-ride or over-ride push button.
 2. Manufacturers:
 - a. American Standard, Inc: www.americanstandard-us.com/
 - b. Sloan Valve Company: www.sloanvalve.com/
 - c. Toto; Model TEU1LA: www.totousa.com/.
 - d. Substitutions: See Section 01 6000 - Product Requirements.
- D. Carriers:
1. Manufacturers:
 - a. Jay R. Smith MFG. Co: www.jrsmith.com/#sle.
 - b. Viega LLC: www.viega.us/#sle.
 - c. Zurn Industries, Inc: www.zurn.com/#sle.
 - d. Substitutions: See Section 01 6000 - Product Requirements.
 2. ASME A112.6.1M; cast iron and steel frame with tubular legs, lugs for floor and wall attachment, threaded fixture studs for fixture hanger, bearing studs.

2.05 LAVATORIES (LAV-B) (ADA)

- A. Lavatory Manufacturers:
1. Bradley; Model LVAD1: www.bradleycorp.com.
 2. Substitutions: See Section 01 6000 - Product Requirements.
- B. Natural quartz surface made from a blend of bio-based resin, 21 by 30 inch single hole.
- C. Supply Faucet Manufacturers:
1. American Standard, Inc: www.americanstandard-us.com/
 2. Zurn Industries, Inc: www.zurn.com/
 3. Toto; Model TEL115i2: www.totousa.com.
 4. Substitutions: See Section 01 6000 - Product Requirements.
- D. Sensor Operated Faucet: Cast brass, chrome plated, deck mounted with sensor located on neck of spout.
1. Spout Style: Standard.
 2. Power Supply: Battery, easily replaceable, lithium, minimum 200,000 cycles. Self-generating hydropowered Ecopower System.
 3. Mixing Valve: Thermostatic Mixing Valve (TLT10R).
 4. Water Supply: 3/8 inch compression connections.
 5. Aerator: 0.5 GPM, laminar flow device.
 6. Sensor range: Automatically adjusts.
 7. Finish: Polished chrome.

2.06 WALL-HUNG MULTI-STATION LAVATORY UNITS - SOLID SURFACE (LAV-A)

- A. Description: Rectilinear, level-surface deck, seamless and integral elongated basin, with stainless steel enclosed pedestal cabinet.
- B. Deck and Bowl Material: Fabricate from molded engineered stone material consisting of natural quartz, granite, and other minerals in a matrix of thermoset acrylic modified bio-based polyester resin and meeting requirements of IAPMO Z124.

- C. Surface Burning Characteristics: Smoke developed index less than 450, and flame spread index less than 25, Class A, when tested in accordance with ASTM E84.
- D. Number of Wash Stations: Two.
- E. Unit Length: 60 inches.
- F. Color: As selected by Architect from manufacturer's full line.
- G. Faucet Drilling: (2x) Single Hole.
- H. Supply Faucet Manufacturers:
 - 1. American Standard, Inc: www.americanstandard-us.com
 - 2. Zurn Industries, Inc: www.zurn.com
 - 3. Toto; Model TEL115i2: www.totousa.com
 - 4. Substitutions: See Section 01 6000 - Product Requirements.
- I. Sensor Operated Faucet: Cast brass, chrome plated, deck mounted with sensor located on neck of spout.
 - 1. Spout Style: Standard
 - 2. Power Supply: Battery, easily replaceable, lithium, minimum 200,000 cycles. Self-generating hydropowered Ecopower System.
 - 3. Mixing Valve: Thermostatic Mixing Valve (TLT10R)
 - 4. Water Supply: 3/8 inch compression connections.
 - 5. Aerator: 0.5 GPM, laminar flow device.
- J. Access Panel: Stainless steel.
- K. Support Frame: Wall mounted, heavy gauge, stainless steel.
- L. Manufacturers:
 - 1. Bradley Corporation; VergeLVAD2: www.bradleycorp.com/
 - 2. Substitutions: See Section 01 6000 - Product Requirements.

2.07 SINKS (SK-A)

- A. Sink Manufacturers:
 - 1. American Standard, Inc: www.americanstandard-us.com/
 - 2. Just Manufacturing Company; Model USN-ADA-1620-A: www.justmfg.com.
 - 3. Substitutions: See Section 01 6000 - Product Requirements.
- B. Single Compartment Bowl: ; 16 by 20 by 5 inch outside dimensions 18 gauge, 0.05 inch thick, Type 304 stainless steel, undermount with Intgra-Drain integral drain system.
- C. Supply Faucet Manufacturers:
 - 1. American Standard, Inc: www.americanstandard-us.com
 - 2. Zurn Industries, Inc: www.zurn.com
 - 3. Toto; Model TEL155: www.totousa.com
 - 4. Substitutions: See Section 01 6000 - Product Requirements.
- D. Sensor Operated Faucet: Cast brass, chrome plated, deck mounted with sensor located on neck of spout.
 - 1. Spout Style: Standard
 - 2. Power Supply: Battery, easily replaceable, lithium, minimum 200,000 cycles. Self-generating hydropowered Ecopower System.
 - 3. Mixing Valve: Thermostatic Mixing Valve (TLT10R)
 - 4. Water Supply: 3/8 inch compression connections.
 - 5. Aerator: 0.5 GPM, laminar flow device.

2.08 SINKS (SK-B)

- A. Sink Manufacturers:
 - 1. American Standard, Inc: www.americanstandard-us.com/
 - 2. Just Manufacturing Company; Model USN-ADA-18558-S-CP: www.justmfg.com.
 - 3. Substitutions: See Section 01 6000 - Product Requirements.

- B. Single Compartment Bowl: ; 18 1/2 by 58 by 5 1/2 inch outside dimensions 16 gauge, 0.0625 inch thick, Type 304 stainless steel, undermount with 3 1/2 drain hole.
 - 1. Drain: 3-1/2 inch crumb cup and tailpiece.
- C. Supply Faucet Manufacturers (3 faucets):
 - 1. American Standard, Inc: www.americanstandard-us.com
 - 2. Zurn Industries, Inc: www.zurn.com
 - 3. Chicago Faucets; Model 786-GN8AE3ABCP: www.chicagofaucets.com
 - 4. Substitutions: See Section 01 6000 - Product Requirements.
- D. Manual Faucet: 8" fixed Centers 8" rigid/swing gooseneck spout, chrome plated, deck mounted, 4" metal vandal-proof wristplate handles.
 - 1. Spout Style: Standard
 - 2. Aerator: 2.2 GPM, laminar flow device.

2.09 SINKS (SK-C)

- A. Sink Manufacturers:
 - 1. American Standard, Inc: www.americanstandard-us.com/
 - 2. Just Manufacturing Company; Model USN-ADA-1620-A: www.justmfg.com.
 - 3. Substitutions: See Section 01 6000 - Product Requirements.
- B. Single Compartment Bowl: ; 16 by 20 by 5 inch outside dimensions 18 gauge, 0.05 inch thick, Type 304 stainless steel, undermount with Intgra-Drain integral drain system.
- C. Supply Faucet Manufacturers:
 - 1. American Standard, Inc: www.americanstandard-us.com
 - 2. Zurn Industries, Inc: www.zurn.com
 - 3. Chicago Faucet CO; Model 786-GN8AE3ABCP: www.chicagofaucets.com
 - 4. Substitutions: See Section 01 6000 - Product Requirements.
- D. Manual Faucet: 8" fixed Centers 8" rigid/swing gooseneck spout, chrome plated, deck mounted, 4" metal vandal-proof wristplate handles.
 - 1. Spout Style: Standard
 - 2. Aerator: 2.2 GPM, laminar flow device.

2.10 SHOWERS (SH-B)

- A. Shower Manufacturers:
 - 1. American Standard, Inc: www.americanstandard-us.com/
 - 2. Kohler Company: www.kohler.com/
 - 3. Bradley; Model HN250: www.bradleycorp.com
 - 4. Substitutions: See Section 01 6000 - Product Requirements.
- B. Shower Panel: Constructed of 16 gauge stainless steel.
- C. Shower Head:
 - 1. Standard fixed direction adjustable sprayhead.
- D. Diverter Valve:
 - 1. Lever handle operation for easy transfer of water flow between fixed and hand-held shower spray.
- E. Hand Shower:
 - 1. Consisting of hand shower with on-off control, a 60" stainless steel flexible hose and post style mounting bracket to hold to shower panel. Elevated in-line backflow preventer with quick -disconnect for flexible hose.
- F. ADA compliant
- G. Flow Control:
 - 1. A 1.5 GPM flow control.

2.11 DRINKING FOUNTAINS - BOTTLE FILLERS (EWC-A)

- A. Manufacturers:

1. Elkay Manufacturing Company; Model LZSTL8WSSK: www.elkay.com/
 2. Substitutions: See Section 01 6000 - Product Requirements.
- B. Bottle Filling Station and Versatile Bi-Level ADA Cooler, Filtered Refrigerated Stainless. Chilling Capacity of 8.0 GPH (gallons per hour) of 50F drinking water, based on 80 F inlet water and 90 F ambient, per ASHRAE 18 testing. Features shall include Hands Free, Visual Filter Monitor, Filtered, Green Ticker™, Laminar Flow, Antimicrobial, Real Drain. Furnished with Flexi-Guard® Safety Bubbler. Electronic Bottle Filler Sensor With Electronic Front And Side Bubbler Pushbar activation. Product shall be Wall Mount, for Indoor applications, serving 2 station(s). Unit shall be certified to UL 399 and CAN/CSA C22.2 No. 120. Unit shall be lead-free design which is certified to NSF/ANSI 61 & 372 (lead free) and meets Federal and State low-lead requirements.

2.12 MOP SINKS (MS-A)

- A. Mop Sink Manufacturers:
1. Acorn Engineering Company: www.acorneng.com/
 2. Just Manufacturing Company: www.justmfg.com/
 3. Stern Williams; Model HL-2100: www.sternwilliams.com.
 4. Substitutions: See Section 01 6000 - Product Requirements.
- B. Material: composed of pearl gray marble chips and white Portland cement ground smooth, grouted and sealed to resist stains.
- C. Type: Rectilinear.
- D. Grid Strainer: Stainless steel; integral; removable.
- E. Dimensions: 36"x24"x12".
- F. Supply Faucet Manufacturers:
1. American Standard, Inc: www.americanstandard-us.com
 2. Zurn Industries, Inc; Model Z843M1: www.zurn.com
 3. Chicago Faucet CO: www.chicagofaucets.com
 4. Substitutions: See Section 01 6000 - Product Requirements.
- G. Manual Faucet: 8" Vacuum Breaker Spout with 3/4" Threaded Outlet, Brace and Pail Hook, 2 1/2" metal vandal-resistant color coded lever handles.
- H. Accessories:
1. 5 feet of 1/2 inch diameter plain end reinforced plastic hose.
 2. Hose clamp hanger.
 3. Mop hanger.

2.13 SERVICE SINKS (SK-D)

- A. Service Sink Manufacturers:
1. Acorn Engineering Company: www.americanstandard-us.com/#sle.
 2. Just Manufacturing Company: www.justmfg.com/
 3. Regency Tables and Sinks; Model 600S13624B: www.regencytablesandsinks.com.
 4. Substitutions: See Section 01 6000 - Product Requirements.
- B. Bowl: 36 by 24 by 13 inch high 16-gauge type stainless steel, floor mounted, with 1 1/2 inch wide shoulders, stainless steel strainer.
- C. Trim: ASME A112.18.1 exposed wall type supply with lever handles, spout wall brace, vacuum breaker, hose end spout, strainers, eccentric adjustable inlets, integral screwdriver stops with covering caps and adjustable threaded wall flanges.
- D. Supply Faucet Manufacturers:
1. American Standard, Inc: www.americanstandard-us.com
 2. Zurn Industries, Inc; Model Z842J4-XL: www.zurn.com
 3. Chicago Faucet CO: www.chicagofaucets.com
 4. Substitutions: See Section 01 6000 - Product Requirements.

- E. Manual Faucet: 8" fixed Centers 8" rigid/swing gooseneck spout, chrome plated, wall mounted, 4" metal vandal-proof wristplade handles.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that walls and floor finishes are prepared and ready for installation of fixtures.
- B. Confirm that millwork is constructed with adequate provision for the installation of counter top lavatories and sinks.

3.02 PREPARATION

- A. Rough-in fixture piping connections in accordance with minimum sizes indicated in fixture rough-in schedule for particular fixtures.

3.03 INSTALLATION

- A. Install each fixture with trap, easily removable for servicing and cleaning.
- B. Provide chrome plated rigid or flexible supplies to fixtures with loose key stops, reducers, and escutcheons.
- C. Install components level and plumb.
- D. Install and secure fixtures in place with wall supports and bolts.

3.04 INTERFACE WITH WORK OF OTHER SECTIONS

- A. Review millwork shop drawings. Confirm location and size of fixtures and openings before rough-in and installation.

3.05 ADJUSTING

- A. Adjust stops or valves for intended water flow rate to fixtures without splashing, noise, or overflow.

3.06 CLEANING

- A. Clean plumbing fixtures and equipment.

3.07 PROTECTION

- A. Protect installed products from damage due to subsequent construction operations.
- B. Repair or replace damaged products before Date of Substantial Completion.

3.08 SCHEDULES

- A. Fixture Heights: Install fixtures to heights above finished floor as indicated.
 - 1. Water Closet:
 - a. Standard: 15 inches to top of bowl rim.
 - b. Accessible: 18 inches to top of seat.
 - 2. Water Closet Flush Valves:
 - a. Standard: 11 inches min. above bowl rim.
 - 3. Urinal:
 - a. Accessible: 17 inches to top of bowl rim.
 - 4. Lavatory:
 - a. Standard: 31 inches to top of basin rim.
 - b. Accessible: 34 inches to top of basin rim.
 - 5. Drinking Fountain:
 - a. Standard Adult: 40 inches to top of basin rim.
 - b. Accessible: 36 inches to top of spout.
 - 6. Shower Heads:
 - a. Adult Male: 69.5 inches to bottom of head.
 - b. Adult Female: 64.5 inches to bottom of head.
- B. Fixture Rough-In
 - 1. Water Closet (Flush Valve Type):

- a. Cold Water: 1 Inch.
- b. Waste: 4 Inch.
- c. Vent: 2 Inch.
- 2. Urinal (Flush Valve Type):
 - a. Cold Water: 3/4 Inch.
 - b. Waste: 2 Inch.
 - c. Vent: 1-1/2 Inch.
- 3. Lavatory:
 - a. Hot Water: 1/2 Inch.
 - b. Cold Water: 1/2 Inch.
 - c. Waste: 1-1/2 Inch.
 - d. Vent: 1-1/4 Inch.
- 4. Sink:
 - a. Hot Water: 1/2 Inch.
 - b. Cold Water: 1/2 Inch.
 - c. Waste: 1-1/2 Inch.
 - d. Vent: 1-1/4 Inch.
- 5. Service Sink:
 - a. Hot Water: 1/2 Inch.
 - b. Cold Water: 1/2 Inch.
 - c. Waste: 2 Inch.
 - d. Vent: 1-1/2 Inch.
- 6. Mop Sink:
 - a. Hot Water: 3/4 Inch.
 - b. Cold Water: 3/4 inch.
 - c. Waste: 3 Inch.
 - d. Vent: 1-1/2 Inch.
- 7. Drinking Fountain:
 - a. Cold Water: 1/2 Inch.
 - b. Waste: 1-1/4 Inch.
 - c. Vent: 1-1/4 Inch.
- 8. Shower:
 - a. Hot Water: 1/2 Inch.
 - b. Cold Water: 1/2 Inch.
 - c. Waste: 2 inch.
 - d. Vent: 1-1/4 Inch.

END OF SECTION

SECTION 23 0510
BASIC MECHANICAL REQUIREMENTS

PART 1 GENERAL

1.01 WORK INCLUDED

- A. Provide all labor, tools, materials, accessories, parts, transportation, taxes, and related items, essential for installation of the work and necessary to make work complete and operational. Provide new equipment and material unless otherwise called for. References to codes, specifications, and standards called for in the specification sections and on the drawings mean the latest edition, amendment, and revision of such referenced standard in effect on the date of these contract documents.

1.02 LICENSING

- A. The Contractor shall hold a license to perform the work as issued by the local jurisdiction.
- B. The Contractor shall be responsible for reviewing the local jurisdiction requirements prior to bidding.

1.03 PERMITS

- A. Apply for and obtain all required permits and inspections, pay all fees and charges including all service charges.

1.04 CODE COMPLIANCE

- A. Provide work in compliance with the following:
 - 1. The Building Code of New York State including The Fire Code; Property Maintenance Code; Plumbing Code, Mechanical Code and Fuel Gas Code; and The Energy Code of New York.
 - 2. New York State Department of Labor Rules and Regulations.
 - 3. Occupational Safety and Health Administration (OSHA).
 - 4. National Fuel Gas Code, NFPA 54.
 - 5. National Electrical Code, NFPA 70.
 - 6. Local Codes and Ordinances.
 - 7. Life Safety Codes, NFPA 101 (2003).
 - 8. New York Board of Fire Underwriters.
 - 9. New York State Education Department "Manual of Planning Standards".
 - 10. Part 4 of Title 12 Rules and Regulations of the State of New York Industrial Code Rule No. 4 (12NYCRR4).

1.05 GLOSSARY

- A. AGA American Gas Association
- B. AIA American Institute of Architects
- C. AFBMA Anti-Friction Bearing Manufacturer's Association
- D. AMCA Air Moving and Conditioning Association, Inc.
- E. ANSI American National Standards Institute
- F. ARI Air Conditioning and Refrigeration Institute
- G. ASHRAE American Society of Heating, Refrigeration, and Air Conditioning Engineers, Inc.
- H. ASME American Society of Mechanical Engineers
- I. ASPE American Society of Plumbing Engineers
- J. ASTM American Society for Testing Materials
- K. IBR Institute of Boiler & Radiation Manufacturers
- L. IEEE Institute of Electrical and Electronics Engineers
- M. NYBFU New York Board of Fire Underwriters
- N. NEC National Electrical Code

- O. NEMA National Electrical Manufacturer's Association
- P. NESC National Electrical Safety Code
- Q. NFPA National Fire Protection Association
- R. NYS/DEC New York State Department of Environmental Conservation
- S. SMACNA Sheet Metal and Air Conditioning Contractors National Association
- T. UFPO Underground Facilities Protective Organization
- U. UL Underwriter's Laboratories, Inc.
- V. OSHA Occupational Safety and Health Administration
- W. NYS/UFPBC New York State Uniform Fire Prevention and Building Code

1.06 DEFINITIONS

- A. Acceptance: Owner acceptance of the project from Contractor upon certification by Owner's Representative.
- B. Approval/approved written permission to use a material or system.
- C. As Called for Materials: Equipment including the execution specified/shown in the contract documents.
- D. Code requirements: Minimum requirements.
- E. Concealed Work: Installed in pipe and duct shafts, chases or recesses, inside walls, above ceilings, in slabs or below grade.
- F. Design Equipment: Refer to the article, Equipment Arrangements, and the article, Substitutions.
- G. Design Make: Refer to the articles, Equipment Arrangements, and the article, Substitutions.
- H. Exposed Work not identified as concealed.
- I. Equal or Equivalent: Equally acceptable as determined by Owner's Representative.
- J. Furnish: Supply and deliver to installed location.
- K. Furnished by Others: Receive delivery at job site or where called for and install.
- L. Inspection: Visual observations by Owner's Site Representative.
- M. Install: Mount and connect equipment and associated materials ready for use.
- N. Labeled Refers to classification by a standards agency.
- O. Make: Refers to the article, Equipment Arrangements, and the article, Substitutions.
- P. Or Approved Equal: Approved equal or equivalent as determined by Owner's Representative.
- Q. Owner's Representative: The Prime Professional.
- R. Prime Professional: Architect or Engineer having a contract directly with the Owner for professional services.
- S. Provide: Furnish, install, and connect ready for use.
- T. Relocate: Disassemble, disconnect, and transport equipment to new locations, then clean, test, and install ready for use.
- U. Replace: Remove and provide new item.
- V. Review: A general contractual conformance check of specified products.
- W. Roughing: Pipe, duct, conduit, equipment layout and installation.
- X. Satisfactory: As specified in contract documents.
- Y. Site Representative: Owner's inspector or "Clerk of Works" at the work site.

1.07 SHOP DRAWINGS/PRODUCT DATA/SAMPLES

- A. Submit Shop Drawings on all items of equipment and materials to be furnished and installed. Submission of Shop Drawings and samples shall be accompanied by a transmittal letter, stating name of project and contractor, number of drawings, titles, and other pertinent data called for in individual sections. Shop Drawings shall be dated and contain: Name of project; name of prime professional; name of prime contractor; description or names of equipment, materials and items; and complete identification of locations at which materials or equipment are to be installed. Individual piecemeal or incomplete submittals will not be accepted. Similar items, (all types specified) shall be submitted at one time. Number each submittal by trade. Indicate deviations from contract requirements on Letter of Transmittal. Shop Drawings will be given a general review only. Corrections or comments made on the Shop Drawings during the review do not relieve Contractor from compliance with requirements of the Drawings and specifications. The Contractor is responsible for: confirming and correcting all quantities; checking electrical characteristics and dimensions; selecting fabrication processes and techniques of construction; coordinating his work with that of all other trades; and performing his work in a safe and satisfactory manner.
- B. See Specification Section 01 3000 - Administrative Requirements for submittal procedures.

1.08 PROTECTION OF PERSONS AND PROPERTY

- A. Contractor shall assume responsibility for construction safety at all times and provide as part of Contract all trench or building shoring, scaffolding, shielding, dust/fume protection, mechanical/electrical protection, special grounding, safety railings, barriers, and other safety features required to provide safe conditions for all workmen and site visitors.

1.09 EQUIPMENT ARRANGEMENTS

- A. The Contract Documents are prepared on basis of one (1) manufacturer as "design equipment," even though other manufacturer's names are listed as acceptable makes. If Contractor elects to use one (1) of the listed makes other than "design equipment," submit detailed Drawings, indicating proposed installation of equipment. Show maintenance arrangement. Make required changes in the Work of other trades, at no increase in any Contract. Provide larger motors, feeders, breakers, and equipment, additional control devices, valves, fittings and other miscellaneous equipment required for proper operation, and assume responsibility for proper location of roughing and connections by other trades. Remove and replace door frames, access doors, walls, ceilings, or floors required to install other than design make equipment. If revised arrangement submittal is rejected, revise and resubmit specified "design equipment" item which conforms to Contract Documents.

1.10 CONTINUITY OF SERVICES

- A. The building will be in use during construction operations. Maintain existing systems in operation within all rooms of building at all times. Refer to "General Conditions of the Contract for Construction" for temporary facilities for additional contract requirements. Schedules for various phases of Contract Work shall be coordinated with all other trades and with Owner's Representative. Provide, as part of contract, temporary mechanical connections and relocations as required to accomplish the above. Obtain approval in writing as to date, time, and location for shutdown of existing mechanical facilities or associated services.

1.11 ROUGHING

- A. Due to small scale of Drawings, it is not possible to indicate all offsets, fittings, changes in elevation, interferences, etc. Make necessary changes in Contract Work, equipment locations, etc., as part of a Contract to accommodate Work to obstacles and interferences encountered. Before installing, verify exact location and elevations at work site. DO NOT SCALE plans. If field conditions, details, changes in equipment or Shop Drawing information require an important rearrangement, report same to Owner's Representative for review. Obtain written approval for all major changes before installing.
- B. Install work so that items both existing and new are operable and serviceable. Eliminate interference with removal of coils, motors, filters, belt guards and/or operation of doors. Provide easy, safe, and code mandated clearances at controllers, motor starters, valve access, and

other equipment requiring maintenance and operation. Where Contractor could not reasonably be expected to find such trade interferences due to concealment in walls, ceiling or floors, such relocations will be done by Change Order, if not, included in Contract Work. Contractor shall relocate existing work in way of new construction. VISIT SITE BEFORE BIDDING TO DETERMINE SCOPE OF WORK SINCE FEW OF SUCH ITEMS CAN BE SHOWN. Provide new materials, including new piping and insulation for relocated work.

- C. Coordinate Work with other trades and determine exact route or location of each duct, pipe, conduit, etc., before fabrication and installation. Coordinate with Architectural Drawings. Obtain from Owner's Representative exact location of all equipment in finished areas (i.e., thermostat, fixture, and switch mounting heights, and equipment mounting heights). Coordinate all Work with the architectural reflected ceiling plans and/or existing Architecture. Mechanical Drawings show design arrangement only for diffusers, grilles, registers, air terminals, and other items. Do not rough-in Contract Work without reflected ceiling location plans.
- D. Before roughing for equipment furnished by Owner or in other Contracts, obtain from Owner and other Contractors, approved Roughing Drawings giving exact location for each piece of equipment. Do not "rough in" services without Final Layout Drawings approved for construction. Cooperate with other trades to insure proper location and size of connections to insure proper functioning of all systems and equipment. For equipment and connections provided in this Contract, prepare Roughing Drawing as follows:
 - 1. Existing equipment: Measure the existing equipment and prepare for installation in new location.
 - 2. New equipment: Obtain equipment roughing drawings and dimensions, then prepare roughing-in-drawings. If such information is not available in time, obtain an acknowledgement in writing, then make space arrangements as required with Owner's Representative.

1.12 REMOVAL WORK

- A. Where existing equipment removals are called for, submit complete list to Owner's Representative. All items that Owner wishes to retain that do not contain asbestos or PCB Material shall be delivered to location directed by Owner. Items that Owner does not wish to retain shall be removed from site and legally disposed of. Removal and disposal of material containing asbestos and/or PCB's shall be in accordance with Federal, State, and Local law requirements. Where equipment is called for to be relocated, Contractor shall carefully remove, clean and recondition, then re-install. Removal all abandoned piping, equipment, ductwork, tubing, supports, fixtures, etc. Visit each room, crawl space, and roof to determine the total Scope of Work. The disturbance or dislocation of asbestos-containing materials causes asbestos fibers to be released into the building's atmosphere, thereby creating a health hazard to workmen and building occupants. Consistent with Industrial Code Rule 56 and the content of recognized asbestos-control work, the Contractor shall apprise all of his workers, supervisory personnel, subcontractors, Owner and Consultants who will be at the job site of the seriousness of the hazard and of proper safeguards and work procedures which must be followed, as described in New York State Department of Labor Industrial Code Rule 56.

1.13 EQUIPMENT AND MATERIAL INSTALLATION

- A. Provide materials that meet the following minimum requirements:
 - 1. Materials shall have a flame spread rating of 25 or less and smoke developed rating of 50 or less, in accordance with NFPA 255.
 - 2. All equipment and material for which there is a listing service shall bear a UL label.
 - 3. Gas-fired equipment and system shall meet AGA Regulations and shall have AGA label.
 - 4. Mechanical and electrical equipment and systems with electrical components shall be UL Listed and meet UL Standards and requirements of the NEC.

1.14 CUTTING AND PATCHING

- A. Mechanical trade shall include their required cutting and patching work unless shown as part of the General Construction Work on the Architectural Drawings. Refer to "General Conditions of the Contract for Construction," for additional requirements. Cut and drill from both sides of

walls and/or floors to eliminate splaying. Patch any cut or abandoned holes left by removals of equipment, fixtures, etc. Patch adjacent existing Work disturbed by installation of new Work including insulation, walls and wall covering, ceiling and floor covering, other finished surfaces. Patch openings and damaged areas equal to existing surface finish. Cut openings in prefabricated construction units in accordance with manufacturer's instructions.

1.15 PAINTING

- A. Include painting for patchwork with color to match adjacent surfaces. Where color cannot be adequately matched, paint entire surface. Provide one (1) coat of primer and two (2) finish coats. Refer to General Construction Specifications for additional information.

1.16 CONCEALMENT

- A. Conceal all Contract Work above ceilings and in walls, below slabs, and elsewhere throughout building. If concealment is impossible or impractical, notify Owner's Representative before starting that part of the Work and install only after his review. In areas with no ceilings, install only after Owner's Representative reviews and comments on arrangement and appearance.

1.17 CHASES

- A. New Construction:
 - 1. Certain chases, recessed, openings, shafts, and wall pockets will be provided as part of "General Building Construction Plans and Specifications." Mechanical Trade Work shall provide all other openings required for their Contract Work.
 - 2. Check Architectural and Structural Design and Shop Drawings to verify correct size and location for all openings, recesses and chases in general building construction Work.
 - 3. Assume responsibility for correct and final location and size of such openings.
 - 4. Rectify improperly sized, improperly located or omitted chases or openings due to faulty or late information or failure to check final location.
 - 5. Provide 18 gauge galvanized sleeves and inserts. Extend all sleeves 2 inches above finished floor. Set sleeves and inserts in place ahead of new construction, securely fastened during concrete pouring. Correct, by drilling, omitted or improperly located sleeves. Assume responsibility for all Work and equipment damaged during course of drilling. Firestop all unused sleeves.
 - 6. Provide angle iron frame where openings are required for Contract Work, unless provided by General Contractor.
- B. In Existing Buildings:
 - 1. Drill holes for floor and/or roof slab openings.
 - 2. Multiple Pipes Smaller than 1 Inch: Properly spaced and supported may pass through one (1) 6 inch or smaller diameter opening.
 - 3. Seal voids in fire rated assemblies with a fire-stopping seal system to maintain the fire resistance of the assembly. Provide 18 gauge galvanized sleeves at fire rated assemblies. Extend sleeves 2 inches above floors.
 - 4. In wall openings, drill or cut holes to suit. Provide 18 gauge galvanized sleeves at shafts and fire rated assemblies. Provide fire-stopping seal between sleeves and wall in drywall construction. Provide fire-stopping similar to that for floor openings.

1.18 FLASHING, SEALING, FIRE-STOPPING

- A. See Specification Section 07 8400 - Firestopping.

1.19 SUPPORTS

- A. Provide required supports, beams, angles, hangers, rods, bases, braces, and other items to properly support Contract Work. Supports shall meet the approval of the Owner's Representative. Modify studs, add studs, add framing, or otherwise reinforce studs in metal stud walls and partitions as required to suit Contract Work. If necessary in stud walls, provide special supports from floor to structure above. For Precast Panels/Planks and Metal Decks, support Mechanical/Electrical Work as determined by manufacturer and Owner's Representative. Provide heavy gauge steel mounting plates for mounting Contract Work. Mounting plates shall span two (2) or more studs. Size, gauge, and strength of mounting

plates shall be sufficient for equipment size, weight, and desired rigidity.

1.20 ACCESS PANELS

- A. Access panels shall be furnished by the Mechanical Trade and installed by General Contractor. Location and size shall be the responsibility of Mechanical Trade. Bear cost of construction changes necessary due to improper information or failure to provide proper information in ample time. Access panels over 324 square inches shall have two (2) cam locks. Contractor shall provide proper frame and door type for various wall or ceiling finishes. Access panels shall be equal to "Milcor" as manufactured by Inland Steel Products Co., Milwaukee, Wisconsin. Provide General Contractor with a set of architectural black and white prints with size and approximate locations of access panels shown.

1.21 CONCRETE BASES

- A. Provide concrete bases for all floor-mounted equipment (unless otherwise noted). Provide 3,000 lb. concrete, chamfer edges, trowel finish, and securely bond to floor by roughening slab and coating with cement grout. Bases 4 inches high (unless otherwise indicated); shape and size to accommodate equipment. Set anchor bolts in sleeves before pouring and after anchoring and leveling, fill equipment bases with grout.

1.22 HVAC EQUIPMENT CONNECTIONS

- A. Mechanical Contractor is responsible for draining, filling, venting, chemically treating and restarting any systems which are affected by work shown on the Contract Documents unless specifically noted otherwise.
- B. Provide final hydronic, steam, drain, vent, and gas connections to all equipment as required by the equipment. Provide final connections, including domestic water piping, controls, and devices from equipment to outlets left by other trades. Provide equipment waste, drip, overflow and rail connections extended to floor drains.
- C. Provide for Owner furnished and Contractor furnished equipment all valves, piping, piping accessories, traps, pressure reducing valves, gauges, relief valves, vents, drains, insulation, sheet metal work, controls, dampers, as required.
- D. Refer to manufacturer drawings and specifications for requirements of kitchen equipment, laboratory equipment and special equipment. Verify connection requirements before bidding.

1.23 DELIVERY

- A. Accept materials delivered on site in manufacturer's packaging, labeled with manufacturer's identification and product information.

1.24 STORAGE AND PROTECTION OF MATERIALS

- A. Store materials on dry base, at least 6 inches above ground or floor. Store so as not to interfere with other Work or obstruct access to buildings or facilities. Provide waterproof/windproof covering. Remove and provide special storage for items subject to moisture damage. Protect against theft or damage from any cause. Replace items stolen or damaged, at no cost to Owner.
- B. Maintain ambient conditions for each product as required by each manufacturer from time of delivery. Maintain appropriate ambient conditions for installation as recommended by each manufacturer for a minimum of 24 hours prior and 24 hours after installation.
- C. Refer to "General Conditions of the Contract for Construction."

1.25 FREEZING AND WATER DAMAGE

- A. Take all necessary precautions with equipment, systems and building to prevent damage due to freezing and/or water damage. Repair or replace, at no charge in contract, any such damage to equipment, systems, and building. Perform first seasons winterizing in presence of Owner's operating staff.

1.26 LUBRICATION CHART

- A. Provide lubrication chart, 8-1/2 inch x 11 inch minimum size, typed in capital letters, mounted under clear laminated plastic; secure to wall in area of equipment. List all motors and

equipment in contract. Obtain and list necessary information by name/location of equipment, manufacturer recommended types of lubrication and schedule. Lubricate motors as soon as installed and perform lubrication maintenance until final acceptance. Plumbing trade shall add contract items to the chart provided by the heating trade or provide separate charts.

1.27 OWNER INSTRUCTIONS

- A. Before final acceptance of the Work, furnish necessary skilled labor to operate all systems by seasons. Instruct designated person on proper operation and care of systems/equipment. Repeat instructions, if necessary. Obtain written acknowledgement from person instructed prior to final payment. Contractor is fully responsible for system until final acceptance, even though operated by Owner's personnel, unless otherwise agreed in writing. List under clear plastic, operating, maintenance, and starting precautions procedures to be followed by Owner for operating systems and equipment.

1.28 MAINTENANCE MANUALS

- A. Prepare Instructions and Maintenance Portfolios. Include one (1) copy of each of approved Shop Drawing, wiring diagram, piping diagram spare parts lists, as-built drawings and manufacturer's instructions. Include typewritten instructions, describing equipment, starting/operating procedures, emergency operating instructions, summer-winter changeover, freeze protection, precautions and recommended maintenance procedures. Include name, address, and telephone number of supplier manufacturer representative and service agency for all major equipment items in a 3-ring binder with name of project on the cover. Deliver to Owner's Representative before request for final acceptance.

1.29 RECORD DRAWINGS

- A. The Contractor shall obtain at his expense one (1) set of construction Contract Drawings including non-reproducible black and white prints and one (1) set of reproducible mylars for the purpose of recording record conditions.
- B. The Contractor shall perform all survey work required for the location and construction of the work and to record information necessary for completion of the Record Drawings. Record Drawings shall show the actual location of the constructed facilities in the same manner as was shown on the Bid Drawings. All elevations and dimensions shown on the Drawings shall be verified or corrected so as to provide a complete and accurate record of the facilities as constructed.
- C. It shall be the responsibility of the Contractor to mark each sheet of the non-reproducible drawings in pencil and to record thereon in a legible manner, any and all approved field changes and conditions as they occur. A complete file of approved field sketches, diagrams, and other changes shall also be maintained. At completion of the work, each sheet of record prints, plus all approved field sketches and diagrams shall be used in preparation of the mylar reproducible record drawings.
- D. Completed reproducible mylar Drawings shall be certified as reflecting record conditions and submitted to the Engineer for approval.

1.30 ADDITIONAL ENGINEERING SERVICES

- A. In the event that the Consultant is required to provide additional engineering services as a result of substitution of equivalent materials or equipment by the Contractor or changes by the Contractor in dimension, weight, power requirements, etc., of the equipment and accessories furnished, or if the Consultant is required to examine and evaluate any changes proposed by the Contractor for the convenience of the Contractor, then the Consultant's expenses in connection with such additional services shall be paid by the Contractor and may be deducted from any monies owed to the Contractor.

1.31 FINAL INSPECTION

- A. Upon completion of all punch list items, the Contractor shall provide a copy of the punch list back to the Architect/Engineer with each item noted as completed or the current status of the item. Upon receipt, the Architect/Engineer will schedule a final inspection.

1.32 ALL TRADES TEMPORARY HEAT

- A. Refer to the General Conditions of the Contract for Construction and Supplementary Conditions of the Contract for Construction.

1.33 HVAC MAINTENANCE OF SYSTEMS DURING TEMPORARY USE PERIODS

- A. Provide each air handling system with a set of prefilters in addition to the permanent filters. Furnish four (4) sets of prefilters for each system for use when system is operated for temporary heating or cooling. During such use, change prefilters as often as directed by Owner's Representative. Provide necessary temporary throw away filters in all return openings to keep dust out of ductwork. Change as often as necessary. Remove all such temporary filters upon completion. Use supply units only. Do not operate return fans.
- B. Blank-off outside air intake opening during temporary heating period. Install first set of permanent filters and prefilters.
- C. Adjust dampers on supply system.
- D. Set all heating coil control valves for manual operation.
- E. Do not install any grilles or diffusers at room terminal ends of ducts until permission is given.
- F. Assume responsibility for systems and equipment at all times, even though used for temporary heat or ventilating. Repair or replace all dented, scratched or damaged parts of systems prior to final acceptance.
- G. Remove concrete, rust, paint spots, other blemishes, then clean.
- H. Just prior to final acceptance, remove used final filter. Deliver all unused sets of prefilters to the Owner and obtain written receipt. Properly lubricate system bearings before and during temporary use. Maintain thermostats, freeze stats, overload devices, and all other safety controls in operating condition.

1.34 CLEANING

- A. It is the Contractor's responsibility to keep clean all equipment and fixtures provided under this Contract for the duration of the project. Each trade shall keep the premises free from an accumulation of waste material or rubbish caused by his operations. The facilities require an environment of extreme cleanliness, and it is the Contractor's responsibility to adhere to the strict regulations regarding procedures on the existing premises after all tests are made and installations completed satisfactorily:
- B. Thoroughly clean entire installation, both exposed surfaces and interiors.
- C. Remove all debris caused by work.
- D. Remove tools, surplus, materials, when work is finally accepted.

1.35 SYSTEM START-UP AND TESTING

- A. All new heating and ventilating shall be started up and operated at normal operating temperature for a period of 24 hours to "bake-off" the equipment. The associated ventilation system shall run on 100 percent outside air during the bake-off for an additional 8 hours to purge the building. This Work shall be completed prior to building occupancy or if the Work is not completed in time for summer "bake-off" on a Saturday with the Contractor responsible for being on-site during the entire purge and bake-off operation.
- B. Work of any Contract which includes system "bake-off", system start-up, system cut-over or staff training shall not be done 1 week prior to and 1 week after the opening of the building/addition except upon written approval by the Owner.
- C. Start-up of testing of HVAC systems shall occur while the building is not occupied by Owner and only after notice to the Project Inspector is made at least 24 hours in advance. The Mechanical Contractor shall be responsible for providing temporary filter media over all supply air registers and diffusers during the HVAC system start-up procedure. The Mechanical Contractor shall provide airtight plastic covers over all supply and return air openings prior to the start of construction by any Contractor. The plastic shall be maintained airtight throughout the project construction and removed only with the approval of the Project Inspector.

PART 2 PRODUCTS - NOT USED
PART 3 EXECUTION - NOT USED

END OF SECTION

This Page Intentionally Left Blank

**SECTION 23 0516
EXPANSION FITTINGS AND LOOPS FOR HVAC PIPING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Flexible pipe connectors.
- B. Expansion joints and compensators.
- C. Pipe loops, offsets, and swing joints.

1.02 RELATED REQUIREMENTS

- A. Section 23 2113 - Hydronic Piping.
- B. Section 23 2300 - Refrigerant Piping.

1.03 REFERENCE STANDARDS

- A. ASME B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard 2020.
- B. ASTM A536 - Standard Specification for Ductile Iron Castings 1984 (Reapproved 2019)e1.
- C. EJMA (STDS) - EJMA Standards Tenth Edition.
- D. FM (AG) - FM Approval Guide current edition.
- E. UL (DIR) - Online Certifications Directory Current Edition.

1.04 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data:
 - 1. Flexible Pipe Connectors: Indicate maximum temperature and pressure rating, face-to-face length, live length, hose wall thickness, hose convolutions per foot and per assembly, fundamental frequency of assembly, braid structure, and total number of wires in braid.
- C. Manufacturer's Instructions: Indicate manufacturer's installation instructions, special procedures, and external controls.

PART 2 PRODUCTS

2.01 FLEXIBLE PIPE CONNECTORS - STEEL PIPING

- A. Manufacturers:
 - 1. The Metraflex Company: www.metralflex.com/#sle.
- B. Inner Hose: Stainless Steel.
- C. Exterior Sleeve: Single braided, stainless steel.
- D. Pressure Rating: 125 psi and 450 degrees F.
- E. Joint: As Specified for Pipe Joints.
- F. Size: Use pipe sized units.
- G. Maximum offset: 3/4 inch on each side of installed center line.

2.02 FLEXIBLE PIPE CONNECTORS - COPPER PIPING

- A. Manufacturer:
 - 1. The Metraflex Company: www.metralflex.com/#sle.
- B. Inner Hose: Bronze.
- C. Exterior Sleeve: Braided bronze.
- D. Pressure Rating: 125 psi and 450 degrees F.
- E. Joint: As specified for pipe joints.

- F. Size: Use pipe sized units.
- G. Maximum offset: 3/4 inch on each side of installed center line.

2.03 EXPANSION LOOPS - HOSE AND BRAID

- A. Manufacturers:
 - 1. Flex-Weld, Inc; Keflex Ke-Loop: www.flex-weld.com/#sle.
 - 2. The Metraflex Company; Metraloop: www.metralflex.com/#sle.
- B. Provide flexible loops with two flexible sections of hose and braid, two 90 degree elbows, and 180 degree return with support bracket and air release or drain plug.
- C. Provide flexible loops capable of movement in the x, y, and z planes. Flexible loops to impart no thrust loads to the building structure.
- D. Flexible Connectors: Flanged, braided type with wetted components of stainless steel, sized to match piping.
 - 1. Maximum Allowable Working Pressure: 150 psig at 180 degrees F.
 - 2. Accommodate the Following:
 - a. Axial Deflection in Compression and Expansion:
 - b. Lateral Movement: 2 inch.
 - c. Angular Rotation: 15 degrees.
 - d. Force developed by 1.5 times specified maximum allowable operating pressure.
 - 3. End Connections: Same as specified for pipe jointing.
 - 4. Provide necessary accessories including, but not limited to, swivel joints.

2.04 ACCESSORIES

- A. Pipe Alignment Guides:
 - 1. Manufacturers:
 - a. Flex-Weld, Inc: www.flex-weld.com/#sle.
 - b. The Metraflex Company; PGQ Glide Riser Guide: www.metralflex.com/#sle.
 - 2. Two piece welded steel with enamel paint, bolted, with spider to fit standard pipe, frame with four mounting holes, clearance for minimum 1 inch thick insulation, minimum 3 inches travel.
- B. Engineered Riser Anchor Clamps:
 - 1. Manufacturers:
 - a. The Metraflex Company; Engineered Riser Anchor Clamp: www.metralflex.com/#sle.
 - 2. Applications:
 - a. Provide one clamp to serve as a riser clip.
 - 1) Verify the total load of filled pipe to be supported will be a safety factor of one less than the maximum loading of the clamp per the manufacturer's instructions.
 - b. Provide one clamp above and one clamp below the slab to anchor pipe.
 - 3. Provide two piece, ductile iron in compliance with ASTM A536. Use with metal pipes with an outer diameter of 2.5 inches to 8 inches.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install in accordance with EJMA (Expansion Joint Manufacturers Association) Standards.
- C. Install flexible pipe connectors on pipes connected to vibration isolated equipment. Provide line size flexible connectors.
- D. Anchor pipe to building structure where indicated. Provide pipe guides so movement is directed along axis of pipe only. Erect piping such that strain and weight is not on cast connections or apparatus.

- E. Provide support and equipment required to control expansion and contraction of piping.
Provide loops, pipe offsets, and swing joints, or expansion joints where required.

END OF SECTION

This Page Intentionally Left Blank

**SECTION 23 0517
SLEEVES AND SLEEVE SEALS FOR HVAC PIPING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Pipe sleeves.
- B. Manufactured sleeve-seal systems.

1.02 RELATED REQUIREMENTS

- A. Section 07 8400 - Firestopping.
- B. Section 23 0553 - Identification for HVAC Piping and Equipment: Piping identification.
- C. Section 23 0719 - HVAC Piping Insulation.

1.03 REFERENCE STANDARDS

- A. ASTM C592 - Standard Specification for Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered) (Industrial Type) 2016.
- B. ASTM E814 - Standard Test Method for Fire Tests of Penetration Firestop Systems 2013a (Reapproved 2017).

1.04 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Shop Drawings: Indicate pipe materials used, jointing methods, supports, floor and wall penetration seals. Indicate installation, layout, weights, mounting and support details, and piping connections.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store sleeve and sleeve seals in shipping containers, with labeling in place.
- B. Provide temporary protective coating on cast iron and steel sleeves if shipped loose.

PART 2 PRODUCTS

2.01 PIPE SLEEVES

- A. Vertical Piping:
 - 1. Sleeve Length: 1 inch above finished floor.
 - 2. Provide sealant for watertight joint.
- B. Pipe Passing Through Exterior Walls:
 - 1. Zinc coated or cast iron pipe with asphalt coating.
 - 2. Provide watertight space with link rubber or modular seal between sleeve and pipe on both pipe ends.
- C. Pipe Passing Through Mechanical Floors and walls:
 - 1. Galvanized steel pipe or black iron pipe with asphalt coating.
 - 2. Connect sleeve with floor plate except in mechanical rooms.
- D. Clearances:
 - 1. Provide allowance for insulated piping.
 - 2. Wall, Floor, Floor, Partitions, and Beam Flanges: 1-1/2 inch greater than external; pipe diameter.
 - 3. All Rated Openings: Caulked tight with fire stopping material in compliance with ASTM E814 in accordance with Section 07 8400 to prevent the spread of fire, smoke, and gases.

2.02 MANUFACTURED SLEEVE-SEAL SYSTEMS

- A. Manufacturers:
 - 1. Advance Products & Systems, LLC; Innerlynx: www.apsonline.com/#sle.
 - 2. Flexicraft Industries; PipeSeal: www.flexicraft.com/#sle.

- B. Modular/Mechanical Seal:
 - 1. Synthetic rubber interlocking links continuously fill annular space between pipe and wall/casing opening.
 - 2. Provide watertight seal between pipe and wall/casing opening.
 - 3. Elastomer element size and material in accordance with manufacturer's recommendations.
 - 4. Glass reinforced plastic pressure end plates.

PART 3 EXECUTION

3.01 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Remove scale and foreign material, from inside and outside, before assembly.

3.02 INSTALLATION

- A. Route piping in orderly manner, plumb and parallel to building structure. Maintain gradient.
- B. Install piping to conserve building space, to not interfere with use of space and other work.
- C. Install piping and pipe sleeves to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- D. Structural Considerations:
 - 1. Do not penetrate building structural members unless indicated.
- E. Provide sleeves when penetrating footings, floors, walls, and partitions. Seal pipe including sleeve penetrations to achieve fire resistance equivalent to fire separation required.
 - 1. Aboveground Piping:
 - a. Pack solid using mineral fiber in compliance with ASTM C592.
 - b. Fill space with an elastomer caulk to a depth of 0.50 inch where penetrations occur between conditioned and unconditioned spaces.
 - 2. All Rated Openings: Caulk tight with fire stopping material in compliance with ASTM E814 in accordance with Section 07 8400 to prevent the spread of fire, smoke, and gases.
 - 3. Caulk exterior wall sleeves watertight with lead and oakum or mechanically expandable chloroprene inserts with mastic-sealed components.
- F. Manufactured Sleeve-Seal Systems:
 - 1. Install manufactured sleeve-seal systems in sleeves located in grade slabs and exterior concrete walls at piping entrances into building.
 - 2. Provide sealing elements of the size, quantity, and type required for the piping and sleeve inner diameter or penetration diameter.
 - 3. Locate piping in center of sleeve or penetration.
 - 4. Install field assembled sleeve-seal system components in annular space between sleeve and piping.
 - 5. Tighten bolting for a water-tight seal.
 - 6. Install in accordance with manufacturer's recommendations.
- G. When installing more than one piping system material, ensure system components are compatible and joined to ensure the integrity of the system. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.

3.03 CLEANING

- A. Upon completion of work, clean all parts of the installation.
- B. Clean equipment, pipes, valves, and fittings of grease, metal cuttings, and sludge that may have accumulated from the installation and testing of the system.

END OF SECTION

**SECTION 23 0519
METERS AND GAUGES FOR HVAC PIPING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Pressure gauges and pressure gauge taps.
- B. Thermometers and thermometer wells.

1.02 RELATED REQUIREMENTS

- A. Section 23 0923 - Direct-Digital Control System for HVAC.
- B. Section 23 2113 - Hydronic Piping.

1.03 REFERENCE STANDARDS

- A. ASME B40.100 - Pressure Gauges and Gauge Attachments 2013.
- B. ASTM E1 - Standard Specification for ASTM Liquid-in-Glass Thermometers 2014 (Reapproved 2020).
- C. ASTM E77 - Standard Test Method for Inspection and Verification of Thermometers 2014 (Reapproved 2021).
- D. UL 393 - Indicating Pressure Gauges for Fire-Protection Service Current Edition, Including All Revisions.

1.04 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide list that indicates use, operating range, total range and location for manufactured components.

PART 2 PRODUCTS

2.01 PRESSURE GAUGES

- A. Manufacturers:
 - 1. Dwyer Instruments, Inc: www.dwyer-inst.com/#sle.
 - 2. Moeller Instrument Company, Inc: www.moellerinstrument.com/#sle.
 - 3. Omega Engineering, Inc: www.omega.com/#sle.
- B. Pressure Gauges: ASME B40.100, UL 393 drawn steel case, phosphor bronze bourdon tube, rotary brass movement, brass socket, with front recalibration adjustment, black scale on white background.
 - 1. Case: Steel with brass bourdon tube.
 - 2. Size: 4-1/2 inch diameter.
 - 3. Mid-Scale Accuracy: One percent.
 - 4. Scale: Psi.

2.02 PRESSURE GAUGE TAPPINGS

- A. Gauge Cock: Tee or lever handle, brass for maximum 150 psi.

2.03 STEM TYPE THERMOMETERS

- A. Manufacturers:
 - 1. Dwyer Instruments, Inc: www.dwyer-inst.com/#sle.
 - 2. Omega Engineering, Inc: www.omega.com/#sle.
 - 3. Weksler Glass Thermometer Corp: www.wekslerglass.com/#sle.
- B. Thermometers - Adjustable Angle: Red- or blue-appearing non-toxic liquid in glass; ASTM E1; lens front tube, cast aluminum case with enamel finish, cast aluminum adjustable joint with positive locking device; adjustable 360 degrees in horizontal plane, 180 degrees in vertical plane.
 - 1. Size: 9 inch scale.

2. Window: Clear Lexan.
3. Stem: 3/4 inch NPT brass.
4. Accuracy: 2 percent, per ASTM E77.
5. Calibration: Degrees F.

2.04 DIAL THERMOMETERS

- A. Manufacturers:
 1. Dwyer Instruments, Inc: www.dwyer-inst.com/#sle.
 2. Omega Engineering, Inc: www.omega.com/#sle.
 3. Weksler Glass Thermometer Corp: www.wekslerglass.com/#sle.
- B. Thermometers - Fixed Mounting: Dial type bimetallic actuated; ASTM E1; stainless steel case, silicone fluid damping, white with black markings and black pointer, hermetically sealed lens, stainless steel stem.
 1. Size: 5 inch diameter dial.
 2. Lens: Clear glass.
 3. Accuracy: 1 percent.
 4. Calibration: Degrees F.

2.05 THERMOMETER SUPPORTS

- A. Socket: Brass separable sockets for thermometer stems with or without extensions as required, and with cap and chain.

2.06 TEST PLUGS

- A. Test Plug: 1/4 inch or 1/2 inch brass fitting and cap for receiving 1/8 inch outside diameter pressure or temperature probe with neoprene core for temperatures up to 200 degrees F.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Provide one pressure gauge per pump, installing taps before strainers and on suction and discharge of pump. Pipe to gauge.
- C. Install thermometers in piping systems in sockets in short couplings. Enlarge pipes smaller than 2-1/2 inch for installation of thermometer sockets. Ensure sockets allow clearance from insulation.
- D. Provide instruments with scale ranges selected according to service with largest appropriate scale.
- E. Install gauges and thermometers in locations where they are easily read from normal operating level. Install vertical to 45 degrees off vertical.
- F. Adjust gauges and thermometers to final angle, clean windows and lenses, and calibrate to zero.
- G. Locate test plugs adjacent thermometers and thermometer sockets.

END OF SECTION

**SECTION 23 0523
GENERAL-DUTY VALVES FOR HVAC PIPING**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Applications.
- B. General requirements.
- C. Ball valves.
- D. Butterfly valves.
- E. Check valves.
- F. Chainwheels.

1.02 RELATED REQUIREMENTS

- A. Section 07 8400 - Firestopping.
- B. Section 08 3100 - Access Doors and Panels.
- C. Section 23 0719 - HVAC Piping Insulation.
- D. Section 23 2113 - Hydronic Piping.

1.03 REFERENCE STANDARDS

- A. ASME B16.1 - Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250 2020.
- B. ASME B16.5 - Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard 2020.
- C. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings 2018.
- D. ASME B31.9 - Building Services Piping 2020.
- E. ASTM A126 - Standard Specification for Gray Iron Castings for Valves, Flanges, and Pipe Fittings 2004 (Reapproved 2019).
- F. ASTM A395/A395M - Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures 1999 (Reapproved 2018).
- G. ASTM A536 - Standard Specification for Ductile Iron Castings 1984 (Reapproved 2019)e1.
- H. ASTM B62 - Standard Specification for Composition Bronze or Ounce Metal Castings 2017.
- I. AWWA C606 - Grooved and Shouldered Joints 2015.
- J. MSS SP-45 - Drain and Bypass Connections 2020.
- K. MSS SP-67 - Butterfly Valves 2017, with Errata.
- L. MSS SP-71 - Gray Iron Swing Check Valves, Flanged and Threaded Ends 2018.
- M. MSS SP-72 - Ball Valves with Flanged or Butt-Welding Ends for General Service 2010a.
- N. MSS SP-80 - Bronze Gate, Globe, Angle, and Check Valves 2019.
- O. MSS SP-110 - Ball Valves Threaded, Socket-Welding, Solder Joint, Grooved and Flared Ends 2010, with Errata .

1.04 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on valves including manufacturers catalog information. Submit performance ratings, rough-in details, weights, support requirements, and piping connections.
- C. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, maintenance and repair data, and parts listings.

1.05 QUALITY ASSURANCE

- A. Manufacturer:
 - 1. Obtain valves for each valve type from single manufacturer.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Prepare valves for shipping as follows:
 - 1. Minimize exposure of operable surfaces by setting plug and ball valves to open position.
 - 2. Protect valve parts exposed to piped medium against rust and corrosion.
 - 3. Protect valve piping connections such as grooves, weld ends, threads, and flange faces.
 - 4. Secure check valves in either the closed position or open position.
 - 5. Adjust butterfly valves to closed or partially closed position.
- B. Use the following precautions during storage:
 - 1. Maintain valve end protection and protect flanges and specialties from dirt.
 - a. Provide temporary inlet and outlet caps.
 - b. Maintain caps in place until installation.
 - 2. Store valves in shipping containers and maintain in place until installation.
 - a. Store valves indoors in dry environment.
 - b. Store valves off the ground in watertight enclosures when indoor storage is not an option.

PART 2 PRODUCTS

2.01 APPLICATIONS

- A. Provide the following valves for the applications if not indicated on drawings:
 - 1. Isolation (Shutoff): Butterfly and Ball.
 - 2. Swing Check (Pump Outlet):
 - a. 2 NPS and Smaller: Bronze with bronze disc.
 - b. 2-1/2 NPS and Larger: Iron with lever and weight, lever and spring, center-guided metal, or center-guided with resilient seat.
- B. Required Valve End Connections for Non-Wafer Types:
 - 1. Steel Pipe:
 - a. 2 NPS and Smaller: Threaded ends.
 - b. 2-1/2 NPS and Larger: Grooved ends.
 - 2. Copper Tube:
 - a. 2 NPS and Smaller: Threaded ends (Exception: Solder-joint valve-ends).
 - b. 2-1/2 NPS and Larger: Grooved ends.
- C. Chilled Water Valves:
 - 1. 2 NPS and Smaller, Brass and Bronze Valves:
 - a. Threaded ends.
 - b. Ball: Full port, one piece, brass trim.
 - c. Swing Check: Bronze disc, Class.
 - 2. 2-1/2 NPS and Larger, Iron Valves:
 - a. Ball: 2-1/2 NPS to 10 NPS, Class 150.
 - b. Single-Flange Butterfly: 2-1/2 NPS to 12 NPS, aluminum-bronze disc, EPDM seat, 200 CWP.
 - c. Grooved-End Butterfly: 2-1/2 NPS to 12 NPS, 175 CWP.
 - d. Swing Check: Metal seats, Class 125.
 - e. Grooved-End Check: 3 NPS to 12 NPS, 300 CWP.
- D. Heating Hot Water Valves:
 - 1. 2 NPS and Smaller, Brass and Bronze Valves:
 - a. Ball: Full port, one piece, brass trim.
 - b. Swing Check: Bronze disc, Class 125.
 - 2. 2-1/2 NPS and Larger, Iron Valves:

- a. Ball: 2-1/2 NPS to 10 NPS, Class 150.
- b. Single-Flange Butterfly: 2-1/2 NPS to 12 NPS, aluminum-bronze disc, EPDM seat, 200 CWP.
- c. Grooved-End Butterfly: 2-1/2 NPS to 12 NPS, 175 CWP.
- d. Swing Check: Metal seats, Class 125.
- e. Grooved-End Swing Check: 3 NPS to 12 NPS, 300 CWP.

2.02 GENERAL REQUIREMENTS

- A. Valve Pressure and Temperature Ratings: No less than rating indicated; as required for system pressures and temperatures.
- B. Valve Sizes: Match upstream piping unless otherwise indicated.
- C. Valve Actuator Types:
 - 1. Gear Actuator: Quarter-turn valves 8 NPS and larger.
 - 2. Handwheel: Valves other than quarter-turn types.
 - 3. Hand Lever: Quarter-turn valves 6 NPS and smaller.
 - 4. 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.
- D. Valves in Insulated Piping: Provide 2 NPS stem extensions and the following features:
 - 1. Ball Valves: Extended operating handle of non-thermal-conductive material, and protective sleeve that allows operation of valve without breaking the vapor seal or disturbing insulation.
 - 2. Butterfly Valves: Extended neck.
 - 3. Memory Stops: Fully adjustable after insulation is installed.
- E. Memory Stops: Fully adjustable after insulation is installed.
- F. Valve-End Connections:
 - 1. Flanges on Iron Valves: ASME B16.1 for flanges on iron valves.
 - 2. Pipe Flanges and Flanged Fittings 1/2 NPS through 24 NPS: ASME B16.5.
 - 3. Solder Joint Connections: ASME B16.18.
 - 4. Grooved End Connections: AWWA C606.
- G. General ASME Compliance:
 - 1. Building Services Piping Valves: ASME B31.9.
- H. Bronze Valves:
 - 1. Fabricate from dezincification resistant material.
 - 2. Copper alloys containing more than 15 percent zinc are not permitted.
- I. Valve Bypass and Drain Connections: MSS SP-45.
- J. Source Limitations: Obtain each valve type from a single manufacturer.

2.03 BRASS BALL VALVES

- A. Two Piece, Full Port and Standard Port with Stainless Steel Trim:
 - 1. Comply with MSS SP-110.
 - 2. SWP Rating: 150 psig.
 - 3. Body: Forged brass.
 - 4. Ends: Threaded.
 - 5. Seats: PTFE, TFE, or PTFE or TFE.
 - 6. Stem: Stainless Steel.
 - 7. Ball: Chrome-plated brass.
 - 8. Manufacturers:
 - a. Apollo Valves: www.apollovalves.com/#sle.

2.04 BRONZE BALL VALVES

- A. Two Piece, Standard Port and Full Port with Bronze or Brass Trim:

1. Comply with MSS SP-110.
2. SWP Rating: 150 psig.
3. Body: Bronze.
4. Ends: Threaded.
5. Seats: PTFE .
6. Stem: Bronze or brass.
7. Ball: Chrome plated brass.
8. Manufacturers:
 - a. Apollo Valves: www.apollovalves.com/#sle.

2.05 IRON, GROOVED-END BALL VALVES

- A. Class 200:
 1. CWP Rating: 600 psig.
 2. Body: Ductile iron; ASTM A536, Grade 65-45-12.
 3. Ends: Grooved.
 4. Seats: Teflon.
 5. Stem: Nickel plated carbon steel.
 6. Ball: Type 304 stainless steel.

2.06 IRON, SINGLE FLANGE BUTTERFLY VALVES

- A. Lug type: Bi-directional dead end service without downstream flange.
 1. Comply with MSS SP-67, Type I.
 2. Body Material: ASTM A126 cast iron or ASTM A536 ductile iron.
 3. Stem: One or two-piece stainless steel.
 4. Seat: NBR.
 5. Disc: Coated ductile iron.
 6. Manufacturers:
 - a. Apollo Valves: www.apollovalves.com/#sle.

2.07 IRON, GROOVED-END BUTTERFLY VALVES

- A. CWP Rating: 175 psig (1200 kPa).
 1. Comply with MSS SP-67, Type I.
 2. Body: Coated ductile iron.
 3. Stem: Stainless steel.
 4. Disc: Coated ductile iron.
 5. Disc Seal: EPDM.

2.08 BRONZE LIFT CHECK VALVES

- A. Class 125:
 1. CWP Rating: 200 psig.
 2. Design: Vertical flow.
 3. Body: Bronze.
 4. Ends: Threaded.
 5. Disc (Type 1): Bronze.

2.09 BRONZE SWING CHECK VALVES

- A. Class 125: CWP Rating: 200 psig (1380 kPa).
 1. Comply with MSS SP-80, Type 3.
 2. Body Design: Horizontal flow.
 3. Body Material: Bronze, ASTM B62.
 4. Ends: Threaded.
 5. Disc: Bronze.
 6. Manufacturers:
 - a. Apollo Valves: www.apollovalves.com/#sle.

2.10 IRON, FLANGED END SWING CHECK VALVES

- A. Class 125: CWP Rating: 200 psig (1380 kPa) with Metal Seats.
 - 1. Comply with MSS SP-71, Type I.
 - 2. Design: Clear or full waterway with flanged ends.
 - 3. Body: Gray iron with bolted bonnet in accordance with ASTM A126.
 - 4. Trim: Bronze.
 - 5. Disc Holder: Bronze.
 - 6. Disc: PTFE.

2.11 IRON, GROOVED-END SWING CHECK VALVES

- A. 300 CWP:
 - 1. 10 NPS to 12 NPS.
 - 2. CWP Rating: 300 psig.
 - 3. Body Material: ASTM A536, Grade 65-45-12 ductile iron.
 - 4. Disc: Ductile iron.
 - 5. Coating: Black, non-lead paint.

2.12 CHAINWHEELS

- A. Description: Valve actuation assembly with sprocket rim, brackets, and chain.
 - 1. Brackets: Type, number, size, and fasteners required to mount actuator on valve.
 - 2. Attachment: For connection to butterfly valve stems.
 - 3. Sprocket Rim with Chain Guides: Ductile iron include zinc coating.
 - 4. Chain: Hot-dip galvanized steel. Sized to fit sprocket rim.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Discard all packing materials and verify that valve interior, including threads and flanges, are completely clean without signs of damage or degradation that could result in leakage.
- B. Verify valve parts to be fully operational in all positions from closed to fully open.
- C. Confirm gasket material to be suitable for the service, to be of correct size, and without defects that could compromise effectiveness.
- D. Should valve is determined to be defective, replace with new valve.

3.02 INSTALLATION

- A. Provide unions or flanges with valves to facilitate equipment removal and maintenance while maintaining system operation and full accessibility for servicing.
- B. Provide separate valve support as required and locate valve with stem at or above center of piping, maintaining unimpeded stem movement.
- C. Provide chainwheels on operators for valves 4 NPS and larger where located 8 feet or more above finished floor, terminating 6 feet above finished floor.

END OF SECTION

This Page Intentionally Left Blank

**SECTION 23 0529
HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Support and attachment components for equipment, piping, and other HVAC/hydronic work.

1.02 RELATED REQUIREMENTS

- A. Section 03 3000 - Cast-in-Place Concrete: Concrete equipment pads.

1.03 REFERENCE STANDARDS

- A. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products 2017.
- B. ASTM A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware 2016a.
- C. ASTM A181/A181M - Standard Specification for Carbon Steel Forgings, for General - Purpose Piping 2014 (Reapproved 2020).
- D. ASTM A36/A36M - Standard Specification for Carbon Structural Steel 2019.
- E. ASTM A47/A47M - Standard Specification for Ferritic Malleable Iron Castings 1999, with Editorial Revision (2018).
- F. ASTM B633 - Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel 2019.
- G. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2021a.
- H. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials 2021.
- I. MFMA-4 - Metal Framing Standards Publication 2004.
- J. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation 2018 (Amendment 2019).
- K. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination:
 - 1. Coordinate sizes and arrangement of supports and bases with the actual equipment and components to be installed.
 - 2. Coordinate the work with other trades to provide additional framing and materials required for installation.
 - 3. Coordinate compatibility of support and attachment components with mounting surfaces at the installed locations.
 - 4. Coordinate the arrangement of supports with ductwork, piping, equipment and other potential conflicts installed under other sections or by others.
 - 5. Notify Architect of any conflicts with or deviations from Contract Documents. Obtain direction before proceeding with work.
- B. Sequencing:
 - 1. Do not install products on or provide attachment to concrete surfaces until concrete has fully cured in accordance with Section 03 3000.

1.05 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

- B. Product Data: Provide manufacturer's standard catalog pages and data sheets for channel (strut) framing systems, nonpenetrating rooftop supports, post-installed concrete and masonry anchors, and thermal insulated pipe supports.
- C. Shop Drawings: Include details for fabricated hangers and supports where materials or methods other than those indicated are proposed for substitution.

1.06 QUALITY ASSURANCE

- A. Comply with applicable building code.

1.07 DELIVERY, STORAGE, AND HANDLING

- A. Receive, inspect, handle, and store products in accordance with manufacturer's instructions.

PART 2 PRODUCTS

2.01 SUPPORT AND ATTACHMENT COMPONENTS

- A. General Requirements:
 - 1. Provide all required hangers, supports, anchors, fasteners, fittings, accessories, and hardware as necessary for the complete installation of plumbing work.
 - 2. Provide products listed, classified, and labeled as suitable for the purpose intended, where applicable.
 - 3. Where support and attachment component types and sizes are not indicated, select in accordance with manufacturer's application criteria as required for the load to be supported with a minimum safety factor of 3. Include consideration for vibration, equipment operation, and shock loads where applicable.
 - 4. Do not use wire, chain, perforated pipe strap, or wood for permanent supports unless specifically indicated or permitted.
 - 5. Steel Components: Use corrosion resistant materials suitable for the environment where installed.
 - a. Zinc-Plated Steel: Electroplated in accordance with ASTM B633.
 - b. Galvanized Steel: Hot-dip galvanized after fabrication in accordance with ASTM A123/A123M or ASTM A153/A153M.
- B. Metal Channel (Strut) Framing Systems: Factory-fabricated continuous-slot metal channel (strut) and associated fittings, accessories, and hardware required for field-assembly of supports.
 - 1. Manufacturers:
 - a. Cooper B-Line, a division of Eaton Corporation: www.cooperindustries.com/#sle.
 - b. Thomas & Betts Corporation: www.tnb.com/#sle.
 - c. Unistrut, a brand of Atkore International Inc: www.unistrut.com/#sle.
 - d. Source Limitations: Furnish channels (struts) and associated fittings, accessories, and hardware produced by a single manufacturer.
 - 2. Comply with MFMA-4.
 - 3. Channel Material:
 - a. Indoor Dry Locations: Use galvanized steel.
 - b. Outdoor and Damp or Wet Indoor Locations: Use galvanized steel.
 - 4. Minimum Channel Thickness: Steel sheet, 12 gage, 0.1046 inch.
 - 5. Minimum Channel Dimensions: 1-5/8 inch width by 13/16 inch height.
- C. Hanger Rods: Threaded zinc-plated steel unless otherwise indicated.
 - 1. Minimum Size, Unless Otherwise Indicated or Required:
 - a. Equipment Supports: 1/2 inch diameter.
 - b. Piping up to 1 inch (27 mm) nominal: 1/4 inch diameter.
 - c. Piping larger than 1 inch (27 mm) nominal: 3/8 inch diameter.
 - d. Trapeze Support for Multiple Pipes: 3/8 inch diameter.
- D. Thermal Insulated Pipe Supports:
 - 1. General Construction and Requirements:

- a. Insulated pipe supports to be provided at hanger, support, and guide locations on pipe requiring insulation or additional support.
 - b. Surface Burning Characteristics: Flame spread index/smoke developed index of 5/30, maximum, when tested in accordance with ASTM E84 or UL 723.
 - c. Pipe supports to be provided for nominally sized, 1/2 inch to 30 inch iron pipes.
 - d. Insulation inserts to consist of rigid polyisocyanurate (urethane) insulation surrounded by a 360 degree, PVC jacketing.
- 2. PVC Jacket:
 - a. Pipe insulation protection shields to be provided with a ball bearing hinge and locking seam.
 - b. Moisture Vapor Transmission: 0.0071 perm inch, when tested in accordance with ASTM E96/E96M.
 - c. Thickness: 60 mil.
- 3. Pipe insulation protection shields to be provided at the hanger points and guide locations on pipes requiring insulation as indicated on drawings.
- E. Pipe Supports:
 - 1. Liquid Temperatures Up To 122 degrees F:
 - a. Overhead Support: MSS SP-58 Types 1, 3 through 12.
 - b. Support From Below: MSS SP-58 Types 35 through 38.
- F. Pipe Stanchions: For pipe runs, use stanchions of same type and material where vertical adjustment is required for stationary pipe.
 - 1. Material: Malleable iron, ASTM A47/A47M; or carbon steel, ASTM A36/A36M.
 - 2. Provide coated or plated saddles to isolate steel hangers from dissimilar metal tube or pipe.
- G. Beam Clamps: MSS SP-58 Types 19 through 23, 25 or 27 through 30 based on required load.
 - 1. Material: ASTM A36/A36M carbon steel or ASTM A181/A181M forged steel.
 - 2. Provide clamps with hardened steel cup-point set screws and lock-nuts for anchoring in place.
- H. Riser Clamps:
 - 1. Provide copper plated clamps for copper tubing support.
 - 2. For insulated pipe runs, provide two bolt-type clamps designed for installation under insulation.
- I. Offset Pipe Clamps: Double-leg design two-piece pipe clamp.
- J. Strut Clamps: Two-piece pipe clamp.
- K. Insulation Clamps: Two bolt-type clamps designed for installation under insulation.
- L. Pipe Hangers: For a given pipe run, use hangers of the same type and material.
 - 1. Material: Malleable iron, ASTM A47/A47M; or carbon steel, ASTM A36/A36M.
 - 2. Provide coated or plated hangers to isolate steel hangers from dissimilar metal tube or pipe.
- M. Dielectric Barriers: Provide between metallic supports and metallic piping and associated items of dissimilar type; acceptable dielectric barriers include rubber or plastic sheets or coatings attached securely to pipe or item.
- N. Nonpenetrating Rooftop Supports for Low-Slope Roofs:
 - 1. Provide steel pedestals with thermoplastic or rubber base that rest on top of roofing membrane, not requiring any attachment to the roof structure and not penetrating the roofing assembly, with support fixtures as specified.
 - 2. Base Sizes: As required to distribute load sufficiently to prevent indentation of roofing assembly.
 - 3. Attachment/Support Fixtures: As recommended by manufacturer, same type as indicated for equivalent indoor hangers and supports.

4. Mounting Height: Provide minimum clearance of 6 inches under supported component to top of roofing.
- O. Pipe Shields for Insulated Piping:
 1. General Construction and Requirements:
 - a. Surface Burning Characteristics: Comply with ASTM E84 or UL 723.
 - b. Shields Material: UV-resistant polypropylene with glass fill.
 - c. Maximum Insulated Pipe Outer Diameter: 12-5/8 inch.
 - d. Minimum Service Temperature: Minus 40 degrees F.
 - e. Maximum Service Temperature: 178 degrees F.
 - f. Pipe shields to be provided at hanger, support, and guide locations on pipe requiring insulation or additional support.
- P. Anchors and Fasteners:
 1. Unless otherwise indicated and where not otherwise restricted, use the anchor and fastener types indicated for the specified applications.
 2. Concrete: Use preset concrete inserts, expansion anchors, or screw anchors.
 3. Solid or Grout-Filled Masonry: Use expansion anchors or screw anchors.
 4. Hollow Masonry: Use toggle bolts.
 5. Hollow Stud Walls: Use toggle bolts.
 6. Steel: Use beam clamps, machine bolts, or welded threaded studs.
 7. Sheet Metal: Use sheet metal screws.
 8. Wood: Use wood screws.
 9. Plastic and lead anchors are not permitted.
 10. Powder-actuated fasteners are not permitted.
 11. Preset Concrete Inserts: Continuous metal channel (strut) and spot inserts specifically designed to be cast in concrete ceilings, walls, and floors.
 - a. Comply with MFMA-4.
 - b. Channel Material: Use galvanized steel.
 - c. Manufacturer: Same as manufacturer of metal channel (strut) framing system.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install products in accordance with manufacturer's instructions.
- B. Provide independent support from building structure. Do not provide support from piping, ductwork, conduit, or other systems.
- C. Unless specifically indicated or approved by Architect, do not provide support from suspended ceiling support system or ceiling grid.
- D. Unless specifically indicated or approved by Architect, do not provide support from roof deck.
- E. Do not penetrate or otherwise notch or cut structural members without approval of Structural Engineer.
- F. Provide thermal insulated pipe supports complete with hangers and accessories. Install thermal insulated pipe supports during the installation of the piping system.
- G. Equipment Support and Attachment:
 1. Use metal fabricated supports or supports assembled from metal channel (strut) to support equipment as required.
 2. Use metal channel (strut) secured to studs to support equipment surface-mounted on hollow stud walls when wall strength is not sufficient to resist pull-out.
 3. Use metal channel (strut) to support surface-mounted equipment in wet or damp locations to provide space between equipment and mounting surface.
 4. Securely fasten floor-mounted equipment. Do not install equipment such that it relies on its own weight for support.

- H. Preset Concrete Inserts: Use manufacturer-provided closure strips to inhibit concrete seepage during concrete pour.
- I. Secure fasteners according to manufacturer's recommended torque settings.
- J. Remove temporary supports.

END OF SECTION

This Page Intentionally Left Blank

**SECTION 23 0553
IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Nameplates.
- B. Tags.
- C. Adhesive-backed duct markers.
- D. Stencils.
- E. Pipe markers.
- F. Ceiling tacks.

1.02 RELATED REQUIREMENTS

- A. Section 09 9123 - Interior Painting: Identification painting.

1.03 REFERENCE STANDARDS

- A. ASME A13.1 - Scheme for the Identification of Piping Systems 2020.
- B. ASTM D709 - Standard Specification for Laminated Thermosetting Materials 2017.

1.04 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements for submittal procedures.
- B. Chart and Schedule: Submit valve chart and schedule, including valve tag number, location, function, and valve manufacturer's name and model number.
- C. Product Data: Provide manufacturers catalog literature for each product required.

PART 2 PRODUCTS

2.01 IDENTIFICATION APPLICATIONS

- A. Air Handling Units: Nameplates.
- B. Air Terminal Units: Tags.
- C. Control Panels: Nameplates.
- D. Dampers: Ceiling tacks, where located above lay-in ceiling.
- E. Ductwork: Nameplates.
- F. Heat Transfer Equipment: Nameplates.
- G. Piping: Tags.
- H. Pumps: Nameplates.
- I. Tanks: Nameplates.
- J. Valves: Tags and ceiling tacks where located above lay-in ceiling.
- K. Water Treatment Devices: Nameplates.

2.02 NAMEPLATES

- A. Manufacturers:
 - 1. Seton Identification Products, a Tricor Direct Company: www.seton.com/#sle.
- B. Letter Color: White.
- C. Letter Height: 1/4 inch.
- D. Background Color: Black.
- E. Plastic: Comply with ASTM D709.

2.03 TAGS

- A. Manufacturers:
 - 1. Advanced Graphic Engraving: www.advancedgraphicengraving.com/#sle.
 - 2. Kolbi Pipe Marker Co: www.kolbipipemarkers.com/#sle.
 - 3. Seton Identification Products, a Tricor Company: www.seton.com/#sle.
- B. Metal Tags: Brass with stamped letters; tag size minimum 1-1/2 inch diameter with smooth edges.
- C. Valve Tag Chart: Typewritten letter size list in anodized aluminum frame.

2.04 ADHESIVE-BACKED DUCT MARKERS

- A. Material: High gloss acrylic adhesive-backed vinyl film 0.0032 inch; printed with UV and chemical resistant inks.
- B. Style: Individual Label.
- C. Color: Yellow/Black.

2.05 STENCILS

- A. Stencils: With clean cut symbols and letters of following size:
 - 1. 3/4 to 1-1/4 inch Outside Diameter of Insulation or Pipe: 8 inch long color field, 1/2 inch high letters.
 - 2. 1-1/2 to 2 inch Outside Diameter of Insulation or Pipe: 8 inch long color field, 3/4 inch high letters.
 - 3. 2-1/2 to 6 inch Outside Diameter of Insulation or Pipe: 12 inch long color field, 1-1/4 inch high letters.
 - 4. 8 to 10 inch Outside Diameter of Insulation or Pipe: 24 inch long color field, 2-1/2 inch high letters.
 - 5. Over 10 inch Outside Diameter of Insulation or Pipe: 32 inch long color field, 3-1/2 inch high letters.
- B. Stencil Paint: As specified in Section 09 9123, semi-gloss enamel, colors complying with ASME A13.1.

2.06 PIPE MARKERS

- A. Manufacturers:
 - 1. Kolbi Pipe Marker Co: www.kolbipipemarkers.com/#sle.
 - 2. Seton Identification Products, a Tricor Company: www.seton.com/#sle.
- B. Color: Comply with ASME A13.1.
- C. Plastic Pipe Markers: Factory fabricated, flexible, semi-rigid plastic, preformed to fit around pipe or pipe covering; minimum information indicating flow direction arrow and identification of fluid being conveyed.
- D. Plastic Tape Pipe Markers: Flexible, vinyl film tape with pressure sensitive adhesive backing and printed markings.
- E. Color code as follows:
 - 1. Heating, Cooling, and Boiler Feedwater: Green with white letters.

2.07 CEILING TACKS

- A. Description: Steel with 3/4 inch diameter color coded head.
- B. Color code as follows:
 - 1. HVAC Equipment: Yellow.
 - 2. Fire Dampers and Smoke Dampers: Red.
 - 3. Heating/Cooling Valves: Blue.

PART 3 EXECUTION

3.01 PREPARATION

- A. Degrease and clean surfaces to receive adhesive for identification materials.
- B. Prepare surfaces in accordance with Section 09 9123 for stencil painting.

3.02 INSTALLATION

- A. Install nameplates with corrosive-resistant mechanical fasteners, or adhesive. Apply with sufficient adhesive to ensure permanent adhesion and seal with clear lacquer.
- B. Install tags with corrosion resistant chain.
- C. Apply stencil painting in accordance with Section 09 9123.
- D. Install plastic pipe markers in accordance with manufacturer's instructions.
- E. Install plastic tape pipe markers complete around pipe in accordance with manufacturer's instructions.
- F. Use tags on piping 3/4 inch diameter and larger.
 - 1. Identify service, flow direction, and pressure.
 - 2. Install in clear view and align with axis of piping.
 - 3. Locate identification not to exceed 20 feet on straight runs including risers and drops, adjacent to each valve and Tee, at each side of penetration of structure or enclosure, and at each obstruction.
- G. Install ductwork with plastic nameplates. Identify with air handling unit identification number and area served. Locate identification at air handling unit, at each side of penetration of structure or enclosure, and at each obstruction.
- H. Locate ceiling tacks to locate valves or dampers above lay-in panel ceilings. Locate in corner of panel closest to equipment.

END OF SECTION

This Page Intentionally Left Blank

**SECTION 23 0593
TESTING, ADJUSTING, AND BALANCING FOR HVAC**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Testing, adjustment, and balancing of air systems.
- B. Testing, adjustment, and balancing of hydronic and refrigerating systems.
- C. Measurement of final operating condition of HVAC systems.
- D. Commissioning activities.

1.02 RELATED REQUIREMENTS

- A. Section 01 9113 - General Commissioning Requirements: Commissioning requirements that apply to all types of work.
- B. Section 23 0800 - Commissioning of HVAC.

1.03 REFERENCE STANDARDS

- A. AABC (NSTSB) - AABC National Standards for Total System Balance, 7th Edition 2016.
- B. ASHRAE Std 111 - Measurement, Testing, Adjusting, and Balancing of Building HVAC Systems 2008, with Errata (2019).
- C. NEBB (TAB) - Procedural Standards for Testing Adjusting and Balancing of Environmental Systems 2015, with Errata (2017).
- D. SMACNA (TAB) - HVAC Systems Testing, Adjusting and Balancing 2002.

1.04 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Installer Qualifications: Submit name of adjusting and balancing agency and TAB supervisor for approval within 30 days after award of Contract.
- C. TAB Plan: Submit a written plan indicating the testing, adjusting, and balancing standard to be followed and the specific approach for each system and component.
 - 1. Include at least the following in the plan:
 - a. List of all air flow, water flow, sound level, system capacity and efficiency measurements to be performed and a description of specific test procedures, parameters, formulas to be used.
 - b. Copy of field checkout sheets and logs to be used, listing each piece of equipment to be tested, adjusted and balanced with the data cells to be gathered for each.
 - c. Discussion of what notations and markings will be made on the duct and piping drawings during the process.
 - d. Final test report forms to be used.
 - e. Procedures for formal deficiency reports, including scope, frequency and distribution.
- D. Final Report: Indicate deficiencies in systems that would prevent proper testing, adjusting, and balancing of systems and equipment to achieve specified performance.
 - 1. Revise TAB plan to reflect actual procedures and submit as part of final report.
 - 2. Submit draft copies of report for review prior to final acceptance of Project. Provide final copies for Architect and for inclusion in operating and maintenance manuals.
 - 3. Include actual instrument list, with manufacturer name, serial number, and date of calibration.
 - 4. Form of Test Reports: Where the TAB standard being followed recommends a report format use that; otherwise, follow ASHRAE Std 111.
 - 5. Units of Measure: Report data in both I-P (inch-pound) and SI (metric) units.

PART 2 PRODUCTS - NOT USED

PART 3 EXECUTION

3.01 GENERAL REQUIREMENTS

- A. Perform total system balance in accordance with one of the following:
 - 1. AABC (NSTSB), AABC National Standards for Total System Balance.
 - 2. ASHRAE Std 111, Practices for Measurement, Testing, Adjusting and Balancing of Building Heating, Ventilation, Air-Conditioning, and Refrigeration Systems.
 - 3. SMACNA (TAB).
- B. Begin work after completion of systems to be tested, adjusted, or balanced and complete work prior to Substantial Completion of the project.
- C. TAB Agency Qualifications:
 - 1. Company specializing in the testing, adjusting, and balancing of systems specified in this section.
 - 2. Certified by one of the following:
 - a. AABC, Associated Air Balance Council: www.aabc.com/#sle; upon completion submit AABC National Performance Guaranty.
 - b. NEBB, National Environmental Balancing Bureau: www.nebb.org/#sle.
 - c. TABB, The Testing, Adjusting, and Balancing Bureau of National Energy Management Institute: www.tabbcertified.org/#sle.
- D. TAB Supervisor and Technician Qualifications: Certified by same organization as TAB agency.

3.02 EXAMINATION

- A. Verify that systems are complete and operable before commencing work. Ensure the following conditions:
 - 1. Systems are started and operating in a safe and normal condition.
 - 2. Temperature control systems are installed complete and operable.
 - 3. Proper thermal overload protection is in place for electrical equipment.
 - 4. Final filters are clean and in place. If required, install temporary media in addition to final filters.
 - 5. Duct systems are clean of debris.
 - 6. Fans are rotating correctly.
 - 7. Fire and volume dampers are in place and open.
 - 8. Air coil fins are cleaned and combed.
 - 9. Access doors are closed and duct end caps are in place.
 - 10. Air outlets are installed and connected.
 - 11. Duct system leakage is minimized.
 - 12. Hydronic systems are flushed, filled, and vented.
 - 13. Pumps are rotating correctly.
 - 14. Service and balance valves are open.
- B. Submit field reports. Report defects and deficiencies that will or could prevent proper system balance.

3.03 PREPARATION

- A. Provide instruments required for testing, adjusting, and balancing operations. Make instruments available to Architect to facilitate spot checks during testing.

3.04 ADJUSTMENT TOLERANCES

- A. Air Handling Systems: Adjust to within plus or minus 5 percent of design for supply systems and plus or minus 10 percent of design for return and exhaust systems.
- B. Air Outlets and Inlets: Adjust total to within plus 10 percent and minus 5 percent of design to space. Adjust outlets and inlets in space to within plus or minus 10 percent of design.
- C. Hydronic Systems: Adjust to within plus or minus 10 percent of design.

Port Jervis City School District

23 0593

Additions & Alterations to PJMS

RE-BID 02.04.2022

Testing, Adjusting, and Balancing
for HVAC

Project No. 2019-011 PH1

Page No. 2 of 8

3.05 RECORDING AND ADJUSTING

- A. Ensure recorded data represents actual measured or observed conditions.
- B. Permanently mark settings of valves, dampers, and other adjustment devices allowing settings to be restored. Set and lock memory stops.
- C. After adjustment, take measurements to verify balance has not been disrupted or that such disruption has been rectified.
- D. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, and restoring thermostats to specified settings.
- E. Check and adjust systems approximately six months after final acceptance and submit report.

3.06 AIR SYSTEM PROCEDURE

- A. Adjust air handling and distribution systems to provide required or design supply, return, and exhaust air quantities at site altitude.
- B. Make air quantity measurements in ducts by Pitot tube traverse of entire cross sectional area of duct.
- C. Measure air quantities at air inlets and outlets.
- D. Adjust distribution system to obtain uniform space temperatures free from objectionable drafts and noise.
- E. Use volume control devices to regulate air quantities only to extend that adjustments do not create objectionable air motion or sound levels. Effect volume control by duct internal devices such as dampers and splitters.
- F. Vary total system air quantities by adjustment of fan speeds. Provide drive changes required. Vary branch air quantities by damper regulation.
- G. Provide system schematic with required and actual air quantities recorded at each outlet or inlet.
- H. Measure static air pressure conditions on air supply units, including filter and coil pressure drops, and total pressure across the fan. Make allowances for 50 percent loading of filters.
- I. Adjust outside air automatic dampers, outside air, return air, and exhaust dampers for design conditions.
- J. Measure temperature conditions across outside air, return air, and exhaust dampers to check leakage.
- K. Where modulating dampers are provided, take measurements and balance at extreme conditions.

3.07 WATER SYSTEM PROCEDURE

- A. Adjust water systems to provide required or design quantities.
- B. Use calibrated Venturi tubes, orifices, or other metered fittings and pressure gages to determine flow rates for system balance. Where flow metering devices are not installed, base flow balance on temperature difference across various heat transfer elements in the system.
- C. Adjust systems to provide specified pressure drops and flows through heat transfer elements prior to thermal testing. Perform balancing by measurement of temperature differential in conjunction with air balancing.
- D. Effect system balance with automatic control valves fully open to heat transfer elements.
- E. Effect adjustment of water distribution systems by means of balancing cocks, valves, and fittings. Do not use service or shut-off valves for balancing unless indexed for balance point.
- F. Where available pump capacity is less than total flow requirements or individual system parts, full flow in one part may be simulated by temporary restriction of flow to other parts.

3.08 COMMISSIONING

- A. See Sections 01 9113 - General Commissioning Requirements and 23 0800 for additional requirements.
- B. Perform prerequisites prior to starting commissioning activities.
- C. Fill out Prefunctional Checklists for:
 - 1. Air side systems.
 - 2. Water side systems.
- D. Furnish to the Commissioning Authority, upon request, any data gathered but not shown in the final TAB report.
- E. Re-check minimum outdoor air intake flows and maximum and intermediate total airflow rates for 20 percent of the air handlers plus a random sample equivalent to 10 percent of the final TAB report data as directed by Commissioning Authority.
 - 1. Original TAB agency shall execute the re-checks, witnessed by the Commissioning Authority.
 - 2. Use the same test instruments as used in the original TAB work.
 - 3. Failure of more than 10 percent of the re-checked items of a given system shall result in the rejection of the system TAB report; rebalance the system, provide a new system TAB report, and repeat random re-checks.
 - 4. For purposes of re-check, failure is defined as follows:
 - a. Air Flow of Supply and Return: Deviation of more than 10 percent of instrument reading.
 - b. Minimum Outside Air Flow: Deviation of more than 20 percent of instrument reading; for inlet vane or VFD OSA compensation system using linear proportional control, deviation of more than 30 percent at intermediate supply flow.
 - c. Temperatures: Deviation of more than one degree F.
 - d. Air and Water Pressures: Deviation of more than 10 percent of full scale of test instrument reading.
 - e. Sound Pressures: Deviation of more than 3 decibels, with consideration for variations in background noise.
 - 5. For purposes of re-check, a whole system is defined as one in which inaccuracies will have little or no impact on connected systems; for example, the air distribution system served by one air handler or the hydronic chilled water supply system served by a chiller or the condenser water system.
- F. In the presence of the Commissioning Authority, verify that:
 - 1. Final settings of all valves, splitters, dampers and other adjustment devices have been permanently marked.
 - 2. The air system is being controlled to the lowest possible static pressure while still meeting design loads, less diversity; this shall include a review of TAB methods, established control setpoints, and physical verification of at least one leg from fan to diffuser having all balancing dampers wide open and that during full cooling of all terminal units taking off downstream of the static pressure sensor, the terminal unit on the critical leg has its damper 90 percent or more open.
 - 3. The water system is being controlled to the lowest possible pressure while still meeting design loads, less diversity; this shall include a review of TAB methods, established control setpoints, and physical verification of at least one leg from the pump to the coil having all balancing valves wide open and that during full cooling the cooling coil valve of that leg is 90 percent or more open.

3.09 SCOPE

- A. Test, adjust, and balance the following:
 - 1. Plumbing Pumps.
 - 2. HVAC Pumps.

3. Packaged Steel Fire Tube Boilers.
4. Air Cooled Water Chillers.
5. Packaged Roof Top Heating/Cooling Units.
6. Computer Room Air Conditioning Units.
7. Air Coils.
8. Terminal Heat Transfer Units.
9. Induction Units.
10. Air Handling Units.
11. Fans.
12. Air Filters.
13. Air Inlets and Outlets.

3.10 MINIMUM DATA TO BE REPORTED

- A. Electric Motors:
 1. Manufacturer.
 2. Model/Frame.
 3. HP/BHP.
 4. Phase, voltage, amperage; nameplate, actual, no load.
 5. RPM.
 6. Service factor.
 7. Starter size, rating, heater elements.
 8. Sheave Make/Size/Bore.
- B. Pumps:
 1. Identification/number.
 2. Manufacturer.
 3. Size/model.
 4. Impeller.
 5. Service.
 6. Design flow rate, pressure drop, BHP.
 7. Actual flow rate, pressure drop, BHP.
 8. Discharge pressure.
 9. Suction pressure.
 10. Total operating head pressure.
 11. Shut off, discharge and suction pressures.
 12. Shut off, total head pressure.
- C. Combustion Equipment:
 1. Boiler manufacturer.
 2. Model number.
 3. Serial number.
 4. Firing rate.
 5. Overfire draft.
 6. Gas pressure at meter outlet.
 7. Gas flow rate.
 8. Heat input.
 9. Burner manifold gas pressure.
 10. Percent carbon monoxide (CO).
 11. Percent carbon dioxide (CO₂).
 12. Percent oxygen (O₂).
 13. Percent excess air.
 14. Flue gas temperature at outlet.
 15. Ambient temperature.
 16. Net stack temperature.

17. Percent stack loss.
 18. Percent combustion efficiency.
 19. Heat output.
- D. Chillers:
1. Identification/number.
 2. Manufacturer.
 3. Capacity.
 4. Model number.
 5. Serial number.
 6. Evaporator entering water temperature, design and actual.
 7. Evaporator leaving water temperature, design and actual.
 8. Evaporator pressure drop, design and actual.
 9. Evaporator water flow rate, design and actual.
- E. Cooling Coils:
1. Identification/number.
 2. Location.
 3. Service.
 4. Manufacturer.
 5. Air flow, design and actual.
 6. Entering air DB temperature, design and actual.
 7. Entering air WB temperature, design and actual.
 8. Leaving air DB temperature, design and actual.
 9. Leaving air WB temperature, design and actual.
 10. Water flow, design and actual.
 11. Water pressure drop, design and actual.
 12. Entering water temperature, design and actual.
 13. Leaving water temperature, design and actual.
 14. Air pressure drop, design and actual.
- F. Heating Coils:
1. Identification/number.
 2. Location.
 3. Service.
 4. Manufacturer.
 5. Air flow, design and actual.
 6. Water flow, design and actual.
 7. Water pressure drop, design and actual.
 8. Entering water temperature, design and actual.
 9. Leaving water temperature, design and actual.
 10. Entering air temperature, design and actual.
 11. Leaving air temperature, design and actual.
 12. Air pressure drop, design and actual.
- G. Induction Units:
1. Manufacturer.
 2. Identification/number.
 3. Location.
 4. Model number.
 5. Size.
 6. Design air flow.
 7. Design nozzle pressure drop.
 8. Final nozzle pressure drop.
 9. Final air flow.

- H. Air Moving Equipment:
 - 1. Location.
 - 2. Manufacturer.
 - 3. Model number.
 - 4. Serial number.
 - 5. Arrangement/Class/Discharge.
 - 6. Air flow, specified and actual.
 - 7. Return air flow, specified and actual.
 - 8. Outside air flow, specified and actual.
 - 9. Total static pressure (total external), specified and actual.
 - 10. Inlet pressure.
 - 11. Discharge pressure.
 - 12. Sheave Make/Size/Bore.
 - 13. Number of Belts/Make/Size.
 - 14. Fan RPM.
- I. Return Air/Outside Air:
 - 1. Identification/location.
 - 2. Design air flow.
 - 3. Actual air flow.
 - 4. Design return air flow.
 - 5. Actual return air flow.
 - 6. Design outside air flow.
 - 7. Actual outside air flow.
 - 8. Return air temperature.
 - 9. Outside air temperature.
 - 10. Required mixed air temperature.
 - 11. Actual mixed air temperature.
 - 12. Design outside/return air ratio.
 - 13. Actual outside/return air ratio.
- J. Exhaust Fans:
 - 1. Location.
 - 2. Manufacturer.
 - 3. Model number.
 - 4. Serial number.
 - 5. Air flow, specified and actual.
 - 6. Total static pressure (total external), specified and actual.
 - 7. Inlet pressure.
 - 8. Discharge pressure.
 - 9. Sheave Make/Size/Bore.
 - 10. Number of Belts/Make/Size.
 - 11. Fan RPM.
- K. Duct Traverses:
 - 1. System zone/branch.
 - 2. Duct size.
 - 3. Area.
 - 4. Design velocity.
 - 5. Design air flow.
 - 6. Test velocity.
 - 7. Test air flow.
 - 8. Duct static pressure.
 - 9. Air temperature.

10. Air correction factor.
- L. Duct Leak Tests:
 1. Description of ductwork under test.
 2. Duct design operating pressure.
 3. Duct design test static pressure.
 4. Duct capacity, air flow.
 5. Maximum allowable leakage duct capacity times leak factor.
 6. Test apparatus:
 - a. Blower.
 - b. Orifice, tube size.
 - c. Orifice size.
 - d. Calibrated.
 7. Test static pressure.
 8. Test orifice differential pressure.
 9. Leakage.
- M. Terminal Unit Data:
 1. Manufacturer.
 2. Type, constant, variable, single, dual duct.
 3. Identification/number.
 4. Location.
 5. Model number.
 6. Size.
 7. Minimum static pressure.
 8. Minimum design air flow.
 9. Maximum design air flow.
 10. Maximum actual air flow.
 11. Inlet static pressure.

END OF SECTION

SECTION 23 0713 DUCT INSULATION

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Duct insulation.
- B. Duct liner.
- C. Insulation jackets.

1.02 RELATED REQUIREMENTS

- A. Section 23 0553 - Identification for HVAC Piping and Equipment.
- B. Section 23 3100 - HVAC Ducts and Casings: Glass fiber ducts.

1.03 REFERENCE STANDARDS

- A. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus 2021.
- B. ASTM C534/C534M - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form 2020a.
- C. ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications 2013 (Reapproved 2019).
- D. ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation 2014 (Reapproved 2019).
- E. ASTM C916 - Standard Specification for Adhesives for Duct Thermal Insulation 2020.
- F. ASTM C1071 - Standard Specification for Fibrous Glass Duct Lining Insulation (Thermal and Sound Absorbing Material) 2019.
- G. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2021a.
- H. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials 2021.
- I. ASTM G21 - Standard Practice for Determining Resistance of Synthetic Polymeric Materials to Fungi 2015, with Editorial Revision (2021).
- J. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible 2020.
- K. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials Current Edition, Including All Revisions.

1.04 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Accept materials on site in original factory packaging, labelled with manufacturer's identification, including product density and thickness.
- B. Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original wrapping.

PART 2 PRODUCTS

2.01 REGULATORY REQUIREMENTS

- A. Surface Burning Characteristics: Flame spread index/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84 or UL 723.

2.02 GLASS FIBER, FLEXIBLE

- A. Manufacturer:
 - 1. CertainTeed Corporation: www.certainteed.com/#sle.
 - 2. Johns Manville: www.jm.com/#sle.
 - 3. Knauf Insulation: www.knaufinsulation.com/#sle.
- B. Insulation: ASTM C553; flexible, noncombustible blanket.
 - 1. K value: 0.36 at 75 degrees F, when tested in accordance with ASTM C518.
 - 2. Maximum Service Temperature: 1200 degrees F.
 - 3. Maximum Water Vapor Absorption: 5.0 percent by weight.
- C. Vapor Barrier Jacket:
 - 1. Kraft paper with glass fiber yarn and bonded to aluminized film.
 - 2. Moisture Vapor Permeability: 0.02 perm inch, when tested in accordance with ASTM E96/E96M.
 - 3. Secure with pressure sensitive tape.
- D. Vapor Barrier Tape:
 - 1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure sensitive rubber based adhesive.

2.03 GLASS FIBER, RIGID

- A. Manufacturer:
 - 1. CertainTeed Corporation: www.certainteed.com/#sle.
 - 2. Johns Manville: www.jm.com/#sle.
 - 3. Knauf Insulation: www.knaufinsulation.com/#sle.
- B. Insulation: ASTM C612; rigid, noncombustible blanket.
 - 1. K Value: 0.24 at 75 degrees F, when tested in accordance with ASTM C518.
 - 2. Maximum Service Temperature: 450 degrees F.
 - 3. Maximum Water Vapor Absorption: 5.0 percent.
 - 4. Maximum Density: 8.0 lb/cu ft.
- C. Vapor Barrier Jacket:
 - 1. Kraft paper with glass fiber yarn and bonded to aluminized film.
 - 2. Moisture Vapor Permeability: 0.02 perm inch, when tested in accordance with ASTM E96/E96M.
 - 3. Secure with pressure sensitive tape.
- D. Vapor Barrier Tape:
 - 1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure sensitive rubber based adhesive.

2.04 FLEXIBLE ELASTOMERIC CELLULAR INSULATION

- A. Manufacturers:
 - 1. Aeroflex USA, Inc: www.aeroflexusa.com/#sle.
 - 2. Armacell LLC: www.armacell.us/#sle.
 - 3. K-Flex USA LLC: www.kflexusa.com/#sle.
- B. Insulation: Preformed flexible elastomeric cellular rubber insulation complying with ASTM C534/C534M Grade 1, in sheet form.
 - 1. Minimum Service Temperature: Minus 40 degrees F.
 - 2. Maximum Service Temperature: 180 degrees F.
 - 3. Connection: Waterproof vapor barrier adhesive.
- C. Elastomeric Foam Adhesive: Air dried, contact adhesive, compatible with insulation.

2.05 JACKETS

- A. Canvas Jacket: UL listed 6 oz/sq yd plain weave cotton fabric treated with dilute fire retardant lagging adhesive.

2.06 DUCT LINER

- A. Manufacturers:
 - 1. Armacell LLC: www.armacell.us/#sle.
 - 2. CertainTeed Corporation: www.certainteed.com/#sle.
 - 3. Johns Manville: www.jm.com/#sle.
 - 4. Knauf Insulation: www.knaufinsulation.com/#sle.
- B. Elastomeric Foam Insulation: Preformed flexible elastomeric cellular rubber insulation complying with ASTM C534/C534M Grade 1, in sheet form.
 - 1. Minimum Service Temperature: Minus 40 degrees F.
 - 2. Maximum Service Temperature: 180 degrees F.
 - 3. Fungal Resistance: No growth when tested according to ASTM G21.
 - 4. Apparent Thermal Conductivity: Maximum of 0.28 at 75 degrees F.
 - 5. Minimum Noise Reduction Coefficients:
 - a. 1 inch Thickness: 0.40.
 - 6. Erosion Resistance: Does not show evidence of breaking away, flaking off, or delamination at velocities of 10,000 fpm per ASTM C1071.
 - 7. Connection: Waterproof vapor barrier adhesive.
- C. Elastomeric Foam Adhesive: Air dried, contact adhesive, compatible with insulation. Comply with ASTM C916.
- D. Glass Fiber Insulation: Non-corrosive, incombustible glass fiber complying with ASTM C1071; rigid board and preformed round liner board; impregnated surface and edges coated with poly vinyl acetate polymer, acrylic polymer, or black composite.
 - 1. Fungal Resistance: No growth when tested according to ASTM G21.
 - 2. Apparent Thermal Conductivity: Maximum of 0.31 at 75 degrees F.
 - 3. Service Temperature: Up to 250 degrees F.
 - 4. Rated Velocity on Coated Air Side for Air Erosion: 5,000 fpm, minimum.
 - 5. Minimum Noise Reduction Coefficients:
 - a. 1 inch Thickness: 0.45.
- E. Adhesive: Waterproof, fire-retardant type, ASTM C916.
- F. Liner Fasteners: Galvanized steel, self-adhesive pad with integral head.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that surfaces are clean, foreign material removed, and dry.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Insulated Ducts Conveying Air Below Ambient Temperature:
 - 1. Provide insulation with vapor barrier jackets.
 - 2. Finish with tape and vapor barrier jacket.
 - 3. Continue insulation through walls, sleeves, hangers, and other duct penetrations.
 - 4. Insulate entire system, including fittings, joints, flanges, fire dampers, flexible connections, and expansion joints.
- C. Insulated Ducts Conveying Air Above Ambient Temperature:
 - 1. Provide with or without standard vapor barrier jacket.
 - 2. Insulate fittings and joints. Where service access is required, bevel and seal ends of insulation.
- D. Ducts Exposed in Mechanical Equipment Rooms or Finished Spaces (below 10 feet above finished floor): Finish with canvas jacket sized for finish painting.
- E. External Duct Insulation Application:

1. Secure insulation with vapor barrier with wires and seal jacket joints with vapor barrier adhesive or tape to match jacket.
 2. Secure insulation without vapor barrier with staples, tape, or wires.
 3. Install without sag on underside of duct. Use adhesive or mechanical fasteners where necessary to prevent sagging. Lift duct off trapeze hangers and insert spacers.
 4. Seal vapor barrier penetrations by mechanical fasteners with vapor barrier adhesive.
 5. Stop and point insulation around access doors and damper operators to allow operation without disturbing wrapping.
- F. Duct and Plenum Liner Application:
1. Adhere insulation with adhesive for 90 percent coverage.
 2. Secure insulation with mechanical liner fasteners. Refer to SMACNA (DCS) for spacing.
 3. Seal and smooth joints. Seal and coat transverse joints.
 4. Seal liner surface penetrations with adhesive.
 5. Duct dimensions indicated are net inside dimensions required for air-flow. Increase duct size to allow for insulation thickness.

3.03 SCHEDULES

- A. Exhaust Ducts within 10 Feet of Exterior Openings:
1. Flexible Blanket: Ducts up to 18" wide.
 - a. Minimum Thickness: 2 inch.
 - b. Minimum R value: R-6.
 - c. Jacket Type: Vapor Barrier.
 2. Rigid Board: Ducts over 18" wide.
 - a. Minimum Thickness: 1-1/2 inches.
 - b. Minimum R value: R-6.
 - c. Jacket Type: Vapor Barrier.
- B. 100% Outside Air Ducts:
1. Concealed inside building envelope in unconditioned spaces:
 - a. Flexible Blanket: Ducts up to 18" wide.
 - 1) Minimum Thickness: 2 inches.
 - 2) Minimum R value: R-6.
 - 3) Jacket Type: Vapor Barrier.
 - b. Rigid Board: Ducts over 18" wide.
 - 1) Minimum Thickness: 1-1/2 inches.
 - 2) Minimum R value: R-6.
 - 3) Jacket Type: Vapor Barrier.
 2. Exposed inside building envelope:
 - a. Rigid Board
 - 1) Minimum Thickness: 1-1/2 inches.
 - 2) Minimum R value: R-6.
 - 3) Jacket Type: Vapor Barrier.
- C. Air Conditioning Supply and Return; Heating Supply and Return:
1. Concealed inside building envelope in unconditioned spaces:
 - a. Flexible Blanket: Ducts up to 18" wide.
 - 1) Minimum Thickness: 2 inches.
 - 2) Minimum R value: R-6.
 - 3) Jacket Type: Vapor Barrier.
 - b. Rigid Board: Ducts over 18" wide.
 - 1) Minimum Thickness: 1-1/2 inches.
 - 2) Minimum R value: R-6.
 - 3) Jacket Type: Vapor Barrier.
 2. Exposed inside building envelope in unconditioned spaces and mechanical rooms:
 - a. Rigid Board
 - 1) Minimum Thickness: 1-1/2 inches.

- 2) Minimum R value: R-6.
 - 3) Jacket Type: Vapor Barrier.
 - 3. Exposed inside building envelope in conditioned spaces:
 - a. Uninsulated unless otherwise indicated on Drawings.
 - 4. Inside building envelope, exposed to outside air (i.e., ventilated attic):
 - a. Flexible Blanket: Ducts up to 18" wide.
 - 1) Minimum Thickness: 4 inches.
 - 2) Minimum R value: R-12.
 - 3) Jacket Type: Vapor Barrier.
 - b. Rigid Board: Ducts over 18" wide.
 - 1) Minimum Thickness: 3 inches.
 - 2) Minimum R value: R-12.
 - 3) Jacket Type: Vapor Barrier.
- D. Duct Liner:
 - 1. Provide where shown on drawings.

END OF SECTION

This Page Intentionally Left Blank

**SECTION 23 0716
HVAC EQUIPMENT INSULATION**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Equipment insulation.
- B. Flexible removable and reusable blanket insulation.
- C. Covering.

1.02 REFERENCE STANDARDS

- A. ASTM C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus 2019.
- B. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus 2021.
- C. ASTM C533 - Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation 2017.
- D. ASTM C534/C534M - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form 2020a.
- E. ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications 2013 (Reapproved 2019).
- F. ASTM C592 - Standard Specification for Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered) (Industrial Type) 2016.
- G. ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation 2014 (Reapproved 2019).
- H. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2021a.
- I. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials 2021.
- J. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials Current Edition, Including All Revisions.

1.03 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide product description, thermal characteristics, list of materials and thickness for equipment scheduled.

1.04 DELIVERY, STORAGE, AND HANDLING

- A. Accept materials on site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.
- B. Protect insulation from weather and construction traffic, dirt, water, chemical, and mechanical damage, by storing in original wrapping.

1.05 FIELD CONDITIONS

- A. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements.
- B. Maintain temperature during and after installation for minimum period of 24 hours.

PART 2 PRODUCTS

2.01 REGULATORY REQUIREMENTS

- A. Surface Burning Characteristics: Flame spread index/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84 or UL 723.

2.02 GLASS FIBER, FLEXIBLE

- A. Manufacturers:
 - 1. CertainTeed Corporation: www.certainteed.com/#sle.
 - 2. Johns Manville Corporation: www.jm.com/#sle.
 - 3. Knauf Insulation: www.knaufinsulation.com/#sle.
- B. Insulation: ASTM C553; flexible, noncombustible.
 - 1. K Value: 0.36 at 75 degrees F, when tested in accordance with ASTM C177 or ASTM C518.
 - 2. Maximum Service Temperature: 450 degrees F.
 - 3. Maximum Water Vapor Absorption: 5.0 percent by weight.
- C. Vapor Barrier Jacket: Kraft paper reinforced with glass fiber yarn and bonded to aluminized film.
 - 1. Moisture Vapor Permeability: 0.02 perm inch, when tested in accordance with ASTM E96/E96M.
 - 2. Secure with self-sealing longitudinal laps and butt strips.
 - 3. Secure with outward clinch expanding staples and vapor barrier mastic.
- D. Vapor Barrier Lap Adhesive: Compatible with insulation.

2.03 GLASS FIBER, RIGID

- A. Manufacturer:
 - 1. CertainTeed Corporation: www.certainteed.com/#sle.
 - 2. Johns Manville Corporation: www.jm.com/#sle.
 - 3. Knauf Insulation: www.knaufinsulation.com/#sle.
- B. Insulation: ASTM C612 or ASTM C592; rigid, noncombustible.
 - 1. K Value: 0.25 at 75 degrees F, when tested in accordance with ASTM C177 or ASTM C518.
 - 2. Maximum Service Temperature: 850 degrees F.
 - 3. Maximum Water Vapor Absorption: 5.0 percent by weight.
 - 4. Maximum Density: 8.0 lb/cu ft.
- C. Vapor Barrier Jacket:
 - 1. Kraft paper reinforced with glass fiber yarn and bonded to aluminized film.
 - 2. Moisture Vapor Permeability: 0.02 perm inch, when tested in accordance with ASTM E96/E96M.
 - 3. Secure with self-sealing longitudinal laps and butt strips.
 - 4. Secure with outward clinch expanding staples and vapor barrier mastic.

2.04 HYDROUS CALCIUM SILICATE

- A. Manufacturer:
 - 1. Johns Manville Corporation: www.jm.com/#sle.
- B. Insulation: ASTM C533; rigid molded, asbestos free, gold color.
 - 1. K Value: 0.40 at 300 degrees F, when tested in accordance with ASTM C177 or ASTM C518.
 - 2. Maximum Service Temperature: 1200 degrees F.
 - 3. Density: 15 lb/cu ft.

2.05 FLEXIBLE ELASTOMERIC CELLULAR INSULATION

- A. Manufacturer:
 - 1. Aeroflex USA, Inc: www.aeroflexusa.com/#sle.
 - 2. Armacell LLC: www.armacell.us/#sle.
 - 3. K-Flex USA LLC: www.kflexusa.com/#sle.
- B. Insulation: Preformed flexible elastomeric cellular rubber insulation complying with ASTM C534/C534M Grade 1, in sheet form.
 - 1. Minimum Service Temperature: Minus 40 degrees F.

2. Maximum Service Temperature: 220 degrees F.
 3. Connection: Waterproof vapor barrier adhesive.
- C. Elastomeric Foam Adhesive: Air dried, contact adhesive, compatible with insulation.

2.06 JACKETS

- A. PVC Plastic:
1. Jacket: Sheet material, off-white color.
 - a. Minimum Service Temperature: Minus 40 degrees F.
 - b. Maximum Service Temperature: 150 degrees F.
 - c. Moisture Vapor Permeability: 0.02 perm inch, when tested in accordance with ASTM E96/E96M.
 - d. Thickness: 10 mil.
 - e. Connections: Brush on welding adhesive.
- B. Canvas Jacket: UL listed 6 oz/sq yd plain weave cotton fabric treated with dilute fire retardant lagging adhesive.
1. Lagging Adhesive: Compatible with insulation.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that surfaces are clean and dry, with foreign material removed.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Factory Insulated Equipment: Do not insulate.
- C. Exposed Equipment: Locate insulation and cover seams in least visible locations.
- D. Apply insulation close to equipment by grooving, scoring, and beveling insulation. Fasten insulation to equipment with studs, pins, clips, adhesive, wires, or bands.
- E. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment, use vapor barrier cement.
- F. Insulated equipment containing fluids below ambient temperature; insulate entire system.
- G. Fiber glass insulated equipment containing fluids below ambient temperature; provide vapor barrier jackets, factory-applied or field-applied. Finish with glass cloth and vapor barrier adhesive.
- H. For hot equipment containing fluids 140 degrees F or less, do not insulate flanges and unions, but bevel and seal ends of insulation.
- I. For hot equipment containing fluids over 140 degrees F, insulate flanges and unions with removable sections and jackets.
- J. Fiber glass insulated equipment containing fluids above ambient temperature; provide standard jackets, with or without vapor barrier, factory-applied or field-applied. Finish with glass cloth and adhesive.
- K. Inserts and Shields:
1. Application: Equipment 1-1/2 inches diameter or larger.
 2. Shields: Galvanized steel between hangers and inserts.
 3. Insert Location: Between support shield and equipment and under the finish jacket.
 4. Insert Configuration: Minimum 6 inches long, of same thickness and contour as adjoining insulation; may be factory fabricated.
 5. Insert Material: Hydrous calcium silicate insulation or other heavy density insulating material suitable for the planned temperature range.
- L. Finish insulation at supports, protrusions, and interruptions.
- M. Equipment in Mechanical Equipment Rooms or Finished Spaces: Finish with canvas jacket sized for finish painting.

3.03 SCHEDULE

- A. Heating Systems:
 - 1. Air Separators:
 - 2. Expansion Tanks:
 - 3. Hot Thermal Storage Tanks:
- B. Cooling Systems:
 - 1. Pump Bodies:
 - 2. Air Separators:
 - 3. Expansion Tanks:
 - 4. Chiller Cold Surfaces (Not Factory Insulated):

END OF SECTION

**SECTION 23 0719
HVAC PIPING INSULATION**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Piping insulation.
- B. Flexible removable and reusable blanket insulation.
- C. Jackets and accessories.
- D. Engineered wall outlet seals and refrigerant piping insulation protection.

1.02 RELATED REQUIREMENTS

- A. Section 23 2113 - Hydronic Piping: Placement of hangers and hanger inserts.
- B. Section 23 2300 - Refrigerant Piping: Placement of inserts.

1.03 REFERENCE STANDARDS

- A. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate 2014.
- B. ASTM B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric) 2014.
- C. ASTM C177 - Standard Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus 2019.
- D. ASTM C518 - Standard Test Method for Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus 2021.
- E. ASTM C533 - Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation 2017.
- F. ASTM C534/C534M - Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form 2020a.
- G. ASTM C547 - Standard Specification for Mineral Fiber Pipe Insulation 2019.
- H. ASTM C552 - Standard Specification for Cellular Glass Thermal Insulation 2021a.
- I. ASTM C795 - Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel 2008 (Reapproved 2018).
- J. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2021a.
- K. ASTM E96/E96M - Standard Test Methods for Gravimetric Determination of Water Vapor Transmission Rate of Materials 2021.
- L. ASTM E283 - Standard Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Curtain Walls, and Doors Under Specified Pressure Differences Across the Specimen 2004 (Reapproved 2012).
- M. ASTM E331 - Standard Test Method for Water Penetration of Exterior Windows, Skylights, Doors, and Curtain Walls by Uniform Static Air Pressure Difference 2000 (Reapproved 2016).
- N. ASTM G153 - Standard Practice for Operating Enclosed Carbon Arc Light Apparatus for Exposure of Nonmetallic Materials 2013 (Reapproved 2021).
- O. UL 723 - Standard for Test for Surface Burning Characteristics of Building Materials Current Edition, Including All Revisions.

1.04 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide product description, thermal characteristics, list of materials and thickness for each service, and locations.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Accept materials on site, labeled with manufacturer's identification, product density, and thickness.

1.06 FIELD CONDITIONS

- A. Maintain ambient conditions required by manufacturers of each product.

PART 2 PRODUCTS

2.01 REGULATORY REQUIREMENTS

- A. Surface Burning Characteristics: Flame spread index/Smoke developed index of 25/50, maximum, when tested in accordance with ASTM E84 or UL 723.

2.02 GLASS FIBER, RIGID

- A. Manufacturers:
 - 1. CertainTeed Corporation: www.certainteed.com/#sle.
 - 2. Johns Manville Corporation: www.jm.com/#sle.
 - 3. Knauf Insulation: www.knaufinsulation.com/#sle.
- B. Insulation: ASTM C547 and ASTM C795; rigid molded, noncombustible.
 - 1. K Value: ASTM C177, 0.24 at 75 degrees F.
 - 2. Maximum Service Temperature: 850 degrees F.
 - 3. Maximum Moisture Absorption: 0.2 percent by volume.
- C. Vapor Barrier Jacket: White kraft paper with glass fiber yarn, bonded to aluminized film; moisture vapor transmission when tested in accordance with ASTM E96/E96M of 0.02 perm-inches.
- D. Vapor Barrier Lap Adhesive: Compatible with insulation.
- E. Indoor Vapor Barrier Finish:
 - 1. Cloth: Untreated; 9 oz/sq yd weight.
- F. Outdoor Vapor Barrier Mastic: Vinyl emulsion type acrylic or mastic, compatible with insulation, black color.

2.03 CELLULAR GLASS

- A. Pipe and Tubing Insulation: ASTM C552, Type II, Grade 6.
 - 1. K Value: 0.35 at 100 degrees F.
 - 2. Service Temperature Range: From 250 degrees F to 800 degrees F.
 - 3. Water Vapor Permeability: 0.005 perm inch maximum per inch.
 - 4. Water Absorption: 0.5 percent by volume, maximum.
 - 5. Density: A minimum of 6.12 lb/cu ft.
- B. Block Insulation: ASTM C552, Type I, Grade 6.
 - 1. K Value: 0.35 at 100 degrees F.
 - 2. Service Temperature: 800 degrees F, maximum.
 - 3. Water Vapor Permeability: 0.005 perm inch maximum per inch.
 - 4. Water Absorption: 0.5 percent by volume, maximum.

2.04 HYDROUS CALCIUM SILICATE

- A. Manufacturers:
 - 1. Johns Manville Corporation: www.jm.com/#sle.
- B. Insulation: ASTM C533 and ASTM C795; rigid molded, asbestos free, gold color.
 - 1. K Value: 0.40 at 300 degrees F, when tested in accordance with ASTM C177 or ASTM C518.
 - 2. Maximum Service Temperature: 1200 degrees F.
 - 3. Density: 15 lb/cu ft.
- C. Tie Wire: 0.048 inch stainless steel with twisted ends on maximum 12 inch centers.

2.05 FLEXIBLE ELASTOMERIC CELLULAR INSULATION

- A. Manufacturer:
 - 1. Aeroflex USA, Inc; Aerocel Ultra-Low Perm (ULP): www.aeroflexusa.com/#sle.
 - 2. Armacell LLC; AP Armaflex: www.armacell.us/#sle.
 - 3. K-Flex USA LLC; K-Flex Titan: www.kflexusa.com/#sle.
- B. Insulation: Preformed flexible elastomeric cellular rubber insulation complying with ASTM C534/C534M Grade 1; use molded tubular material wherever possible.
 - 1. Minimum Service Temperature: Minus 40 degrees F.
 - 2. Maximum Service Temperature: 180 degrees F.
 - 3. Connection: Waterproof vapor barrier adhesive.
- C. Elastomeric Foam Adhesive: Air dried, contact adhesive, compatible with insulation.

2.06 JACKETS

- A. PVC Plastic.
 - 1. Manufacturers:
 - a. Johns Manville Corporation: www.jm.com/#sle.
 - 2. Jacket: One piece molded type fitting covers and sheet material, off-white color.
 - a. Minimum Service Temperature: 0 degrees F.
 - b. Maximum Service Temperature: 150 degrees F.
 - c. Moisture Vapor Permeability: 0.002 perm inch, maximum, when tested in accordance with ASTM E96/E96M.
 - d. Thickness: 10 mil.
 - e. Connections: Brush on welding adhesive.
 - 3. Covering Adhesive Mastic: Compatible with insulation.
- B. Aluminum Jacket: ASTM B209 (ASTM B209M) formed aluminum sheet.
 - 1. Thickness: 0.016 inch sheet.
 - 2. Finish: Embossed.
 - 3. Joining: Longitudinal slip joints and 2 inch laps.
 - 4. Fittings: 0.016 inch thick die shaped fitting covers with factory attached protective liner.
 - 5. Metal Jacket Bands: 3/8 inch wide; 0.015 inch thick aluminum.

2.07 ENGINEERED WALL OUTLET SEALS AND REFRIGERANT PIPING INSULATION PROTECTION

- A. Pipe Penetration Wall Seal: Seals HVAC piping wall penetrations with compression gasket wall mounted rigid plastic outlet cover.
 - 1. Wall Outlet Size, Stucco and Masonry Applications: 7-1/2 inch wide by 10 inch high.
 - a. Elastomeric Sleeve Diameter: 1-11/16 inch.
 - 2. Outlet Cover Color: White.
 - 3. Water Penetration: Comply with ASTM E331.
 - 4. Air Leakage: Comply with ASTM E283.
- B. Insulation Protection System: Refrigerant piping insulation PVC protective cover.
 - 1. PVC Insulation Cover Color: White with full-length velcro fastener.
 - 2. Weatherization and Ultraviolet Exposure Protection: Comply with ASTM G153.
 - 3. Water/Vapor Permeability: Comply with ASTM E96/E96M.
 - 4. Flame Spread and Smoke Development Rating of 24/450: Comply with ASTM E84 or UL 723.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Test piping for design pressure, liquid tightness, and continuity prior to applying insulation materials.
- B. Verify that surfaces are clean and dry, with foreign material removed.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Exposed Piping: Locate insulation and cover seams in least visible locations.
- C. Insulated Pipes Conveying Fluids Below Ambient Temperature:
 - 1. Insulate entire system, including fittings, valves, unions, flanges, strainers, flexible connections, pump bodies, and expansion joints.
- D. Glass Fiber Insulated Pipes Conveying Fluids Below Ambient Temperature:
 - 1. Provide vapor barrier jackets, factory-applied or field-applied; secure with self-sealing longitudinal laps and butt strips with pressure sensitive adhesive. Secure with outward clinch expanding staples and vapor barrier mastic.
 - 2. Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe. Finish with glass cloth and vapor barrier adhesive or PVC fitting covers.
- E. For hot piping conveying fluids 140 degrees F or less, do not insulate flanges and unions at equipment, but bevel and seal ends of insulation.
- F. For hot piping conveying fluids over 140 degrees F, insulate flanges and unions at equipment.
- G. Glass Fiber Insulated Pipes Conveying Fluids Above Ambient Temperature:
 - 1. Provide standard jackets, with or without vapor barrier, factory-applied, or field-applied. Secure with self-sealing longitudinal laps and butt strips with pressure-sensitive adhesive. Secure with outward clinch expanding staples.
 - 2. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Finish with glass cloth and adhesive or PVC fitting covers.
- H. Inserts and Shields:
 - 1. Application: Piping 1-1/2 inches diameter or larger.
 - 2. Shields: Galvanized steel between pipe hangers or pipe hanger rolls and inserts.
 - 3. Insert location: Between support shield and piping and under the finish jacket.
 - 4. Insert Configuration: Minimum 6 inches long, of same thickness and contour as adjoining insulation; may be factory fabricated.
 - 5. Insert Material: Hydrous calcium silicate insulation or other heavy density insulating material suitable for the planned temperature range.
- I. Continue insulation through walls, sleeves, pipe hangers, and other pipe penetrations. Finish at supports, protrusions, and interruptions. At fire separations, refer to Section 07 8400.
- J. Pipe Exposed in Mechanical Equipment Rooms or Finished Spaces (less than 10 feet above finished floor): Finish with PVC jacket and fitting covers.
- K. Exterior Applications: Provide vapor barrier jacket. Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and finish with glass mesh reinforced vapor barrier cement. Cover with aluminum jacket with seams located on bottom side of horizontal piping. Provide two coats of UV resistant finish for flexible elastomeric cellular insulation without jacketing.

3.03 SCHEDULE

- A. Heating Systems:
 - 1. Heating Water Supply and Return:
 - 2. Glycol Heating Supply and Return:
 - 3. Boiler Feed Water:
- B. Cooling Systems:
 - 1. Chilled Water:
 - 2. Glycol Cooling Supply and Return:
 - 3. Condensate Drains from Cooling Coils:
 - 4. Refrigerant Suction:
 - 5. Refrigerant Hot Gas:

END OF SECTION

**SECTION 23 0923
DIRECT-DIGITAL CONTROL SYSTEM FOR HVAC**

PART 1 GENERAL

1.01 DESCRIPTION OF WORK

- A. This specification is intended for reference only. The Owner will furnish all Invensys Climate Control (aka Schneider Electric: IA Series), control devices and wiring that is included in this section by OGS/GSA contract. The Mechanical Contractor will be responsible for contracting with the temperature controls provider for wiring, programming, commissioning, etc. The Mechanical Contractor shall also be responsible for installing control components in the piping and duct work systems, such as but not excluding the following: Automatic Control Dampers, Automatic Control Valves, Temperature Sensing Thermal Wells and Pressure Control Sensing Taps. The Temperature Controls Contractor (TCC) shall be a factory trained and authorized Invensys Climate Control, Dealer Office. (Stark "TBS Controls")
1. This project is a design make Invensys Climate Control System. See section 2.1 of this specification for Acceptable Manufacturers.
 2. Furnish all labor, materials, equipment, and service necessary to provide a complete and operating temperature control system. System shall use Direct Digital Controls, electronic interfaces and actuation devices, as shown on the drawings and as described herein. Control sequences are specified in this section.
 - a. All actuation of valves and dampers shall be electric unless specifically called out elsewhere in the specifications or drawings.
 3. The Building Automation System (BAS) shall have the following capabilities as described in these specifications:
 - a. The Network Control Units (NCU)(s) and Computer(s) shall be connected directly to the Owners Ethernet Network.
 - b. If existing, off site access for Owner's personnel shall be extended to include new work herein. Identical graphical displays shall be provided for offsite access to match the displays at the on-site Operator Workstation. Connection to the site shall be via a high speed Ethernet connection. The contractor shall coordinate with the Owners IT professionals for high speed system access and shall comply with Owners requirements to maintain the level of security required by the Owner.
 - c. The BMS network controller shall integrate into the existing Invensys Climate Control server.
 - d. All system variables in the BMS system shall be Microsoft variables allowing them to be display and manipulated in other Microsoft products.
 - e. Network controllers shall all be flash upgradeable and not require changing chips for upgrades.
 - f. Short term logging of historical data shall be provided for every DDC input and output in the system. Each point shall be logged for a minimum of 2 weeks.
- B. **QUALITY ASSURANCE**
1. All labor, material, equipment and software necessary to meet the functional intent of the system, as specified herein and as shown on the drawings, shall be provided by one of the manufacturers listed in Part 2 - Products. Equipment and labor not specifically referred to herein or on the plans, which are required to meet the functional intent, shall be provided without additional cost to the Owner. This contractor also is responsible for all costs of changes in the work required by substitute equipment.
 2. The Building Management System (BMS) Contractor must have been in business for not less than 10 years, and providing BMS systems must be the Contractors primary business. BMS Contractor must be an authorized dealer office of the manufacturers specified. BMS Contractor must have a trained staff of application engineers, project managers, software engineers, commissioning staff, and service staff experienced in the configuration, programming and service of the automation system.

3. The BMS Contractor shall have a training facility with regularly scheduled training as outlined in Section 1.4 so as to provide ongoing regularly scheduled application training.
4. Manufacturer: A firm regularly engaged in manufacture of microprocessor temperature control equipment, of types and sizes which are similar to required equipment, and which have been in satisfactory use for not less than 10 years, in similar service.
5. Electrical standards: Provide electrical products that comply with the following agency approvals:
 - a. UL-916; Energy Management Systems for BAS components and ancillary equipment
 - b. UL-873; Temperature Indication and Regulating Equipment
 - c. FCC, Part 15, Subpart J, Class A Computing Devices
6. All products shall be labeled with the appropriate approval markings. System installation shall comply with NFPA, NEMA, Local and National codes.

C. SCOPE OF WORK

1. Except as otherwise noted, the control system shall consist of all Ethernet Network Controllers, Standalone Digital Control Units, workstations, software, sensors, transducers, relays, valves, dampers, damper operators and other accessory equipment, along with a complete system of electrical interlocking wiring as required to fill the intent of the specification and provide for a complete and operable system. Except as otherwise specified, provide operators for equipment such as dampers if the equipment manufacturer does not provide these. Coordinate requirements with the various Contractors.
2. The BAS contractor shall review and study all HVAC drawings and the entire specification to familiarize himself with the equipment and system operation and to verify the quantities and types of dampers, operators, alarms, etc. to be provided.
3. All interlocking, wiring and installation of control devices associated with the equipment listed below shall be provided under this Contract. When the BAS system is fully installed and operational, the BAS Contractor shall review and check out the system. At that time, the BAS contractor shall demonstrate the operation of the system to the Owner and prove that it complies with the intent of the drawings and specifications.
 - a. The Contractor shall furnish and install a complete building automation system including all necessary hardware and all operating and applications software necessary to perform the control sequences of operation as called for in this specification.
4. Provide services and manpower necessary for commissioning of system in coordination with the HVAC Contractor, Balancing Contractor and Owner's representative. Commissioning reports showing the testing of each DDC point on the system shall be submitted to the Engineer for review and approval upon completion of the commissioning process. See Section 3.6 Commissioning and System Startup section for detail.
5. All work performed under this section of the specifications shall comply with all codes, laws and governing bodies. If the drawings and/or specifications are in conflict with governing codes, the Contractor shall submit a proposal with appropriate modifications to the project for code compliance. If this specification and associated drawings exceed governing code requirements, the specification shall govern. The Contractor shall obtain and pay for all necessary construction permits and licenses.
6. All 120V power circuitry required for control devices shall be by the BAS contractor in accordance with DIVISION 26 specifications.

D. TRAINING

1. The BAS Contractor shall provide both on-site and classroom training to the Owner's representative and maintenance personnel per the following description:
 - a. On-site training shall consist of a minimum of (4) hours of hands-on instruction geared at the operation and maintenance of the systems. The curriculum shall include:
 - 1) System Overview
 - 2) System Software and Operation

- (a) System access
 - (b) Software features overview
 - (c) Changing setpoints and other attributes
 - (d) Scheduling
 - (e) Editing programmed variables
 - (f) Displaying color graphics
 - (g) Running reports
 - (h) Workstation maintenance
 - (i) Application programming
 - 3) Operational sequences including start-up, shutdown, adjusting and balancing.
 - 4) Equipment maintenance.
 - 2. Classroom training shall include a minimum of (1) training slot for two days of course material covering workstation operation and controller programming. The cost for travel and lodging shall be included in this contract if Training Center is more than 150 miles from the Project Site.
 - 3. The training facility shall have the capability to provide hands on training experience for all applications that can be run on the Invensys Climate Controls application.
- E. SYSTEM DESCRIPTION
- 1. The Building Automation System (BAS) shall consist of existing PC-based workstation and microcomputer controllers of modular design providing distributed processing capability, and allowing future expansion of both input/output points and processing/control functions.
 - 2. For this project the system shall consist of the following components:
 - a. Ethernet-based Network Controller(s): The BAS Contractor shall furnish (1 or more) Ethernet-based network controllers as described in Part 2 of the specification. If the existing controller is sufficient to include the new work, a new controller is not required. These controllers shall connect directly to the Operator Workstation over Ethernet, provide communication to the Standalone Digital Control Units and/or other Input/Output Modules and serve as a gateway to equipment furnished by others (if applicable).
 - b. Standalone Digital Control Units (SDCUs): Provide the necessary quantity and types of SDCUs to meet the requirements of the project for mechanical equipment control including air handlers, central plant control, and terminal unit control. Each SDCU shall operate completely standalone, containing all of the I/O and programs to control its associated equipment.
 - c. A high speed Ethernet connection to the school shall be furnished by the school district. BMS contractor shall coordinate with the Owners IT professionals and comply with the Owner's IT professionals requirements.
- F. WORK BY OTHERS
- 1. The BAS Contractor shall cooperate with other contractors performing work on this project necessary to achieve a complete and neat installation. To that end, each contractor shall consult the drawings and specifications for all trades to determine the nature and extent of others' work.
 - 2. The BAS Contractor shall furnish all control valves, sensor wells, flow meters and other similar equipment specified in this section for installation by the Mechanical Contractor.
 - 3. The BAS Contractor shall provide field supervision to the designated contractor for the installation of the following:
 - a. Automatic Control Dampers
 - b. Automatic Control Valves.
 - c. Temperature Sensing Thermal Wells
 - d. Pressure Control Sensing Taps
- G. WARRANTY AND ACCEPTANCE
- 1. The microprocessor temperature control contractor shall warrant the control system installed in this contract to be free from defects in material and workmanship, except for

damages from other causes, for a period of one year after final acceptance from the owner. The microprocessor temperature control contractor shall be responsible for all necessary revisions to the software required for a workable system performance through the first year of operation. Any changes in the software shall be transmitted immediately to the owner. The software responsibility is for a complete and workable system as described in the control cycle description of the specification. The software shall become the property of the owner.

2. Updates to the manufacturer's software shall be provided at no charge during the warranty period, unless otherwise purchased by the District under a service agreement.
3. All equipment required to maintain operation of the temperature control system for the project shall be stocked in the microprocessor temperature control contractor's local facility. It shall be immediately available in the event of component failure. A spare or loaner piece of equipment shall be installed immediately when a failure occurs and the equipment shall be returned to the factory for repair.

H. SUBMITTALS

1. Shop drawings shall include a riser diagram depicting locations of all controllers and workstations, with associated network wiring. Also included shall be individual schematics of each mechanical system showing all connected points with reference to their associated controller. Typical schematics will be allowed where appropriate.
 - a. Each drawing containing an equipment schematic shall contain a table indicating what equipment is covered by this drawing (i.e. equipment "tag #") and which drawing in the Construction Document set this piece of equipment is shown on.
2. Submittal data shall contain manufacturer's data on all hardware and software products required by the specification. Valve, damper and airflow station schedules shall indicate size, configuration, capacity and location of all equipment.
3. Software submittals shall contain narrative descriptions of sequences of operation, program listings, point lists, and a complete description of the graphics, reports, alarms and configuration to be furnished with the workstation software. Information shall be bound or in a three ring binder with an index and tabs.
4. Submit five (5) copies of submittal data and shop drawings to the Engineer for review prior to ordering or fabrication of the equipment. Prior to submitting, the Contractor shall check all documents for accuracy.
5. The Engineer will make corrections, if required, and return to the Contractor. The Contractor shall then resubmit with the corrected or additional data. This procedure shall be repeated until all corrections are made to the satisfaction of the Engineer and the submittals are fully approved.
6. Each point in the system shall be tested for both hardware and software functionality. In addition, each mechanical and electrical system under control of the BAS shall be tested against the appropriate sequence of operation specified herein. Successful completion of the system test shall constitute the beginning of the warranty period. A written report shall be submitted to the owner indicating that the installed system functions in accordance with the plans and specifications.
7. The BAS contractor shall commission and set in operating condition all major equipment and systems, such as the hot water and all air handling systems, in the presence of the equipment manufacturer's representatives, as applicable, and the Owner and Architect's representatives. See Section 3.6 for detail required in Commissioning the system.
8. The BAS Contractor shall provide all manpower and engineering services required to assist the HVAC Contractor and Balancing Contractor in testing, adjusting, and balancing all systems in the building. The BAS Contractor shall have a trained technician available on request during the balancing of the systems. The BAS Contractor shall coordinate all requirements to provide a complete air balance with the Balancing Contractor and shall include all labor and materials in his contract.

I. OPERATING AND MAINTENANCE MANUALS

1. The operation and maintenance manuals shall contain all information necessary for the operation, maintenance, replacement, installation, and parts procurement for the entire

- BAS. This documentation shall include specific part numbers and software versions and dates. A complete list of recommended spare parts shall be included with the lead-time and expected frequency of use of each part clearly identified.
2. Following project completion and testing, the BAS contractor shall submit as-built drawings reflecting the exact installation of the system. The as-built documentation shall also include a copy of all application software in written form.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

- A. Manufacturer - Provide the following microprocessor control system:
 1. Schneider Electric IA Series. All control devices shall be purchased by the Owner and installed by the Temperature Controls Contractor (TCC). The TCC shall be a factory trained and authorized Invensys Climate Control, factory dealer office.
- B. SYSTEM ARCHITECTURE
 1. The Building Management System (BMS) shall consist of Network Area Controllers (NACs), a family of Local Controllers, Existing Operator Workstations (OWs), and a File Server to support system configurations where more than three operator workstations are required. The BMS shall provide control, alarm detection, scheduling, reporting and information management for the entire facility, and Wide Area Network (WAN) if applicable, from a single ODBC-compliant SQL database. The system shall be designed with a top-level 10/100bT Ethernet network, using ISO 8802-3 data link/physical layer. A sub-network using the RS-485 token passing protocol, with a minimum of 19.2kb speed, shall connect the local, stand-alone controllers with Ethernet-level controller/routers.
 2. Level 1 Network Description: Level 1, the main backbone of the system, shall be an ISO 8802-3, 10/100bT LAN/WAN, using Ethernet as the communications protocol. Network Area Controllers, Operator Workstations, and Servers shall connect directly to this network without the need for Gateway devices.
 3. Level 2 Network Description: Level 2 of the system shall consist of one or more local Controllers. Minimum speed shall be 19.2kbps. The Level 2 field bus consists of an RS485, BACnet MSTP bus that supports 40-60 Local Controllers to operate HVAC equipment, lighting, power metering and monitoring, fuel tank monitoring, UPS battery and generator monitoring, smoke and fire detection, water leak detection, and video surveillance and access control.
 4. BMS LAN Segmentation: The BMS shall be capable of being segmented, through software, into multiple local area networks (LANs) distributed over a wide area network (WAN), sharing a single file server. This enables workstations to manage a single LAN (or building), and/or the entire system with all devices being assured of being updated by and sharing the most current database. In the case of a single workstation system, the workstation shall contain the entire database – with no need for a separate file server.
 5. Standard Network Support: All NACs, Workstations and Servers shall be capable of residing directly on the owner's Ethernet TCP/IP LAN/WAN with no required gateways. Furthermore, the NACs, Workstations and Servers shall be capable of using standard, commercially available, off-the-shelf Ethernet infrastructure components such as routers, switches and hubs. With this design the owner may utilize the investment of an existing or new enterprise network or structured cabling system. This also allows the option of the maintenance of the LAN/WAN to be performed by the owner's Information Technology (IT) Department as all devices utilize standard TCP/IP components.
 6. System Expansion: The BMS shall be scalable and expandable at all levels using the same software interface and the same Level 1 and Level 2 controllers. Systems that require replacement of either the workstation software or field controllers in order to expand the system shall not be acceptable.
 - a. The BMS shall be expandable to include Video Surveillance and Access Control functions at any time in the future without requiring additional workstations, or Level 1 controllers. Biometric readers, keypads or proximity card access controllers shall be able to be added to the existing Level 1 network, to perform security and access

- control applications. In this way, an owner's existing investment in wiring infrastructure may be leveraged and the cost and inconvenience of adding new field bus wiring can be minimized.
- b. Additional web-based operator licenses shall be added in the field through an upgrade of the web server's security key, with no re-programming required.
7. Support for Open Systems Protocols: The BMS design must include solutions to integrate the following open system protocols: BACnet, Modbus, and digital data communication to third party microprocessors such as chiller controllers, smoke, fire and life safety panels and variable frequency drives (VFDs) – as required to complete the work.
- C. NETWORK CONTROL UNITS (NCUs) – Invensys Climate Control, controllers are basis of design
- 1. General: Upgrade existing NCU's to the latest version and software revision.
- D. LOCAL CONTROLLERS – Invensys Climate Control, controllers are basis of design.
- 1. General: Local Controllers shall provide control of HVAC, CRAC units, lighting, power metering, electrical monitoring, UPS, and leak detection. This may include air handling units, rooftop units, variable air volume boxes, unit ventilators, smoke, fire and life safety systems, and other mechanical equipment. Each controller shall be fully programmable, contain its own control programs and will continue to operate in the event of a failure or communication loss to its associated NAC.
 - 2. Hardware Specification:
 - a. Memory: Both the operating system of the controller, plus the application program for the controller, shall be stored in non-volatile, flash memory. Controllers shall contain enough memory for the current application, plus required history logging, plus a minimum of 20% additional free memory.
 - b. Communication Ports: Local Controllers shall have a RS-485 communication port field bus, operating at a speed of at least 19.2kbps.
 - c. Input/Output: Each local Controller shall have enough inputs and outputs to meet the application's required point count. Each local controller shall support universal inputs, whereas any input may be software-defined as:
 - 1) Digital Inputs for status/alarm contacts
 - 2) Counter Inputs for summing pulses from meters.
 - 3) Thermistor Inputs for measuring temperatures in space, ducts and thermowells.
 - 4) Analog inputs for pressure, humidity, flow and position measurements.
 - d. Local controllers must support both digital and analog output types:
 - 1) Digital Outputs for on/off equipment control.
 - 2) Analog Outputs for valve and damper position control, and capacity control of primary equipment.
 - e. Expandability: For larger controllers (16 base inputs and up), provide input and output expansion through the use of plug-in modules. At least two I/O modules must be capable of being added to the base Local Controller.
 - f. Networking: Each local controller will be able to exchange information on a peer to peer basis with other Interoperable Digital Controller. Each local controller shall be capable of storing and referencing global variables (on the LAN) with or without any workstations online. Each local controller shall be able to have its program viewed and/or enabled/disabled through a workstation connected to an NAC.
 - g. Indicator Lamps: Local Controllers will have as a minimum, LED indication of CPU status, and field bus status.
 - h. Real Time Clock (RTC): All Local Controllers shall have a real time clock in either hardware or software. The accuracy shall be within 10 seconds per day. The RTC shall provide the following information: time of day, day, month, year, and day of week. Each Local Controller shall receive a signal, every hour, over the network from the NAC, which synchronizes all Local Controllers real time clocks.
 - i. Automatic Restart after Power Failure: Upon restoration of power, the Local Controller shall automatically and without human intervention, update all monitored

- functions, resume operation based on current, synchronized time and status, and implement special start-up strategies as required.
- j. Battery Back Up: All Local Controllers shall store all programming in non-volatile flash memory. All Local Controllers except terminal controllers shall include an on-board lithium battery to back up the controller's RAM memory. The battery shall have a shelf life of over 10 years, and provide accumulated backup of all RAM and clock functions for at least 3 years. In the case of a power failure, the Local Controller shall first try to restart from the RAM memory. If that memory is corrupted or unusable, then the Local Controller shall restart itself from its application program stored in its flash memory.
3. Software Specification:
- a. General: The Local Controller shall contain flash memory to store both the resident operating system AND the application software. There will be no restrictions placed on the type of application programs in the system. Each Local Controller shall be capable of parallel processing, executing all control programs simultaneously. Any program may affect the operation of any other program. Each program shall have the full access of all I/O facilities of the processor. This execution of control function shall not be interrupted due to normal user communications including interrogation, program entry, printout of the program for storage, etc.
 - b. User Programming Language:
 - 1) The application software shall be user programmable. Controllers should be freely programmable. Fixed function controllers will not be accepted.
 - 2) Control Software, Mathematical Functions, and Energy Management Applications must be identical to that which is provided with the Network Area Controller.
 - c. History Logging: Each controller shall be capable of locally logging any input, output, calculated value or other system variable over user defined time intervals ranging from 1 second to 1440 minutes. Any system can be logged in history. A minimum of 1000 values shall be stored in each log. Each log can record either the instantaneous, average, minimum or maximum value of the point. Logged data shall be downloadable to the Operator Workstation for long term archiving based upon user-defined time intervals, or manual command.
 - d. Alarm Management:
 - 1) For each system point, alarms can be created based on high/low limits or conditional expressions. All alarms will be tested each scan of the Local Controllers and can result in the display of one or more alarm messages or reports.
 - 2) Up to 8 alarms can be configured for each point in the controller.
 - 3) Alarms will be generated based on their priority. A minimum of 255 priority levels shall be provided.
 - 4) If communication with the Operator Workstation is temporarily interrupted, the alarm will be time-stamped and buffered in the controller. When communications return, the alarm will be transmitted to the Operator Workstation if the point is still in the alarm condition.
4. Air Handler Controllers
- a. AHU Controllers shall be capable of meeting the requirements of the sequence of operation found in the Execution portion of this specification and for future expansion.
 - b. AHU Controllers shall support all the necessary point inputs and outputs as required by the sequence and operate in a standalone fashion.
 - c. AHU Controllers shall be fully user programmable to allow for modification of the application software.
5. Unitary Controllers – Invensys Controllers
- a. Unitary Controllers shall support, but not be limited to, control of the following systems as described in the Execution portion of this specification, and for future expansion:

- 1) Packaged Rooftops
 - b. The I/O of each Unitary Controller shall contain sufficient quantity and types, as required, to meet the sequence of operations found in the Execution portion of this specification. In addition, each controller shall have the capability for local time of day scheduling, occupancy mode control, after hour operation, lighting control, alarming, and trending.
- E. COMMUNICATIONS TO 3RD PARTY DEVICES
1. General: Where required, provide a Gateway to interface to that equipment that uses the Modbus protocol, or other proprietary or open protocols.
 2. Communication Ports: In addition to its on-board Ethernet port, the Gateway shall have at least two serial communications ports for interfaces to third-party systems.
 3. Memory: The Gateway shall have enough RAM memory to store all point configuration data, plus required history logging and alarm buffering. Minimum RAM shall be 8MB. The operating system of the gateway must be stored in flash non-volatile memory.
 4. User Programming Language:
 - a. The Gateway shall employ the same user programmable application software that NACs and Local Controllers use.
 - b. Control Software, Mathematical Functions, and Energy Management Applications must be identical to that which is provided with the Network Area Controller. Gateways that do not have an application programming language will not be accepted.
 5. History Logging: Each Gateway shall be capable of locally logging any input, output, calculated value or other system variable over user defined time intervals ranging from 1 second to 1440 minutes. Any system can be logged in history. A minimum of 1000 values shall be stored in each log. Each log can record either the instantaneous, average, minimum or maximum value of the point. Logged data shall be downloadable to the Operator Workstation for long term archiving based upon user-defined time intervals, or manual command.
- F. WORKSTATIONS AND SOFTWARE – Upgrade Existing Invensys Climate Control as Required
- G. DDC SENSORS AND POINT HARDWARE
1. General: Where indicated on the drawings, schedules or sequence of operations, provide equipment that conforms to the following specifications:
 2. Temperature Sensors:
 - a. All temperature devices shall use precision thermistors accurate to +/- 0.36°F over a range of -30 to 230°F.
 - b. Standard space sensors shall be provided in an off white enclosure for mounting on a standard electrical box.
 - c. Where manual override of unoccupied mode of control is indicated on the drawings or sequence of operation, provide a push button for selecting after hours operation.
 - d. Duct temperature sensors shall incorporate a thermistor bead embedded at the tip of a stainless steel tube. Probe style duct sensors shall be used in air handling applications where the air stream temperature is consistent and is not stratified.
 - e. Averaging sensors shall be employed in all mixing plenum applications and in any other application where the temperature might otherwise be stratified. The averaging sensor tube shall contain at least four thermistor sensors.
 - f. Immersion sensors shall be employed for measurement of temperature in all chilled water, hot water and glycol applications. Thermal wells shall be brass or stainless steel for non-corrosive fluids below 250 degrees F and 300 series stainless steel for all other applications.
 3. Pressure Sensors:
 - a. Air pressure or differential air pressure measurements in the range of 0 to 10" water column shall be accurate to +/- 1% of range using a solid-state sensing element. The range of the instrument selected shall be 2 times the operating pressure of the sensed variable. Acceptable manufacturer shall be Setra model C-264.

- b. Liquid pressure or differential liquid pressure measurements shall be accurate to +/- 0.25% of range using a solid-state sensing element. The range of the instrument selected shall be 2 times the operating pressure of the sensed variable. Unit shall be provided with isolation and bypass manifold for start-up and maintenance operations. Acceptable manufacturer shall be Setra model C-230.
- 4. Low Limit Thermostats:
 - a. Safety low limit thermostats shall be vapor pressure type with a 20 foot minimum element. Element shall respond to the lowest temperature sensed by any one foot section. Provide one thermostat for each 25 square foot of coil area.
 - b. Low limit thermostat shall be manual reset and shall be double pole so as to provide input capability for alarm at the BAS.
- 5. Current Sensing Status Switches
 - a. Current status switches shall be used to monitor the run status of fans, pumps, motors and electrical loads. Acceptable manufacturer is Veris or approved equal.
- 6. Control Valves
 - a. Provide automatic control valves suitable for the specified controlled media (water or glycol). Provide valves that mate and match the material of the connected piping.
 - b. Control valves shall meet the heating and cooling loads specified, and close off against the differential pressure conditions within the application. Valves should be sized to operate accurately and with stability from 10 to 100% of the maximum design flow. Valves shall be selected to provide an initial pressure drop of not more than 4 psig for water applications. For low pressure steam application, the pressure drop shall be equal to the supply pressure minus the heating element design inlet pressure.
 - c. Normal position of both heating and cooling valves shall be open. Three Way valves shall be piped to fail open to both heating and cooling.
 - d. Electric Bi-Directional actuators are acceptable on VAV Terminal Units and Reheat coil valve control if so noted.
 - e. All electric actuators for applications other than VAV terminal units and Reheat Coil valve Control shall be Proportional analog 4-20Ma or 0-10Vdc input and shall be positioned to reflect the output value of the computer control system and shall be spring return to normal position.
 - f. Belimo or equal
- 7. Dampers
 - a. Automatic dampers, furnished by the Building Automation Contractor shall be single or multiple blade as required. Dampers shall be installed by the HVAC Contractor under the supervision of the BAS Contractor. All blank-off plates and conversions necessary to install smaller than duct size dampers are the responsibility of the Sheet Metal Contractor.
 - b. Damper frames shall be hat shaped channel, 4" deep constructed of 16 gauge galvanized steel. Stainless steel side seals, and sintered bronze, oil-impregnated bearings shall also be provided.
 - c. Damper blades shall be 16 gauge galvanized steel and shall be 6" on center. Provide vinyl-grip seals on blades.
 - d. Provide damper linkage that consists of 0.50" diameter steel, cadmium plated and chromate treated pivots. Provide a 1/4-20 set-screw with a locking-patch to lock the pivots to a 0.31 diameter aluminum rod. Pivots shall rotate in a Celcon bearing. Blade brackets shall be 12 gauge cadmium plated steel. Blades shall be individually factory adjusted for maximum shut off.
 - e. Provide axles that are steel, 0.350" diameter cadmium plated and driveshafts that are 1/2" diameter cadmium plated steel, extendable 6".
 - f. For high performance applications, control dampers shall meet or exceed the UL Class I leakage rating.
 - g. Control dampers shall be Ruskin, Arrow or approved equal.

- h. Unless otherwise noted, provide opposed blade dampers for modulating applications and parallel blade for two-position control.

PART 3 - EXECUTION

3.01 CONTRACTOR RESPONSIBILITIES

- A. Demolition: Remove controls which do not remain as part of the building automation system, including all associated abandoned wiring, conduit, and pneumatic tubing within visible area of the new controls, up-to 10 feet away. The Owner will inform the Contractor of any equipment that is to be removed that will remain the property of the Owner. This equipment shall be handled with care so as not to damage it. All other equipment that is removed shall be disposed of by the Contractor.
- B. Cleanup: At the completion of the work, all equipment pertinent to this section shall be checked and thoroughly cleaned, and all other areas shall be cleaned around equipment provided under this section. Clean the exposed surfaces of tubing, hangers, and other exposed metal of grease, plaster, or other foreign materials.
- C. Wiring, Conduit and Cable
 - 1. ALL wiring (high voltage, 50 volts and greater) and conduit is to be installed in accordance with local and national electrical codes and Division 26 (Electrical Division) specification. Power circuitry shall originate from the nearest available 120V panel.
 - a. All temperature control cable less than 50 volts is to be considered low voltage.
 - b. All low voltage cable is to be run in conduit in any non-accessible concealed space and up to 10 ft. above floor level within mechanical rooms. Wiring above 10 ft or within accessible areas (ceilings, crawl spaces, between furred walls, enclosed chases) may be run exposed with proper support with bridle rings. Wiring is to be run parallel and perpendicular to building lines in a neat and workmanlike manner and bundled with nylon tie wraps.
 - c. Sensors and wiring on or in concrete or block walls for low voltage cable shall be surface mounted and enclosed in metallic wire-mold.
 - d. All low voltage cable shall be run separate from high voltage cable. All microprocessor communications cable shall be run separate from any low or high voltage cable.
 - e. Any cable running in plenum rated areas shall be plenum rated cable.
 - f. Wires and tubing shall be installed a minimum of three (3) inches from hot water, steam, or condensate piping.
 - g. A true earth ground shall be available in the building. Ground shall be run from the source electrical panel ground to each temperature control panel or controller.
 - h. Metallic surface raceway may be used in finished areas on non accessible masonry walls. All surface raceway in finished areas shall be color matched to the existing finish within the limitations of standard manufacturers' colors.

D. HARDWARE INSTALLATION

- 1. Installation Practices for Field Devices
 - a. Actuators shall be firmly mounted to give positive movement, and linkage shall be adjusted to give smooth continuous movement throughout 100 percent of the actuator stroke.
 - b. Actuators shall be stroked ~5%, tightened and returned to normal position to give a positive seal.
 - c. Relay outputs shall include transient suppression across all coils. Suppression devices shall limit transients to 150% of the rated coil voltage.
 - d. Water line mounted sensors shall be removable without shutting down the system in which they are installed.
 - e. 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.

- f. For building static pressure sensors, the high pressure port shall be inserted into the space via a metal tube. The low pressure port shall be piped to the outside of the building.
 2. Enclosures:
 - a. For all I/O requiring field interface devices, these devices where practical shall be mounted in a field interface panel (FIP). The Contractor shall provide an enclosure that protects the device(s) from dust and moisture, and conceals integral wiring and moving parts.
 - b. FIPs shall contain power supplies for sensors, interface relays and contactors, safety circuits, and I/P transducers.
 - c. The FIP enclosure shall be of steel construction with baked enamel finish, NEMA 1 rated with a hinged door and keyed lock. All locks shall be keyed identically.
 - d. All outside mounted enclosures shall meet the NEMA-4 rating.
- E. SOFTWARE INSTALLATION
1. General: The Contractor shall provide all labor necessary to install, initialize, start-up and debug all system software as described in this section. This includes any operating system software or other third party software necessary for successful operation of the system.
 2. Database Configuration: The Contractor shall provide all labor to configure those portions of the database that are required by the point list and sequence of operation.
 3. Color Graphic Slides: Unless otherwise directed by the owner, the Contractor shall provide color graphic displays as depicted in the schematic drawings for each system and floor plan. For each system or floor plan, the display shall contain the associated points identified in the point list and allow for setpoint changes as required by the owner.
- F. COMMISSIONING AND SYSTEM STARTUP
1. Point to Point Checkout: Each I/O device (both field mounted and those located in FIPs) shall be inspected and verified for proper installation and functionality. A checkout sheet itemizing each device shall be filled out, dated and approved by the Project Manager for submission to the owner or owner's representative.
 2. Controller and Workstation Checkout: A field checkout of all controllers and front-end equipment (computers, printers, modems, etc.) shall be conducted to verify proper operation of both hardware and software. A checkout sheet itemizing each device and a description of the associated tests shall be prepared and submitted to the owner or owner's representative by the completion of the project.
 3. System Acceptance Testing:
 - a. All application software shall be verified and compared against the sequences of operation. Control loops shall be exercised by inducing a setpoint shift of at least 10% and observing whether the system successfully returns the process variable to setpoint. Record all test results and attach to the Test Results Sheet.
 - b. Test each alarm in the system and validate that the system generates the appropriate alarm message, that the message appears at all prescribed destinations (workstations or printers), and that any other related actions occur as defined (i.e. graphic panels are invoked, reports are generated, etc.). Submit a Test Results Sheet to the owner.
 - c. Perform an operational test of each unique graphic display and report to verify that the item exists, that the appearance and content are correct, and that any special features work as intended. Submit a Test Results Sheet to the owner.
 - d. Perform an operational test of each third party interface that has been included as part of the automation system. Verify that all points are properly polled, that alarms have been configured, and that any associated graphics and reports have been completed. If the interface involves a file transfer over Ethernet, test any logic that controls the transmission of the file, and verify the content of the specified information.

END OF SECTION

This Page Intentionally Left Blank

SECTION 23 2113 HYDRONIC PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Hydronic system requirements.
- B. Heating water piping, above grade.
- C. Heating water and glycol piping, above grade.
- D. Chilled water piping, above grade.
- E. Equipment drains and overflows.
- F. Pipe hangers and supports.
- G. Unions, flanges, mechanical couplings, and dielectric connections.
- H. Valves:
 - 1. Ball valves.
 - 2. Butterfly valves.
 - 3. Check valves.
- I. Flow controls.

1.02 RELATED REQUIREMENTS

- A. Section 23 0516 - Expansion Fittings and Loops for HVAC Piping.
- B. Section 23 0553 - Identification for HVAC Piping and Equipment.
- C. Section 23 0719 - HVAC Piping Insulation.
- D. Section 23 2114 - Hydronic Specialties.
- E. Section 23 2500 - HVAC Water Treatment: Pipe cleaning.

1.03 REFERENCE STANDARDS

- A. ASME BPVC-IX - Boiler and Pressure Vessel Code, Section IX - Qualification Standard for Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing, and Fusing Operators 2021.
- B. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings 2018.
- C. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings 2018.
- D. ASME B31.9 - Building Services Piping 2020.
- E. ASTM A53/A53M - Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless 2020.
- F. ASTM A123/A123M - Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products 2017.
- G. ASTM A234/A234M - Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service 2019.
- H. ASTM A536 - Standard Specification for Ductile Iron Castings 1984 (Reapproved 2019)e1.
- I. ASTM B32 - Standard Specification for Solder Metal 2020.
- J. ASTM B88 - Standard Specification for Seamless Copper Water Tube 2020.
- K. ASTM B88M - Standard Specification for Seamless Copper Water Tube (Metric) 2020.
- L. ASTM D2000 - Standard Classification System for Rubber Products in Automotive Applications 2018.
- M. ASTM F1476 - Standard Specification for Performance of Gasketed Mechanical Couplings for Use in Piping Applications 2007 (Reapproved 2019).
- N. AWS A5.8M/A5.8 - Specification for Filler Metals for Brazing and Braze Welding 2019.

- O. AWS D1.1/D1.1M - Structural Welding Code - Steel 2020, with Errata (2021).
- P. AWWA C606 - Grooved and Shouldered Joints 2015.
- Q. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation 2018 (Amendment 2019).

1.04 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Welders Certificate: Include welders certification of compliance with ASME BPVC-IX.
- C. Product Data:
 - 1. Include data on pipe materials, pipe fittings, valves, and accessories.
 - 2. Provide manufacturers catalog information.
 - 3. Indicate valve data and ratings.
 - 4. Show grooved joint couplings, fittings, valves, and specialties on drawings and product submittals, specifically identified with the manufacturer's style or series designation.
- D. Manufacturer's Installation Instructions: Indicate hanging and support methods, joining procedures.

1.05 QUALITY ASSURANCE

- A. Provide all grooved joint couplings, fittings, valves, specialties, and grooving tools from a single manufacturer.
- B. Coupling Manufacturer:
 - 1. Perform on-site training by factory-trained representative to the Contractor's field personnel in the proper use of grooving tools and installation of grooved joint products.
 - 2. Periodic job site visits by factory-trained representative to ensure best practices in grooved joint installation.
 - 3. A distributor's representative is not considered qualified to perform the training.
- C. Welder Qualifications: Certify in accordance with ASME BPVC-IX.
 - 1. Provide certificate of compliance from authority having jurisdiction, indicating approval of welders.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.
- B. Provide temporary protective coating on cast iron and steel valves.
- C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.
- D. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

PART 2 PRODUCTS

2.01 HYDRONIC SYSTEM REQUIREMENTS

- A. Comply with ASME B31.9 and applicable federal, state, and local regulations.
- B. Piping: Provide piping, fittings, hangers, and supports as required, as indicated, and as follows:
 - 1. Where more than one piping system material is specified, provide joining fittings that are compatible with piping materials and ensure that the integrity of the system is not jeopardized.
 - 2. Use non-conducting dielectric connections whenever jointing dissimilar metals.
 - 3. Grooved mechanical joints may be used in accessible locations only.
 - a. Accessible locations include those exposed on interior of building, in pipe chases, and in mechanical rooms, aboveground outdoors, and as approved by Architect.
 - b. Use rigid joints unless otherwise indicated.
 - c. Use gaskets of molded synthetic rubber with central cavity, pressure-responsive configuration, and complying with ASTM D2000, Grade 2CA615A15B44F17Z for

circulating medium up to maximum 230 degrees F or Grade M3BA610A15B44Z for circulating medium up to maximum 200 degrees F.

4. Provide pipe hangers and supports in accordance with ASME B31.9 or MSS SP-58 unless indicated otherwise.
- C. Pipe-to-Valve and Pipe-to-Equipment Connections: Use flanges, unions, or grooved couplings to allow disconnection of components for servicing; do not use direct welded, soldered, or threaded connections.
- D. Valves: Provide valves where indicated:
 1. Provide drain valves where indicated, and if not indicated, provide at least at main shut-off, low points of piping, bases of vertical risers, and at equipment. Use 3/4 inch ball valves with cap; pipe to nearest floor drain.
 2. Isolate equipment using butterfly valves with lug end flanges or grooved mechanical couplings.
 3. For shut-off and to isolate parts of systems or vertical risers, use ball or butterfly valves.
- E. Welding Materials and Procedures: Comply with ASME BPVC-IX.

2.02 HEATING WATER AND GLYCOL PIPING, ABOVE GRADE

- A. Steel Pipe: ASTM A53/A53M, Schedule 40, black, using one of the following joint types:
 1. Welded Joints: ASTM A234/A234M, wrought steel welding type fittings; AWS D1.1/D1.1M welded.
 2. Grooved Joints: AWWA C606 grooved pipe, fittings of same material, and mechanical couplings.
- B. Copper Tube: ASTM B88 (ASTM B88M), Type L (B), drawn, using one of the following joint types:
 1. Solder Joints: ASME B16.18 cast brass/bronze or ASME B16.22 solder wrought copper fittings.
 - a. Solder: ASTM B32 lead-free solder, HB alloy (95-5 tin-antimony) or tin and silver.
 - b. Braze: AWS A5.8M/A5.8 BCuP copper/silver alloy.
 2. Tee Connections: Mechanically extracted collars with notched and dimpled branch tube.
 3. Mechanical Press Sealed Fittings: Double pressed type complying with ASME B16.22, utilizing EPDM, nontoxic synthetic rubber sealing elements.
 - a. Manufacturers:
 - 1) Apollo Valves: www.apollovalves.com/#sle.
 - 2) Grinnell Products: www.grinnell.com/#sle.
 - 3) Viega LLC: www.viega.us/#sle.

2.03 CHILLED WATER PIPING, ABOVE GRADE

- A. Steel Pipe: ASTM A53/A53M, Schedule 40, black; using one of the following joint types:
 1. Welded Joints: ASTM A234/A234M, wrought steel welding type fittings; AWS D1.1/D1.1M welded.
 2. Grooved Joints: AWWA C606 grooved pipe, fittings of same material, and mechanical couplings.
- B. Copper Tube: ASTM B88 (ASTM B88M), Type L (B), hard drawn; using one of the following joint types:
 1. Solder Joints: ASME B16.18 cast brass/bronze or ASME B16.22, solder wrought copper fittings.
 - a. Solder: ASTM B32 lead-free solder, HB alloy (95-5 tin-antimony) or tin and silver.
 2. Tee Connections: Mechanically extracted collars with notched and dimpled branch tube.
 3. Mechanical Press Sealed Fittings: Double pressed type complying with ASME B16.22, utilizing EPDM, nontoxic synthetic rubber sealing elements.
 - a. Manufacturers:
 - 1) Apollo Valves: www.apollovalves.com/#sle.
 - 2) Grinnell Products: www.grinnell.com/#sle.
 - 3) Viega LLC: www.viega.us/#sle.

2.04 EQUIPMENT DRAINS AND OVERFLOWS

- A. Copper Tube: ASTM B88 (ASTM B88M), Type L (B), drawn; using one of the following joint types:
 - 1. Solder Joints: ASME B16.18 cast brass/bronze or ASME B16.22 solder wrought copper fittings; ASTM B32 lead-free solder, HB alloy (95-5 tin-antimony) or tin and silver.

2.05 PIPE HANGERS AND SUPPORTS

- A. Provide hangers and supports that comply with MSS SP-58.
 - 1. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.
 - 2. Hangers for Pipe Sizes 1/2 to 1-1/2 Inches: Malleable iron, adjustable swivel, split ring.
 - 3. Hangers for Cold Pipe Sizes 2 Inches and Greater: Carbon steel, adjustable, clevis.
 - 4. Hangers for Hot Pipe Sizes 2 to 4 Inches: Carbon steel, adjustable, clevis.
 - 5. Hangers for Hot Pipe Sizes 6 Inches and Greater: Adjustable steel yoke, cast iron roll, double hanger.
 - 6. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
 - 7. Multiple or Trapeze Hangers for Hot Pipe Sizes 6 Inches and Greater: Steel channels with welded spacers and hanger rods, cast iron roll.
 - 8. Vertical Support: Steel riser clamp.
 - 9. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.
- B. In grooved installations, use rigid couplings with offsetting angle-pattern bolt pads or with wedge-shaped grooves in header piping to permit support and hanging in accordance with ASME B31.9.
- C. Rooftop Supports for Low-Slope Roofs: Steel pedestals with bases that rest on top of roofing membrane, not requiring any attachment to the roof structure and not penetrating the roofing assembly, with support fixtures as specified; and as follows:
 - 1. Bases: High-density polypropylene.
 - 2. Base Sizes: As required to distribute load sufficiently to prevent indentation of roofing assembly.
 - 3. Steel Components: Stainless steel or carbon steel hot-dip galvanized after fabrication in accordance with ASTM A123/A123M.
 - 4. Attachment/Support Fixtures: As recommended by manufacturer, same type as indicated for equivalent indoor hangers and supports; corrosion-resistant material.
 - 5. Height: Provide minimum clearance of 6 inches under pipe to top of roofing.
 - 6. Manufacturers:
 - a. PHP Systems/Design: www.phpsd.com/#sle.

2.06 UNIONS, FLANGES, MECHANICAL COUPLINGS, AND DIELECTRIC CONNECTIONS

- A. Unions for Pipe 2 Inches and Less:
 - 1. Copper Pipe: Bronze, soldered joints.
- B. Flanges for Pipe 2 Inches and Greater:
 - 1. Ferrous Piping: 150 psig forged steel, slip-on.
 - 2. Copper Piping: Bronze.
 - 3. Gaskets: 1/16 inch thick, preformed neoprene.
- C. Mechanical Couplings for Grooved and Shouldered Joints: Two or more curved housing segments with continuous key to engage pipe groove, circular C-profile gasket, and bolts to secure and compress gasket.
 - 1. Dimensions and Testing: In accordance with AWWA C606.
 - 2. Mechanical Couplings: Comply with ASTM F1476.
 - 3. Housing Material: Ductile iron, galvanized complying with ASTM A536.
 - 4. Gasket Material: EPDM suitable for operating temperature range from minus 30 degrees F to 230 degrees F.
 - 5. Bolts and Nuts: Hot dipped galvanized or zinc-electroplated steel.
 - 6. When pipe is field grooved, provide coupling manufacturer's grooving tools.

7. Manufacturers:
 - a. Anvil International: www.anvilintl.com/#sle.
 - b. Grinnell Products: www.grinnell.com/#sle.
 - c. Victaulic Company: www.victaulic.com/#sle.
- D. Dielectric Connections:
 1. Waterways:
 - a. Water impervious insulation barrier capable of limiting galvanic current to 1 percent of short circuit current in a corresponding bimetallic joint.
 - b. Dry insulation barrier able to withstand 600-volt breakdown test.
 - c. Construct of galvanized steel with threaded end connections to match connecting piping.
 - d. Suitable for the required operating pressures and temperatures.
 2. Flanges:
 - a. Dielectric flanges with same pressure ratings as standard flanges.
 - b. Water impervious insulation barrier capable of limiting galvanic current to 1 percent of short circuit current in a corresponding bimetallic joint.
 - c. Dry insulation barrier able to withstand 600-volt breakdown test.
 - d. Construct of galvanized steel with threaded end connections to match connecting piping.
 - e. Suitable for the required operating pressures and temperatures.

2.07 BALL VALVES

- A. Manufacturers:
 1. Anvil International: www.anvilintl.com/#sle.
 2. Apollo Valves: www.apollovalves.com/#sle.
 3. Victaulic Company: www.victaulic.com/#sle.
- B. Up To and Including 2 Inches:
 1. Bronze one piece body, stainless steel ball, teflon seats and stuffing box ring, lever handle with balancing stops, solder ends with union.
- C. Over 2 Inches:
 1. Ductile iron body, chrome plated stainless steel ball, teflon or Virgin TFE seat and stuffing box seals, lever handle or gear operated, flanged ends, rated to 800 psi.

2.08 BUTTERFLY VALVES

- A. Manufacturers:
 1. Anvil International: www.anvilintl.com/#sle.
 2. Apollo Valves: www.apollovalves.com/#sle.
 3. Victaulic Company: www.victaulic.com/#sle.
- B. Body: Cast or ductile iron with resilient replaceable EPDM seat, wafer, lug, or grooved ends, extended neck.
- C. Disc: Construct of chrome plated ductile iron, stainless steel, ductile iron with EPDM encapsulation, or Buna-N encapsulation.
- D. Stem: Stainless steel with stem offset from the centerline to provide full 360-degree circumferential setting.
- E. Operator: 10 position lever handle.

2.09 SWING CHECK VALVES

- A. Manufacturers:
 1. Anvil International: www.anvilintl.com/#sle.
 2. Apollo Valves: www.apollovalves.com/#sle.
 3. Victaulic Company: www.victaulic.com/#sle.
- B. Up To and Including 2 Inches:
 1. Bronze body, bronze trim, bronze rotating swing disc, with composition disc, solder ends.

- C. Over 2 Inches:
 - 1. Iron body, bronze trim, stainless steel or bronze swing disc, renewable disc and seat, flanged or grooved ends.

2.10 SPRING LOADED CHECK VALVES

- A. Manufacturers:
 - 1. Anvil International: www.anvilintl.com/#sle.
 - 2. Shurjoint Piping Products, Inc: www.shurjoint.com/#sle.
 - 3. Victaulic Company: www.victaulic.com/#sle.
- B. Iron body, bronze trim, split plate, hinged with stainless steel spring, resilient seal bonded to body, wafer, or threaded lug ends.

2.11 FLOW CONTROLS

- A. Manufacturers:
 - 1. Griswold Controls: www.griswoldcontrols.com/#sle.
 - 2. Hays Fluid Controls: www.haysfluidcontrols.com/#sle.
 - 3. ITT Bell & Gossett: www.bellgossett.com/#sle.
 - 4. Victaulic Company: www.victaulic.com/#sle.
- B. Construction: Class 125, Brass or bronze body with union on inlet and outlet, temperature and pressure test plug on inlet and outlet, blowdown/backflush drain.
- C. Calibration: Control flow within 10 percent of selected rating, over operating pressure range of 10 times minimum pressure required for control, minimum pressure 2 psi.

PART 3 EXECUTION

3.01 PREPARATION

- A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.
- B. Prepare pipe for grooved mechanical joints as required by coupling manufacturer.
- C. Remove scale and dirt on inside and outside before assembly.
- D. Prepare piping connections to equipment using jointing system specified.
- E. Keep open ends of pipe free from scale and dirt. Protect open ends with temporary plugs or caps.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install heating water, glycol, chilled water piping to ASME B31.9 requirements.
- C. Route piping in orderly manner, parallel to building structure, and maintain gradient.
- D. Install piping to conserve building space and to avoid interference with use of space.
- E. Group piping whenever practical at common elevations.
- F. Sleeve pipe passing through partitions, walls, and floors.
- G. Install firestopping to preserve fire resistance rating of partitions and other elements, using materials and methods specified.
- H. Slope piping and arrange to drain at low points.
- I. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. Refer to Section 22 0516.
- J. Grooved Joints:
 - 1. Install in accordance with the manufacturer's latest published installation instructions.
 - 2. Gaskets to be suitable for the intended service, molded, and produced by the coupling manufacturer.
- K. Inserts:
 - 1. Provide inserts for placement in concrete formwork.

2. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.
 3. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.
 4. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above slab.
- L. Pipe Hangers and Supports:
1. Install hangers to provide minimum 1/2-inch space between finished covering and adjacent work.
 2. Place hangers within 12 inches of each horizontal elbow.
 3. Use hangers with 1-1/2 inches minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.
 4. Support vertical piping at every other floor. Support riser piping independently of connected horizontal piping.
 5. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.
 6. Provide copper plated hangers and supports for copper piping.
- M. Provide clearance in hangers and from structure and other equipment for installation of insulation and access to valves and fittings. Refer to Section 22 0719.
- N. Install valves with stems upright or horizontal, not inverted.

3.03 SCHEDULES

- A. Hanger Spacing for Copper Tubing.
1. 1/2 Inch and 3/4 inch: Maximum span, 5 feet; minimum rod size, 1/4 inch.
 2. 1 Inch: Maximum span, 6 feet; minimum rod size, 1/4 inch.
 3. 1-1/2 Inches and 2 Inches: Maximum span, 8 feet; minimum rod size, 3/8 inch.
 4. 2-1/2 Inches: Maximum span, 9 feet; minimum rod size, 3/8 inch.
- B. Hanger Spacing for Steel Piping.
1. 2-1/2 Inches: Maximum span, 11 feet; minimum rod size, 3/8 inch.
 2. 3 Inches: Maximum span, 12 feet; minimum rod size, 3/8 inch.
 3. 4 Inches: Maximum span, 14 feet; minimum rod size, 1/2 inch.
 4. 6 Inches: Maximum span, 17 feet; minimum rod size, 1/2 inch.
 5. 8 Inches: Maximum span, 19 feet; minimum rod size, 5/8 inch.
 6. 10 Inches: Maximum span, 20 feet; minimum rod size, 3/4 inch.

END OF SECTION

This Page Intentionally Left Blank

**SECTION 23 2114
HYDRONIC SPECIALTIES**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Expansion tanks.
- B. Air vents.
- C. Air separators.
- D. Strainers.
- E. Suction diffusers.
- F. Pump connectors.
- G. Combination pump discharge valves.
- H. Pressure-temperature test plugs.
- I. Balancing valves.
- J. Combination flow controls.
- K. Relief valves.
- L. Pressure reducing valves.
- M. Glycol system.

1.02 RELATED REQUIREMENTS

- A. Section 23 2113 - Hydronic Piping.
- B. Section 23 2500 - HVAC Water Treatment: Pipe cleaning.

1.03 REFERENCE STANDARDS

- A. ASME BPVC-VIII-1 - Boiler and Pressure Vessel Code, Section VIII, Division 1: Rules for Construction of Pressure Vessels 2021.

PART 2 PRODUCTS

2.01 EXPANSION TANKS

- A. Manufacturers:
 - 1. Amtrol Inc: www.amtrol.com/#sle.
 - 2. ITT Bell & Gossett: www.bellgossett.com/#sle.
 - 3. Taco, Inc: www.taco-hvac.com/#sle.
- B. Construction: Welded steel, tested and stamped in accordance with ASME BPVC-VIII-1; supplied with National Board Form U-1, rated for working pressure of 125 psi, with flexible EPDM diaphragm or bladder sealed into tank, and steel support stand.
- C. Accessories: Pressure gauge and air-charging fitting, tank drain; precharge to 12 psi.
- D. Automatic Cold Water Fill Assembly: Pressure reducing valve, reduced pressure double check backflow preventer, test cocks, strainer, vacuum breaker, and valved by-pass.

2.02 AIR VENTS

- A. Manufacturers:
 - 1. Armstrong International, Inc: www.armstronginternational.com/#sle.
 - 2. ITT Bell & Gossett: www.bellgossett.com/#sle.
 - 3. Taco, Inc: www.taco-hvac.com/#sle.
- B. Manual Type: Short vertical sections of 2-inch diameter pipe to form air chamber, with 1/8 inch brass needle valve at top of chamber.
- C. Float Type:
 - 1. Brass or semi-steel body, copper, polypropylene, or solid non-metallic float, stainless steel valve and valve seat; suitable for system operating temperature and pressure; with

- isolating valve.
2. Cast iron body and cover, float, bronze pilot valve mechanism suitable for system operating temperature and pressure; with isolating valve.

2.03 AIR SEPARATORS

- A. Coalescing Air/Dirt Separators:
 1. Manufacturers:
 - a. Armstrong International, Inc: www.armstronginternational.com/#sle.
 - b. ITT Bell & Gossett: www.bellgossett.com/#sle.
 - c. Spirotherm, Inc: www.spirotherm.com/#sle.
 2. Tank: Fabricated steel tank; tested and stamped in accordance with ASME BPVC-VIII-1; for 150 psi operating pressure and 270 degrees F maximum operating temperature; subject to the requirements of the application and the manufacturer's standard maximum operating conditions.
 3. Coalescing Medium: Provide structured copper or stainless steel medium filling the entire vessel to suppress turbulence and provide air elimination efficiency of 100 percent free air, 100 percent entrained air, and 99.6 percent dissolved air at the installed location.
 4. Air Vent: Integral float actuated air vent at top fitting of tank rated at 150 psi, threaded to the top of the separator.
 5. Inlet and Outlet Connections: Threaded for 2 NPS and smaller; Class 150 flanged connections for 2-1/2 NPS and larger.
 6. Blowdown Connection: Threaded.
 7. Size: Match system flow capacity.

2.04 STRAINERS

- A. Manufacturers:
 1. Armstrong International, Inc: www.armstronginternational.com/#sle.
 2. Grinnell Products: www.grinnell.com/#sle.
 3. The Metraflex Company: www.metralflex.com/#sle.
- B. Size 2 inch and Under:
 1. Screwed brass or iron body for 175 psi working pressure, Y pattern with 1/32 inch stainless steel perforated screen.
- C. Size 2-1/2 inch to 4 inch:
 1. Provide flanged or grooved iron body for 175 psi working pressure, Y pattern with 1/16 inch or 3/64 inch stainless steel perforated screen.
- D. Size 5 inch and Larger:
 1. Provide flanged or grooved iron body for 175 psi working pressure, basket pattern with 1/8 inch stainless steel perforated screen.

2.05 SUCTION DIFFUSERS

- A. Manufacturers:
 1. Anvil International: www.anvilintl.com/#sle.
 2. ITT Bell & Gossett: www.bellgossett.com/#sle.
 3. Victaulic Company of America: www.victaulic.com/#sle.
- B. Fitting: Angle pattern, cast-iron body, threaded for 2 inch and smaller, flanged for 2-1/2 inch and larger, rated for 175 psi working pressure, with inlet vanes, cylinder strainer with 3/16 inch diameter openings, disposable 5/32 inch mesh strainer to fit over cylinder strainer, 20 mesh startup screen, and permanent magnet located in flow stream and removable for cleaning.
- C. Accessories: Adjustable foot support, blowdown tapping in bottom, gauge tapping in side.

2.06 PUMP CONNECTORS

- A. Manufacturers:
 1. The Metraflex Company: www.metralflex.com/#sle.
- B. Flexible Connectors: Flanged, braided type with wetted components of stainless steel, sized to match piping.

1. Maximum Allowable Working Pressure: 150 psig at 200 degrees F.
2. Accommodate the Following:
 - a. Axial Deflection in Compression and Expansion: 1 inch.
 - b. Lateral Movement: 1 inch.
 - c. Angular Rotation: 15 degrees.
 - d. Force developed by 1.5 times specified maximum allowable operating pressure.
3. End Connections: Same as specified for pipe jointing.

2.07 COMBINATION PUMP DISCHARGE VALVES

- A. Manufacturers:
 1. Anvil International: www.anvilintl.com/#sle.
 2. Taco, Inc: www.taco-hvac.com/#sle.
 3. Victaulic Company of America: www.victaulic.com/#sle.
- B. Valves: Straight or angle pattern, flanged cast-iron valve body with bolt-on bonnet for 175 psi operating pressure, non-slam check valve with spring-loaded bronze disc and seat, stainless steel stem, and calibrated adjustment permitting flow regulation.

2.08 PRESSURE-TEMPERATURE TEST PLUGS

- A. Construction: Brass body designed to receive temperature or pressure probe with removable protective cap, and Neoprene rated for minimum 200 degrees F.
- B. Application: Use extended length plugs to clear insulated piping.

2.09 BALANCING VALVES

- A. Manufacturers:
 1. Armstrong International, Inc: www.armstronginternational.com/#sle.
 2. Hays Fluid Controls: www.haysfluidcontrols.com/#sle.
 3. ITT Bell & Gossett: www.bellgossett.com/#sle.
- B. Size 2 inch and Smaller:
 1. Provide ball or globe style with flow balancing, flow measurement, and shut-off capabilities, memory stops, minimum of two metering ports and NPT threaded, soldered, or grooved connections.
 2. Metal construction materials consist of bronze or brass.
 3. Non-metal construction materials consist of Teflon, EPDM, or engineered resin.
- C. Size 2.5 inch and Larger:
 1. Provide globe style with flow balancing, flow measurement, and shut-off capabilities, memory stops, minimum of two metering ports and flanged, grooved, or weld end connections.
 2. Valve body construction materials consist of cast iron, carbon steel, or ductile iron.
 3. Internal components construction materials consist of brass, aluminum bronze, bronze, Teflon, EPDM, NORYL, or engineered resin.

2.10 COMBINATION FLOW CONTROLS

- A. Manufacturers:
 1. Armstrong International: www.armstronginternational.com/#sle.
 2. Hays Fluid Controls: www.haysfluidcontrols.com/#sle.
 3. ITT Bell & Gossett: www.bellgossett.com/#sle.
- B. Construction: Brass or bronze body with union on inlet and outlet, temperature and pressure test plug on inlet and outlet with blowdown/backflush drain.
- C. Calibration: Control flow within 10 percent of selected rating, over operating pressure range of 10 times minimum pressure required for control, minimum pressure 2 psi.
- D. Provide with inlet and outlet unions as required.
- E. Control Mechanism: Provide stainless steel or nickel-plated, brass piston or regulator cup, operating against stainless steel helical or wave formed spring or elastomeric diaphragm and polyphenylsulfone orifice plate.

2.11 RELIEF VALVES

- A. Manufacturers:
 - 1. Apollo Valves: www.apollovalves.com/#sle.
 - 2. Armstrong International, Inc: www.armstronginternational.com/#sle.
 - 3. ITT Bell & Gossett: www.bellgossett.com/#sle.
- B. Bronze body, teflon seat, stainless steel stem and springs, automatic, direct pressure actuated, capacities ASME certified and labelled.

2.12 PRESSURE REDUCING VALVES

- A. Manufacturers:
 - 1. Apollo Valves: www.apollovalves.com/#sle.
 - 2. Armstrong International, Inc: www.armstronginternational.com/#sle.
 - 3. ITT Bell & Gossett: www.bellgossett.com/#sle.
- B. Operation: Automatically feeds make-up water to the hydronic system whenever pressure in the system drops below the pressure setting of the valve. Refer to Section 23 2113.
- C. Materials of Construction:
 - 1. Valve Body: Constructed of bronze or brass.
 - 2. Internal Components: Construct of stainless steel or brass and engineered plastics or composition material.
- D. Connections:
 - 1. Soldered: 0.50 inch.
- E. Provide integral check valve and strainer.
- F. Maximum Fluid Temperature: 180 degrees F.

2.13 GLYCOL SYSTEM

- A. Mixing Tank: 55 gallon steel drum with fittings suitable for filling and hand pump for charging, rubber hose for connection of hand pump to system.
- B. Storage Tank: Closed type, welded-steel construction, tested and stamped in accordance with ASME BPVC-VIII-1; 100 psi rating; cleaned, prime coated, and supplied with steel support saddles. Construct with tappings for installation of accessories.
- C. Glycol Solution:
 - 1. Inhibited propylene glycol and water solution mixed 40 percent glycol - 60 percent water, suitable for operating temperatures from minus 40 degrees F to 250 degrees F.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install specialties in accordance with manufacturer's instructions.
- B. Where large air quantities can accumulate, provide enlarged air collection standpipes.
- C. Provide manual air vents at system high points and as indicated.
- D. For automatic air vents in ceiling spaces or other concealed locations, provide vent tubing to nearest drain.
- E. Provide air separator on suction side of system circulation pump and connect to expansion tank.
- F. Provide valved drain and hose connection on strainer blowdown connection.
- G. Provide pump suction fitting on suction side of base-mounted centrifugal pumps where indicated. Remove temporary strainers after cleaning systems.
- H. Provide combination pump discharge valve on discharge side of base mounted centrifugal pumps where indicated.
- I. Support pump fittings with floor-mounted pipe and flange supports.

- J. Provide relief valves on pressure tanks, low-pressure side of reducing valves, heat exchangers, and expansion tanks.
- K. Select system relief valve capacity so that it is greater than make-up pressure reducing valve capacity. Select equipment relief valve capacity to exceed rating of connected equipment.
- L. Clean and flush glycol system before adding glycol solution. Refer to Section 23 2500.
- M. Feed glycol solution to system through make-up line with pressure regulator, venting system high points.
- N. Perform tests determining strength of glycol and water solution and submit written test results.

END OF SECTION

This Page Intentionally Left Blank

SECTION 23 2123 HYDRONIC PUMPS

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. In-line circulators.
- B. Base-mounted pumps.

1.02 RELATED REQUIREMENTS

- A. Section 23 2113 - Hydronic Piping.
- B. Section 23 2114 - Hydronic Specialties.

1.03 REFERENCE STANDARDS

- A. UL 778 - Standard for Motor-Operated Water Pumps Current Edition, Including All Revisions.

1.04 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide certified pump curves showing performance characteristics with pump and system operating point plotted. Include NPSH curve when applicable. Include electrical characteristics and connection requirements.
- C. Millwright's Certificate: Certify that base mounted pumps have been aligned.
- D. Operation and Maintenance Data: Include installation instructions, assembly views, lubrication instructions, and replacement parts list.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Bell & Gossett, a Xylem Inc. brand: www.bellgossett.com/#sle.

2.02 HVAC PUMPS - GENERAL

- A. Provide pumps that operate at specified system fluid temperatures without vapor binding and cavitation, are non-overloading in parallel or individual operation, and operate within 25 percent of midpoint of published maximum efficiency curve.
- B. Base Mounted Pumps: Aligned by qualified millwright.
- C. Products Requiring Electrical Connection: Listed and classified by UL as suitable for the purpose specified and indicated.

2.03 IN-LINE CIRCULATORS

- A. Type: Horizontal shaft, single stage, direct connected, with resiliently mounted motor for in-line mounting, oil lubricated, for 125 psi maximum working pressure.
- B. Casing: Cast iron, with flanged pump connections.
- C. Impeller: Cadmium plated steel, keyed to shaft.
- D. Bearings: Permanently-lubricated ball bearings.
- E. Shaft: Stainless steel with bronze sleeve, integral thrust collar.
- F. Seal: Mechanical seal, 225 degrees F maximum continuous operating temperature.
- G. Drive: Flexible coupling.

2.04 BASE-MOUNTED PUMPS

- A. Type: Horizontal shaft, single stage, direct connected, radially or horizontally split casing, for 125 psi maximum working pressure.
- B. Casing: Cast iron, or ductile iron with suction and discharge gauge ports, renewable bronze casing wearing rings, seal flush connection, drain plug, flanged suction and discharge.
- C. Impeller: Bronze, fully enclosed, keyed to shaft.

- D. Bearings: Oil lubricated roller or ball bearings.
- E. Shaft: Alloy steel with copper, bronze, or stainless steel shaft sleeve.
- F. Seal: Mechanical seal, 225 degrees F maximum continuous operating temperature.
- G. Seal: Packing gland with minimum four rings graphite impregnated packing and bronze lantern rings, 250 degrees F maximum continuous operating temperature.
- H. Drive: Flexible coupling with coupling guard.
- I. Baseplate: Cast iron or fabricated steel with integral drain rim.

PART 3 EXECUTION

3.01 PREPARATION

- A. Verify that electric power is available and of the correct characteristics.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Provide access space around pumps for service. Provide no less than minimum space recommended by manufacturer.
- C. Decrease from line size with long radius reducing elbows or reducers. Support piping adjacent to pump such that no weight is carried on pump casings. For close-coupled or base-mounted pumps, provide supports under elbows on pump suction and discharge line sizes 4 inches and over.
- D. Provide line sized shut-off valve and pump suction fitting on pump suction, and line sized combination pump discharge valve on pump discharge.
- E. Check, align, and certify alignment of base-mounted pumps prior to start-up.
- F. Lubricate pumps before start-up.
- G. Provide side-stream filtration system for closed loop systems. Install across pump with flow from pump discharge to pump suction from pump tapplings.

END OF SECTION

SECTION 23 2300 REFRIGERANT PIPING

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Piping.
- B. Refrigerant.
- C. Moisture and liquid indicators.
- D. Valves.
- E. Strainers.
- F. Filter-driers.
- G. Expansion valves.
- H. Flexible connections.

1.02 RELATED REQUIREMENTS

- A. Section 23 0719 - HVAC Piping Insulation.

1.03 REFERENCE STANDARDS

- A. AHRI 750 - Thermostatic Refrigerant Expansion Valves 2007.
- B. ASHRAE Std 15 - Safety Standard for Refrigeration Systems 2019, with All Amendments and Errata.
- C. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings 2018.
- D. ASME B31.5 - Refrigeration Piping and Heat Transfer Components 2020.
- E. ASTM B280 - Standard Specification for Seamless Copper Tube for Air Conditioning and Refrigeration Field Service 2020.
- F. AWS A5.8M/A5.8 - Specification for Filler Metals for Brazing and Braze Welding 2019.
- G. MSS SP-58 - Pipe Hangers and Supports - Materials, Design, Manufacture, Selection, Application, and Installation 2018 (Amendment 2019).
- H. UL 207 - Standard for Refrigerant-Containing Components and Accessories, Nonelectrical Current Edition, Including All Revisions.

1.04 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide general assembly of specialties, including manufacturers catalogue information. Provide manufacturers catalog data including load capacity.
- C. Shop Drawings: Indicate schematic layout of system, including equipment, critical dimensions, and sizes.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Deliver and store piping and specialties in shipping containers with labeling in place.
- B. Protect piping and specialties from entry of contaminating material by leaving end caps and plugs in place until installation.
- C. Dehydrate and charge components such as piping and receivers, seal prior to shipment, until connected into system.

PART 2 PRODUCTS

2.01 PIPING

- A. Copper Tube: ASTM B280, H58 hard drawn or O60 soft annealed.
 - 1. Fittings: ASME B16.22 wrought copper.
 - 2. Joints: Braze, AWS A5.8M/A5.8 BCuP silver/phosphorus/copper alloy.

- B. Pipe Supports and Anchors:
1. Provide hangers and supports that comply with MSS SP-58.
 - a. If type of hanger or support for a particular situation is not indicated, select appropriate type using MSS SP-58 recommendations.
 2. Hangers for Pipe Sizes 1/2 to 1-1/2 Inch: Malleable iron adjustable swivel, split ring.
 3. Hangers for Pipe Sizes 2 Inches and Over: Carbon steel, adjustable, clevis.
 4. Multiple or Trapeze Hangers: Steel channels with welded spacers and hanger rods.
 5. Wall Support for Pipe Sizes to 3 Inches: Cast iron hook.
 6. Vertical Support: Steel riser clamp.
 7. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.
 8. Hanger Rods: Mild steel threaded both ends, threaded one end, or continuous threaded.
 9. Inserts: Malleable iron case of galvanized steel shell and expander plug for threaded connection with lateral adjustment, top slot for reinforcing rods, lugs for attaching to forms; size inserts to suit threaded hanger rods.

2.02 REFRIGERANT

- A. Refrigerant: Use only refrigerants that have ozone depletion potential (ODP) of zero and global warming potential (GWP) of less than 50.

2.03 MOISTURE AND LIQUID INDICATORS

- A. Indicators: Single port type, UL listed, with copper or brass body, flared or solder ends, sight glass, color coded paper moisture indicator with removable element cartridge and plastic cap; for maximum temperature of 200 degrees F and maximum working pressure of 500 psi.

2.04 VALVES

- A. Diaphragm Packless Valves:
1. UL listed, globe or angle pattern, forged brass body and bonnet, phosphor bronze and stainless steel diaphragms, rising stem and handwheel, stainless steel spring, nylon seat disc, solder or flared ends, with positive backseating; for maximum working pressure of 500 psi and maximum temperature of 275 degrees F.
- B. Packed Angle Valves:
1. Forged brass or nickel plated forged steel, forged brass seal caps with copper gasket, rising stem and seat with backseating, molded stem packing, solder or flared ends; for maximum working pressure of 500 psi and maximum temperature of 275 degrees F.
- C. Service Valves:
1. Forged brass body with copper stubs, brass caps, removable valve core, integral ball check valve, flared or solder ends, for maximum pressure of 500 psi.

2.05 STRAINERS

- A. Straight Line or Angle Line Type:
1. Brass or steel shell, steel cap and flange, and replaceable cartridge, with screen of stainless steel wire or monel reinforced with brass; for maximum working pressure of 430 psi.

2.06 FILTER-DRIERS

- A. Performance:
1. Flow Capacity - Liquid Line: As indicated in schedule, minimum, rated in accordance with AHRI 710.
 2. Pressure Drop: 2 psi, maximum, when operating at full connected evaporator capacity.
 3. Design Working Pressure: 350 psi, minimum.
- B. Cores: Molded or loose-fill molecular sieve desiccant compatible with refrigerant, activated alumina, activated charcoal, and filtration to 40 microns, with secondary filtration to 20 microns; of construction that will not pass into refrigerant lines.
- C. Construction: UL listed.
1. Connections: As specified for applicable pipe type.

2.07 EXPANSION VALVES

- A. Angle or Straight Through Type: AHRI 750; design suitable for refrigerant, brass body, internal or external equalizer, bleed hole, adjustable superheat setting, replaceable inlet strainer, with non-replaceable capillary tube and remote sensing bulb and remote bulb well.
- B. Selection: Evaluate refrigerant pressure drop through system to determine available pressure drop across valve. Select valve for maximum load at design operating pressure and minimum 10 degrees F superheat. Select to avoid being undersized at full load and excessively oversized at part load.

2.08 FLEXIBLE CONNECTORS

- A. Corrugated stainless steel hose with single layer of stainless steel exterior braiding, minimum 9 inches long with copper tube ends; for maximum working pressure of 500 psi.

PART 3 EXECUTION

3.01 PREPARATION

- A. Ream pipe and tube ends. Remove burrs.
- B. Remove scale and dirt on inside and outside before assembly.
- C. Prepare piping connections to equipment with flanges or unions.

3.02 INSTALLATION

- A. Install refrigeration specialties in accordance with manufacturer's instructions.
- B. Route piping in orderly manner, with plumbing parallel to building structure, and maintain gradient.
- C. Install piping to conserve building space and avoid interference with use of space.
- D. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment.
- E. Pipe Hangers and Supports:
 - 1. Install in accordance with ASME B31.5.
 - 2. Support horizontal piping as indicated.
 - 3. Install hangers to provide minimum 1/2 inch space between finished covering and adjacent work.
 - 4. Place hangers within 12 inches of each horizontal elbow.
- F. Arrange piping to return oil to compressor. Provide traps and loops in piping, and provide double risers as required. Slope horizontal piping 0.40 percent in direction of flow.
- G. Provide clearance for installation of insulation and access to valves and fittings.
- H. Flood piping system with nitrogen when brazing.
- I. Follow ASHRAE Std 15 procedures for charging and purging of systems and for disposal of refrigerant.
- J. Fully charge completed system with refrigerant after testing.

3.03 SCHEDULES

- A. Hanger Spacing for Copper Tubing.
 - 1. 1/2 inch, 5/8 inch, and 7/8 inch OD: Maximum span, 5 feet; minimum rod size, 1/4 inch.
 - 2. 1-1/8 inch OD: Maximum span, 6 feet; minimum rod size, 1/4 inch.
 - 3. 1-3/8 inch OD: Maximum span, 7 feet; minimum rod size, 3/8 inch.
 - 4. 1-5/8 inch OD: Maximum span, 8 feet; minimum rod size, 3/8 inch.
 - 5. 2-1/8 inch OD: Maximum span, 8 feet; minimum rod size, 3/8 inch.

END OF SECTION

This Page Intentionally Left Blank

**SECTION 23 2500
HVAC WATER TREATMENT**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Materials.
 - 1. System cleaner.
 - 2. Closed system treatment (water).
- B. By-pass (pot) feeder.
- C. Water meter.
- D. Side-stream filtration equipment.

1.02 RELATED REQUIREMENTS

- A. Section 23 2113 - Hydronic Piping.
- B. Section 23 2114 - Hydronic Specialties.

1.03 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide chemical treatment materials, chemicals, and equipment including electrical characteristics and connection requirements.
- C. Manufacturer's Installation Instructions: Indicate placement of equipment in systems, piping configuration, and connection requirements.

1.04 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience. Company shall have local representatives with water analysis laboratories and full time service personnel.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Nalco, an Ecolab Company: www.nalco.com/#sle.

2.02 REGULATORY REQUIREMENTS

- A. Perform work in accordance with local health department regulations.

2.03 MATERIALS

- A. System Cleaner:
 - 1. Liquid alkaline compound with emulsifying agents and detergents to remove grease and petroleum products; sodiumtripoly phosphate and sodium molybdate.
- B. Closed System Treatment (Water):
 - 1. Sequestering agent to reduce deposits and adjust pH; polyphosphate.
 - 2. Corrosion inhibitors; boron-nitrite, sodium nitrite and borax, sodium totyltriazole, low molecular weight polymers, phosphonates, sodium molybdate, or sulphites.

2.04 BY-PASS (POT) FEEDER

- A. Manufacturers:
 - 1. Griswold Controls: www.griswoldcontrols.com/#sle.
 - 2. J. L. Wingert Company: www.jlwingert.com/#sle.
 - 3. Neptune, a brand of the Dover Company: www.neptune1.com/#sle.
- B. 1.8 gal quick opening cap for working pressure of 175 psi.

2.05 WATER METER

- A. Displacement type cold water meter with sealed, tamper-proof magnetic drive, impulse contact register, single pole, double throw dry contact switch.

2.06 SIDE-STREAM FILTRATION SYSTEM

- A. System: Flow indicator, filter housing with cartridge filter, shut-off valves, and flow control valve.
- B. Hot Water and Glycol Filter Housing: Glass reinforced nylon plastic suitable for 220 degrees F and 200 psi operating conditions.
- C. Chilled Water Filter Housing: Reinforced polypropylene plastic housing suitable for 125 degrees F and 125 psi operating conditions.
- D. Cartridges: 30 micron for start-up and 5 micron for system operation.

PART 3 EXECUTION

3.01 PREPARATION

- A. Systems shall be operational, filled, started, and vented prior to cleaning. Use water meter to record capacity in each system.
- B. Place terminal control valves in open position during cleaning.
- C. Verify that electric power is available and of the correct characteristics.

3.02 CLEANING SEQUENCE

- A. Hot Water Heating Systems:
 - 1. Apply heat while circulating, slowly raising temperature to 160 degrees F and maintain for 12 hours minimum.
 - 2. Remove heat and circulate to 100 degrees F or less; drain systems as quickly as possible and refill with clean water.
 - 3. Circulate for 6 hours at design temperatures, then drain.
 - 4. Refill with clean water and repeat until system cleaner is removed.
- B. Chilled Water Systems:
 - 1. Circulate for 48 hours, then drain systems as quickly as possible.
 - 2. Refill with clean water, circulate for 24 hours, then drain.
 - 3. Refill with clean water and repeat until system cleaner is removed.
- C. Flush open systems and glycol filled closed systems with clean water for one hour minimum. Drain completely and refill.
- D. Remove, clean, and replace strainer screens.
- E. Inspect, remove sludge, and flush low points with clean water after cleaning process is completed. Include disassembly of components as required.

3.03 INSTALLATION

- A. Install in accordance with manufacturer's instructions.

3.04 CLOSED SYSTEM TREATMENT

- A. Provide one bypass feeder on each system. Install isolating and drain valves and necessary piping. Install around balancing valve downstream of circulating pumps unless indicated otherwise.
- B. Introduce closed system treatment through bypass feeder when required or indicated by test.
- C. Provide 3/4 inch water coupon rack around circulating pumps with space for 4 test specimens.

END OF SECTION

SECTION 23 3100.23
TEXTILE AIR DISPERSION DUCTWORK

PART 1 GENERAL

1.01 GENERAL NOTE:

- A. Fabric duct dispersion systems are shown for size, material, and method of hanging. Method of air distribution from manufacturer, such as: laser cut linear vents, orifices, or nozzles and the orientation of these devices, must be submitted through detailed shop drawings. Shop drawings must show air volume performance, precise air throw velocity distances and specific orientation of venting. Method of fabric duct suspension from manufacturer must comply with published specifications, drawing notes as indicated, and submitted through detailed shop drawings. Prior to fabrication approval of fabric duct, the mechanical engineer of record shall appraise submittal content for accuracy. Fabric duct manufacturer deviating from written specifications, drawing notes, drawings details or neglecting to provide the stated information will not be approved.

1.02 DESCRIPTION OF WORK:

- A. Extent of non-metal ductwork is indicated on drawings and by requirements of this section.
- B. Types of non-metal ductwork required for this project include the following:
 - 1. Textile Air Dispersion Products.

1.03 QUALITY ASSURANCE:

- A. Building Codes and Standards:
 - 1. Product must be Classified by Underwriter's Laboratories in accordance with the 25/50 flame spread / smoke developed requirements of NFPA 90-A and UL 2518.
 - 2. All product sections must be labeled with the logo and classification marking of Underwriter's Laboratories.
- B. Design & Quality Control
 - 1. Manufacturer must have documented design support information including duct sizing; vent, orifice, and/or nozzle location; vent, orifice, and/or nozzle sizing; length; and suspension. Parameters for design, including maximum air temperature, velocity, pressure and textile permeability, shall be considered and documented.

1.04 SUBMITTALS:

- A. Product Data: Submit manufacturer's specifications on materials and manufactured products used for work of this section.
- B. Building Code Data: Submit UL file number under which product is Classified by Underwriter's Laboratories for both NFPA 90-A and UL 2518.
- C. Provide detailed drawings confirming configuration of Textile Dispersion System (diameter, lengths, airflow, pressure, and textile permeability).
- D. Provide detailed installation instructions for components to be installed.
- E. Provide warranty and maintenance documentation.

1.05 WARRANTY:

- A. Manufacturer must provide a 10 Year Product Warranty for products supplied for the fabric portion of this system as well as a Design and Performance Warranty.

1.06 DELIVERY, STORAGE AND HANDLING:

- A. Protect textile air dispersion system and SkeleCore Pull-Tight components from damage during shipping, storage, and handling.
- B. Where possible, store products inside and protect from weather. Where necessary to store outside, store above grade and enclose with a vented waterproof wrapping.

PART 2 PRODUCTS

2.01 MANUFACTURER:

- A. DuctSox Corporation.

B. Approved Equal.

2.02 TEXTILE AIR DISPERSION SYSTEM:

- A. SkeleCore Pull-Tight System: Air diffusers shall be constructed with both internal retention and external tensioning.
1. System shall consist of internal tensioning baskets with cable or track stops that externally tension the system off of the suspension system selected below along with 360 degree internal retention hoops that are spaced 5' on center between tensioning baskets.
 2. Tensioning baskets are designed to self-lock when tension is applied to the system.
 3. All straight sections utilize both internal retention hoops and external tensioning with the use of the tension baskets, all fittings(crosses, elbows, reducers, and tees) utilize internal retention hoops.
 4. Distance between consecutive tensioning baskets should not be more than 40'.
 5. System shall be installed with a one row suspension system located 1.5" above top-dead-center of the textile system.
 6. System attachment to cable or U-Track shall be made using Gliders spaced no further than 12 inches apart.
 7. Available for diameters from 8" – 60".
 8. Not available for natatorium applications.
 9. One row suspension options(must specify if multiple on same project)
 - a. Cable suspension hardware to include cable, eye bolts, thimbles, cable clamps, and turnbuckle(s) as required.
 - 1) Cable suspension options(must specify if multiple on same project)
 - (a) Galvanized steel cable
 - (b) Stainless steel cable
 - 2) Support lengths available in 5'(standard), 10', 15', & 30'.
 - b. U-Track suspension hardware to include 8' sections of aluminum track, aluminum splice connectors, track endcaps and vertical cable support kits – consisting of a length of cable with cable connectors. Radius aluminum track must be included for all horizontal/flat radius sections.
 - 1) U-Track suspension options(must specify if multiple on same project)
 - (a) Galvanized steel cable
 - (b) Stainless steel cable
 - 2) Support lengths available in 5'(standard), 10', 15', & 30'.
- B. TEXTILE
1. Verona NP
 - a. Textile Construction: Filament/filament twill polyester, fire retardant in accordance with UL 2518.
 - b. Air Permeability: 0.7 CFM/ft² per ASTM D737, Frazier
 - c. Weight: 6.5 oz. /yd² per ASTM D3776
 - d. Warranty: 10 years
 2. Textile Color
 - a. Standard: blue, white, tan, red, green, silver, black
 - b. Custom
- C. TEXTILE SYSTEM FABRICATION REQUIREMENTS:
1. Textile system to be constructed in modular lengths (zippered) with proper radial securing clips (inlets, endcaps, and mid-sections) and top access zippers for tension lock attachments.
 2. Integrated air dispersion shall be specified and approved by manufacturer. (select only those that apply)
 - a. Linear Vents (Preferred)
 - 1) Air dispersion accomplished by linear vent and permeable fabric. Linear vents must be sized in 1 CFM per linear foot increments (based on .5" SP), starting a 1 CFM through 90 CFM per linear foot. Linear vent is to consist of an array of

- open orifices rather than a mesh style vent to reduce maintenance requirements of mesh style vents. Linear vents should also be designed to minimize dusting on fabric surface.
- 2) Size of vent openings and location of linear vents to be specified and approved by manufacturer.
- b. Orifices – 2" & 3" SG's (Sewn-in Grommets)(Optional)
 - 1) Air dispersion and extended throws are accomplished by reinforced orifices and permeable fabric. Reinforced orifices are to be installed to keep the integrity of opening and withstand laundry processes.
 - 2) Diameter, quantity, and location of reinforced orifices to be specified and approved by manufacturer.
 - c. Fixed Nozzles (Optional)
 - 1) Air dispersion accomplished by using conical aerodynamic nozzles and permeable fabric. Diameter of nozzles height to be minimum ½". Due to exact requirements of throw and maximum level of noise alternative flow models are not acceptable.
 - 2) Color of nozzles must match color of fabric. Unless otherwise specifically mentioned on drawings or otherwise in this specification, suppliers standard table is used for selection of color.
 - 3) Location and number of nozzles to be specified and approved by manufacturer.
 - d. Adjustable Nozzles (Optional) x
 - 1) Air dispersion accomplished by adjustable ball nozzles and permeable fabric. Adjustable ball nozzles to have multiaxial rotation to redirect airflow to desired area. Adjustable ball nozzles are able to completely close off airflow without adding caps or plugs. Adjustable ball nozzles should lock into place once set, preventing constant adjustment. Adjustable ball nozzle should have inset design to be a condensation resistant product.
 - 2) Colors of adjustable nozzles available are white and black. With white material receiving white adjustable nozzles and all other material colors receiving black adjustable nozzles unless otherwise specifically mentioned on drawings or otherwise in the specification.
 - 3) Quantity and location of adjustable ball nozzles to be specified and approved by manufacturer.
3. Inlet connection to metal duct via fabric draw band with anchor patches as supplied by manufacturer. Anchor patches to be secured to metal duct via. zip screw fastener – supplied by contractor.
 4. Inlet connection includes zipper for easy removal / maintenance.
 5. Lengths to include required intermediate zippers as specified by manufacturer.
 6. System to include Adjustable Flow Devices to balance turbulence, airflow and distribution as needed. Flow restriction device shall include ability to adjust the airflow resistance from 0.06 – 0.60 in w.g. static pressure.
 7. End cap includes zipper for easy maintenance.
 8. Each section of the textile shall include identification labels documenting order number, section diameter, section length, piece number, code certifications and other pertinent information.
- D. DESIGN PARAMETERS:
1. Textile air diffusers shall be designed from 0.25" water gage minimum to 3.1" maximum, with 0.5" as the standard.
 2. Textile air diffusers shall be limited to design temperatures between 0 degrees F and 180 degrees F (-17.8 degrees C and 82 degrees C).
 3. System overall design; diameter, length, airflow, operating static pressure and dispersion shall be designed or approved by the manufacturer.
 4. Do not use textile diffusers in concealed locations.
 5. Use textile air dispersion systems only for positive pressure air distribution components of the mechanical ventilation system.

PART 3 EXECUTION

3.01 INSTALLATION OF TEXTILE AIR DISPERSION SYSTEM:

- A. Install chosen suspension system in accordance with the requirements of the manufacturer. Instructions for installation shall be provided by the manufacturer with product.

3.02 CLEANING AND PROTECTION:

- A. Clean air handling unit and ductwork prior to the DuctSox system unit-by-unit as it is installed. Clean external surfaces of foreign substance which may cause corrosive deterioration of facing.
- B. Temporary Closure: At ends of ducts which are not connected to equipment or distribution devices at time of ductwork installation, cover with polyethylene film or other covering which will keep the system clean until installation is completed.
- C. If DuctSox systems become soiled during installation, they should be removed and cleaned following the manufacturers standard terms of laundry.

END OF SECTION

**SECTION 23 3100
HVAC DUCTS AND CASINGS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Metal ductwork.
- B. Nonmetal ductwork.
- C. Kitchen hood ductwork.

1.02 RELATED REQUIREMENTS

- A. Section 23 0593 - Testing, Adjusting, and Balancing for HVAC.
- B. Section 23 0713 - Duct Insulation: External insulation and duct liner.
- C. Section 23 3300 - Air Duct Accessories.
- D. Section 23 3700 - Air Outlets and Inlets.

1.03 REFERENCE STANDARDS

- A. ASTM A36/A36M - Standard Specification for Carbon Structural Steel 2019.
- B. ASTM A653/A653M - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process 2020.
- C. ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar 2015.
- D. ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate 2014.
- E. ASTM B209M - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric) 2014.
- F. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials 2021a.
- G. ICC-ES AC01 - Acceptance Criteria for Expansion Anchors in Masonry Elements 2015.
- H. ICC-ES AC193 - Acceptance Criteria for Mechanical Anchors in Concrete Elements 2015.
- I. NFPA 96 - Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations 2021.
- J. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible 2020.
- K. SMACNA (KVS) - Kitchen Ventilation Systems and Food Service Equipment Fabrication and Installation Guidelines 2001.
- L. SMACNA (LEAK) - HVAC Air Duct Leakage Test Manual 2012.

1.04 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data for duct materials.
- C. Shop Drawings:
 - 1. Prepare 1/4 inch scale or larger drawings within 30 days after contract award for all areas.
 - a. Incorporate dimensions of actual equipment used. (Including light fixtures, structural steel etc.)
 - b. Show adequate sections, elevations and plan views.
 - c. Indicate all dampers and other required accessories.
 - d. indicate size, type, and location of all access doors.
 - e. Include size and location of all floor, wall and roof openings.
 - f. Indicate elevation above floor and ceiling height for each room.
 - g. Indicate SMACNA pressure class required for all duct.
 - 2. Identify in writing, any deviations from contract Drawings and Specifications.
 - a. Highlight all changes from plans required by obstructions and job conditions.

- b. If shop standards do not conform in detail to specifications, submit for approval annotated shop standards showing upgrades as required for conformance.
- c. Call to Architect's attention, in writing by separate letter along with samples for clarification, any proposed deviations from contract plans and specifications.

1.05 FIELD CONDITIONS

- A. Do not install duct sealants when temperatures are less than those recommended by sealant manufacturers.

PART 2 PRODUCTS

2.01 DUCT ASSEMBLIES

- A. Regulatory Requirements: Construct ductwork to comply with NFPA 90A standards.
- B. Ducts: Galvanized steel, unless otherwise indicated.
- C. Low Pressure Supply (Heating Systems): 2 inch w.g. pressure class, galvanized steel.
- D. Low Pressure Supply (System with Cooling Coils): 2 inch w.g. pressure class, galvanized steel.
- E. Return and Relief: 1 inch w.g. pressure class, galvanized steel.
- F. General Exhaust: 1 inch w.g. pressure class, galvanized steel.
- G. Locker Room and Shower Room Exhaust: 1 inch w.g. pressure class, aluminum.
- H. Kitchen Cooking Hood Exhaust: 1 inch w.g. pressure class, stainless steel.
 - 1. Construct of 16 gage, 0.0598 inch sheet steel using continuous external welded joints in rectangular sections.
- I. Dishwasher Exhaust: 1 inch w.g. pressure class, stainless steel.
 - 1. Construct of 16 gage, 0.0598 inch sheet steel using continuous external welded joints in rectangular sections.
- J. Grease Exhaust: 1 inch w.g. pressure class, stainless steel.
 - 1. Construct of 18 gage, 0.0500 inch stainless steel.
 - 2. Construction:
 - a. Where ducts are not self draining back to equipment, provide low point drain pocket with copper drain pipe to sanitary sewer.
 - 3. Access Doors:
 - a. Provide for duct cleaning inside horizontal duct at drain pockets, every 20 feet and at each change of direction.
 - b. Use same material and thickness as duct with gaskets and sealants rated 1500 degrees F for grease tight construction.
- K. Outside Air Intake: 1 inch w.g. pressure class, galvanized steel.
- L. Combustion Air: 1 inch w.g. pressure class, galvanized steel.
- M. Transfer Air and Sound Boots: 1/2 inch w.g. pressure class, sound lined galvanized steel..

2.02 MATERIALS

- A. Galvanized Steel for Ducts: Hot-dipped galvanized steel sheet, ASTM A653/A653M FS Type B, with G60/Z180 coating.
- B. Aluminum for Ducts: ASTM B209 (ASTM B209M); aluminum sheet, alloy 3003-H14. Aluminum Connectors and Bar Stock: Alloy 6061-T651 or of equivalent strength.
- C. Stainless Steel for Ducts: ASTM A666, Type 304.
- D. Joint Sealers and Sealants: Non-hardening, water resistant, mildew and mold resistant.
 - 1. Type: Heavy mastic or liquid used alone or with tape, suitable for joint configuration and compatible with substrates, and recommended by manufacturer for pressure class of ducts.
 - 2. Surface Burning Characteristics: Flame spread index of zero and smoke developed index of zero, when tested in accordance with ASTM E84.
 - 3. For Use With Flexible Ducts: UL labeled.

- E. Gasket Tape: Provide butyl rubber gasket tape for a flexible seal between transfer duct connector (TDC), transverse duct flange (TDF), applied flange connections, and angle rings connections.
- F. Hanger Rod: ASTM A36/A36M; steel, galvanized; threaded both ends, threaded one end, or continuously threaded.
- G. Hanger Fasteners: Attach hangers to structure using appropriate fasteners, as follows:
 - 1. Concrete Wedge Expansion Anchors: Complying with ICC-ES AC193.
 - 2. Masonry Wedge Expansion Anchors: Complying with ICC-ES AC01.

2.03 DUCTWORK FABRICATION

- A. Fabricate and support in accordance with SMACNA (DCS) and as indicated.
- B. Provide duct material, gages, reinforcing, and sealing for operating pressures indicated.
- C. Construct T's, bends, and elbows with radius of not less than 1-1/2 times width of duct on centerline. Where not possible and where rectangular elbows must be used, provide air foil turning vanes of perforated metal with glass fiber insulation.
- D. Increase duct sizes gradually, not exceeding 15 degrees divergence wherever possible; maximum 30 degrees divergence upstream of equipment and 45 degrees convergence downstream.
- E. Fabricate continuously welded round and oval duct fittings in accordance with SMACNA (DCS).
- F. Where ducts are connected to exterior wall louvers and duct outlet is smaller than louver frame, provide blank-out panels sealing louver area around duct. Use same material as duct, painted black on exterior side; seal to louver frame and duct.

2.04 MANUFACTURED DUCTWORK AND FITTINGS

- A. Spiral Ducts: Round spiral lockseam duct with galvanized steel outer wall.
 - 1. Manufacture in accordance with SMACNA (DCS).
- B. Round Ducts: Round lockseam duct with galvanized steel outer wall.
 - 1. Manufacture in accordance with SMACNA (DCS).
- C. Flexible Ducts: Black polymer film supported by helically wound spring steel wire.
 - 1. UL labeled.
 - 2. Insulation: Fiberglass insulation with polyethylene vapor barrier film.
 - 3. Pressure Rating: 4 inches WG positive and 0.5 inches WG negative.
 - 4. Maximum Velocity: 4000 fpm.
 - 5. Temperature Range: Minus 20 degrees F to 175 degrees F.
- D. Transverse Duct Connection System: SMACNA "E" rated rigidly class connection, interlocking angle and duct edge connection system with sealant, gasket, cleats, and corner clips in accordance with SMACNA (DCS).
- E. Round Duct Connection System: Interlocking duct connection system in accordance with SMACNA (DCS).
- F. Kitchen Cooking Hood and Grease Exhaust: Nominal 3 inches thick ceramic fiber insulation between 20 gage, 0.0375 inch, Type 304 stainless steel liner and 24 gage, 0.0239 inch aluminized steel sheet outer jacket.
 - 1. Tested and UL listed for use with commercial cooking equipment in accordance with NFPA 96.
 - 2. Certified for zero clearance to combustible material in accordance with:
 - 3. Materials and construction of the modular sections and accessories to be in accordance with the terms of the following listings:
- G. Dishwasher Exhaust: Minimum 21 gage, 0.0344 inch thick, single wall, Type 304 stainless steel.
 - 1. Single wall, factory built chimney liner system.

2. Joints to be sealed during installation with factory supplied overlapping V-bands and sealant.

2.05 KITCHEN HOOD EXHAUST DUCTWORK

- A. Fabricate in accordance with ductwork manufacturer's installation instructions, SMACNA (DCS), SMACNA (KVS), and NFPA 96.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install, support, and seal ducts in accordance with SMACNA (DCS).
- B. During construction provide temporary closures of metal or taped polyethylene on open ductwork to prevent construction dust from entering ductwork system.
- C. Kitchen Hood Exhaust: Provide residue traps at base of vertical risers with provisions for clean out.
- D. Duct sizes indicated are inside clear dimensions. For lined ducts, maintain sizes inside lining.
- E. Locate ducts with sufficient space around equipment to allow normal operating and maintenance activities.
- F. Connect diffusers to low pressure ducts directly or with 5 feet maximum length of flexible duct held in place with strap or clamp.
- G. At exterior wall louvers, seal duct to louver frame and install blank-out panels.

END OF SECTION

**SECTION 23 3300
AIR DUCT ACCESSORIES**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Air turning devices/extractors.
- B. Backdraft dampers - metal.
- C. Backdraft dampers - fabric.
- D. Combination fire and smoke dampers.
- E. Duct access doors.
- F. Fire dampers.
- G. Flexible duct connectors.
- H. Smoke dampers.
- I. Volume control dampers.

1.02 RELATED REQUIREMENTS

- A. Section 23 3100 - HVAC Ducts and Casings.
- B. Section 25 3523 - Integrated Automation Control Dampers: Product furnishing.

1.03 REFERENCE STANDARDS

- A. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems 2021.
- B. NFPA 92 - Standard for Smoke Control Systems 2021.
- C. NFPA 96 - Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations 2021.
- D. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible 2020.
- E. UL 555S - Standard for Smoke Dampers Current Edition, Including All Revisions.
- F. UL 1978 - Grease Ducts Current Edition, Including All Revisions.

1.04 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide for shop fabricated assemblies including volume control dampers. Include electrical characteristics and connection requirements.

1.05 QUALITY ASSURANCE

- A. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Protect dampers from damage to operating linkages and blades.

PART 2 PRODUCTS

2.01 AIR TURNING DEVICES/EXTRACTORS

- A. Multi-blade device with blades aligned in short dimension; steel construction; with individually adjustable blades, mounting straps.

2.02 BACKDRAFT DAMPERS - METAL

- A. Multi-Blade, Parallel Action Gravity Balanced Backdraft Dampers: Galvanized steel, with center pivoted blades of maximum 6 inch width, with felt or flexible vinyl sealed edges, linked together in rattle-free manner with 90 degree stop, steel ball bearings, and plated steel pivot pin; adjustment device to permit setting for varying differential static pressure.

2.03 BACKDRAFT DAMPERS - FABRIC

- A. Fabric Backdraft Dampers: Factory-fabricated.
 - 1. Blades: Neoprene coated fabric material.
 - 2. Birdscreen: 1/2 inch nominal mesh of galvanized steel or aluminum.
 - 3. Maximum Velocity: 1000 fpm (5 mps) face velocity.

2.04 COMBINATION FIRE AND SMOKE DAMPERS

2.05 DUCT ACCESS DOORS

- A. Fabrication: Rigid and close-fitting of galvanized steel with sealing gaskets and quick fastening locking devices. For insulated ducts, install minimum 1 inch thick insulation with sheet metal cover.
 - 1. Less Than 12 inches Square: Secure with sash locks.
 - 2. Up to 18 inches Square: Provide two hinges and two sash locks.
 - 3. Up to 24 by 48 inches: Three hinges and two compression latches with outside and inside handles.
 - 4. High Temperature Duct Access Doors:
 - a. Comply with NFPA 96.
 - b. Comply with UL 1978.
- B. Access doors with sheet metal screw fasteners are not acceptable.

2.06 FIRE DAMPERS

2.07 FLEXIBLE DUCT CONNECTORS

- A. Fabricate in accordance with SMACNA (DCS) and as indicated.
- B. Flexible Duct Connections: Fabric crimped into metal edging strip.
 - 1. Fabric: UL listed fire-retardant neoprene coated woven glass fiber fabric to NFPA 90A, minimum density 30 oz per sq yd.

2.08 SMOKE DAMPERS

- A. Products furnished per Section 25 3523.
- B. Fabricate in accordance with NFPA 90A and UL 555S, and as indicated.
- C. Dampers: UL Class 1 airfoil blade type smoke damper, normally open automatically operated by electric actuator.

2.09 VOLUME CONTROL DAMPERS

- A. Fabricate in accordance with SMACNA (DCS) and as indicated.
- B. Splitter Dampers:
 - 1. Material: Same gage as duct to 24 inches size in either direction, and two gages heavier for sizes over 24 inches.
 - 2. Blade: Fabricate of single thickness sheet metal to streamline shape, secured with continuous hinge or rod.
 - 3. Operator: Minimum 1/4 inch diameter rod in self aligning, universal joint action, flanged bushing with set screw .
- C. Single Blade Dampers:
 - 1. Fabricate for duct sizes up to 6 by 30 inch.
 - 2. Blade: 24 gage, 0.0239 inch, minimum.
- D. Multi-Blade Damper: Fabricate of opposed blade pattern with maximum blade sizes 8 by 72 inch. Assemble center and edge crimped blades in prime coated or galvanized channel frame with suitable hardware.
 - 1. Blade: 18 gage, 0.0478 inch, minimum.
- E. End Bearings: Except in round ducts 12 inches and smaller, provide end bearings. On multiple blade dampers, provide oil-impregnated nylon, thermoplastic elastomer, or sintered bronze bearings.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install accessories in accordance with manufacturer's instructions, NFPA 90A, and follow SMACNA (DCS). Refer to Section 23 3100 for duct construction and pressure class.
- B. Provide backdraft dampers on exhaust fans or exhaust ducts nearest to outside and where indicated.
- C. Provide duct access doors for inspection and cleaning before and after filters, coils, fans, automatic dampers, at fire dampers, combination fire and smoke dampers, and elsewhere as indicated. Provide for cleaning kitchen exhaust ducts in accordance with NFPA 96 Provide minimum 8 by 8 inch size for hand access, size for shoulder access, and as indicated. Provide 4 by 4 inch for balancing dampers only. Review locations prior to fabrication.
- D. Provide smoke dampers at locations indicated, where ducts and outlets pass through fire rated components, and where required by Authorities Having Jurisdiction. Install with required perimeter mounting angles, sleeves, breakaway duct connections, corrosion resistant springs, bearings, bushings and hinges.
- E. Install smoke dampers and combination smoke and fire dampers in accordance with NFPA 92.
- F. Demonstrate re-setting of fire dampers to Owner's representative.
- G. Provide balancing dampers at points on supply, return, and exhaust systems where branches are taken from larger ducts as required for air balancing. Install minimum 2 duct widths from duct take-off.
- H. Use splitter dampers only where indicated.

END OF SECTION

This Page Intentionally Left Blank

**SECTION 23 3423
HVAC POWER VENTILATORS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Roof exhausters.
- B. Cabinet exhaust fans.
- C. Upblast roof exhausters.
- D. Kitchen hood upblast roof exhausters.

1.02 RELATED REQUIREMENTS

- A. Section 23 3300 - Air Duct Accessories: Backdraft dampers.

1.03 REFERENCE STANDARDS

- A. AMCA 99 - Standards Handbook 2016.
- B. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum) 2020.
- C. NFPA 96 - Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations 2021.
- D. UL 705 - Power Ventilators Current Edition, Including All Revisions.
- E. UL 762 - Outline of Investigation for Power Roof Ventilators for Restaurant Exhaust Appliances Current Edition, Including All Revisions.

1.04 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data on fans and accessories including fan curves with specified operating point clearly plotted, power, RPM, sound power levels at rated capacity, and electrical characteristics and connection requirements.
- C. Maintenance Data: Include instructions for lubrication, motor and drive replacement, spare parts list, and wiring diagrams.

1.05 FIELD CONDITIONS

- A. Permanent ventilators may not be used for ventilation during construction.

PART 2 PRODUCTS

2.01 POWER VENTILATORS - GENERAL

- A. Manufacturers:
 - 1. Greenheck Fan Corporation: www.greenheck.com/#sle.
 - 2. PennBarry, Division of Air System Components: www.pennbarry.com/#sle.
- B. Static and Dynamically Balanced: AMCA 204 - Balance Quality and Vibration Levels for Fans.
- C. Performance Ratings: Determined in accordance with AMCA 210 and bearing the AMCA Certified Rating Seal.
- D. Sound Ratings: AMCA 301, tested to AMCA 300 and bearing AMCA Certified Sound Rating Seal.
- E. Fabrication: Comply with AMCA 99.
- F. UL Compliance: UL listed and labeled, designed, manufactured, and tested in accordance with UL 705.
- G. Electrical Components: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.
- H. Enclosed Safety Switches: Comply with NEMA 250.
- I. Kitchen Hood Exhaust Fans: Comply with requirements of NFPA 96 and UL 762.

2.02 ROOF EXHAUSTERS

- A. Manufacturers:
 - 1. Greenheck Fan Corporation: www.greenheck.com/#sle.
 - 2. PennBarry, Division of Air System Components: www.pennbarry.com/#sle.
- B. Fan Unit: V-belt or direct driven as indicated, with spun aluminum housing; resilient mounted motor; 1/2 inch mesh, 0.62 inch thick aluminum wire birdscreen; square base to suit roof curb with continuous curb gaskets.
- C. Roof Curb: 18 inch high self-flashing of galvanized steel with continuously welded seams, built-in cant strips.
- D. Disconnect Switch: Factory wired, non-fusible, in housing for thermal overload protected motor and wall mounted multiple speed switch.
- E. Sheaves: Cast iron or steel, dynamically balanced, bored to fit shafts and keyed; variable and adjustable pitch motor sheave selected so required rpm is obtained with sheaves set at mid-position; fan shaft with self-aligning pre-lubricated ball bearings.

2.03 CABINET EXHAUST FANS

- A. Manufacturers:
 - 1. Greenheck Fan Corporation: www.greenheck.com/#sle.
 - 2. PennBarry, Division of Air System Components: www.pennbarry.com/#sle.
- B. Centrifugal Fan Unit: V-belt or direct driven with galvanized steel housing lined with acoustic insulation, resilient mounted motor, gravity backdraft damper in discharge.
- C. Disconnect Switch: Factory wired, non-fusible, in housing for thermal overload protected motor and wall mounted multiple speed switch.
- D. Sheaves: Cast iron or steel, dynamically balanced, bored to fit shafts and keyed; variable and adjustable pitch motor sheaves selected so required rpm is obtained with sheaves set at mid-position; fan shaft with self-aligning pre-lubricated ball bearings.

2.04 UPBLAST ROOF EXHAUSTERS

- A. Manufacturers:
 - 1. Greenheck Fan Corporation: www.greenheck.com/#sle.
 - 2. PennBarry, Division of Air System Components: www.pennbarry.com/#sle.
- B. Direct Drive Fan:
 - 1. Fan Wheel:
 - a. Type: Non-overloading, backward inclined centrifugal.
 - b. Material: Aluminum.
 - 2. Statically and dynamically balanced.
 - 3. Motors:
 - a. Heavy duty ball bearing type.
 - b. Mount on vibration isolators or resilient cradle mounts, out of air stream.
 - c. Fully accessible for maintenance.
 - 4. Housing:
 - a. Construct of heavy gage aluminum including curb cap, windband, and motor compartment.
 - b. Rigid internal support structure.
 - c. One-piece fabricated or fully welded curb-cap base to windband for leak proof construction.
 - d. Construct drive frame assembly of heavy gage steel, mounted on vibration isolators.
 - e. Provide breather tube for fresh air motor cooling and wiring.
- C. Shafts and Bearings:
 - 1. Fan Shaft:
 - a. Ground and polished steel with anti-corrosive coating.
 - b. First critical speed at least 25 percent over maximum cataloged operating speed.

2. Bearings:
 - a. Permanently sealed or pillow block type.
 - b. Minimum L10 life in excess of 100,000 hours (equivalent to L50 average life of 500,000 hours), at maximum cataloged operating speed.
 - c. 100 percent factory tested.
- D. Drive Assembly:
 1. Belts, pulleys, and keys oversized for a minimum of 150 percent of driven horsepower.
 2. Belts: Static free and oil resistant.
 3. Fully machined cast iron type, keyed and securely attached to the wheel and motor shafts.
 4. Motor pulley adjustable for final system balancing.
 5. Readily accessible for maintenance.
- E. Disconnect Switches:
 1. Factory mounted and wired.
 2. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
 3. Finish for Painted Steel Enclosures: Provide manufacturer's standard unless otherwise indicated.
 4. Positive electrical shutoff.
 5. Wired from fan motor to junction box installed within motor compartment.
- F. Roof Curb: 18 inch high self-flashing of galvanized steel with continuously welded seams, insulation and curb bottom, curb bottom, ventilated double wall, and factory installed nailer strip.
- G. Drain Trough: Allows for single-point drainage of water, grease, and other residues.

2.05 KITCHEN HOOD UPBLAST ROOF EXHAUSTERS

- A. Manufacturers:
 1. Greenheck Fan Corporation: www.greenheck.com/#sle.
 2. PennBarry, Division of Air System Components: www.pennbarry.com/#sle.
- B. Belt Drive Fan:
 1. Fan Wheel:
 - a. Type: Non-overloading, backward inclined centrifugal.
 - b. Material: Aluminum.
 2. Statically and dynamically balanced.
 3. Motors:
 - a. Open drip-proof (ODP).
 - b. Heavy duty ball bearing type.
 - c. Mount on vibration isolators or resilient cradle mounts, out of air stream.
 - d. Fully accessible for maintenance.
 4. Housing:
 - a. Construct of heavy gage aluminum including curb cap, windband, and motor compartment.
 - b. Rigid internal support structure.
 - c. One-piece fabricated or fully welded curb-cap base to windband for leak proof construction.
 - d. Construct drive frame assembly of heavy gage steel, mounted on vibration isolators.
 - e. Provide breather tube for fresh air motor cooling and wiring.
- C. Shafts and Bearings:
 1. Fan Shaft:
 - a. Ground and polished steel with anti-corrosive coating.
 - b. First critical speed at least 25 percent over maximum cataloged operating speed.
 2. Bearings:
 - a. Permanently sealed or pillow block type.

- b. Minimum L10 life in excess of 100,000 hours (equivalent to L50 average life of 500,000 hours), at maximum cataloged operating speed.
 - c. 100 percent factory tested.
- D. Drive Assembly:
 - 1. Belts, pulleys, and keys oversized for a minimum of 150 percent of driven horsepower.
 - 2. Belts: Static free and oil resistant.
 - 3. Fully machined cast iron type, keyed and securely attached to the wheel and motor shafts.
 - 4. Motor pulley adjustable for final system balancing.
 - 5. Readily accessible for maintenance.
- E. Disconnect Switches:
 - 1. Factory mounted and wired.
 - 2. Environment Type per NEMA 250: Unless otherwise indicated, as specified for the following installation locations:
 - 3. Finish: Aluminum
 - 4. Positive electrical shutoff.
 - 5. Wired from fan motor to junction box installed within motor compartment.
- F. Roof Curb: 20 inch high self-flashing of galvanized steel with continuously welded seams, insulation and curb bottom, curb bottom, ventilated double wall, and factory installed nailer strip.
- G. Drain Trough: Allows for single-point drainage of water, grease, and other residues.
- H. Options/Accessories:
 - 1. Birdscreen:
 - a. Provide aluminum construction.
 - 2. Clean Out Port: Removable grease repellent compression rubber plug allows access for cleaning wheel through windband.
 - 3. Roof Curb Extension: Vented curb extension where required for compliance with minimum clearances required by NFPA 96.
 - 4. Grease Trap:
 - a. Aluminum.
 - b. Includes drain connection.
 - c. Collects grease residue.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Secure roof exhausters with stainless steel lag screws to roof curb.
- C. Extend ducts to roof exhausters into roof curb. Counterflash duct to roof opening.
- D. Hung Cabinet Fans:
 - 1. Install flexible connections specified in Section 23 3300 between fan and ductwork. Ensure metal bands of connectors are parallel with minimum one inch flex between ductwork and fan while running.
- E. Provide backdraft dampers on outlet from cabinet and ceiling exhauster fans and as indicated.

END OF SECTION

**SECTION 23 3700
AIR OUTLETS AND INLETS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Diffusers:
 - 1. Rectangular ceiling diffusers.
 - 2. Round ceiling diffusers.
 - 3. Slot ceiling diffusers.
- B. Registers/grilles:
 - 1. Ceiling-mounted, egg crate exhaust and return register/grilles.
 - 2. Ceiling-mounted, exhaust and return register/grilles.
 - 3. Ceiling-mounted, supply register/grilles.
 - 4. Wall-mounted, supply register/grilles.
- C. Duct-mounted supply and return registers/louvers.
- D. Louvers:
 - 1. Combination louvers.
- E. Roof hoods.
- F. Goosenecks.

1.02 REFERENCE STANDARDS

- A. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems 2021.
- B. SMACNA (ASMM) - Architectural Sheet Metal Manual 2012.
- C. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible 2020.

1.03 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide data for equipment required for this project. Review outlets and inlets as to size, finish, and type of mounting prior to submission. Submit schedule of outlets and inlets showing type, size, location, application, and noise level.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Krueger-HVAC: www.krueger-hvac.com/#sle.
- B. Price Industries: www.price-hvac.com/#sle.
- C. Ruskin Company: www.ruskin.com/#sle.
- D. Titus, a brand of Air Distribution Technologies: www.titus-hvac.com/#sle.

2.02 SUPPLY AIR OUTLETS

- A. Type 'S1':
 - 1. Model: Titus OMNI-AA.
 - 2. Description: Aluminum - Square ceiling diffuser with round neck and plaque face. Back cone shall be one piece seamless construction and incorporate a round inlet collar of sufficient length for connecting, rigid or flexible duct.
 - 3. Diffuser shall integrate with all duct sizes shown on plans without affecting face size or appearance.
 - 4. Provide factory insulated R-6 foil backed insulation on outside of back cone.
 - 5. Border: Provide appropriate border to accommodate mounting per ceiling type.
 - 6. Ensure optimal performance to 30% of design air flow in VAV Systems.
 - 7. Finish: #26 White.
- B. Type 'S2':
 - 1. Model: Titus TMRA-AA.

2. Description: Aluminum - Adjustable round ceiling diffuser.
 3. Uniform 360 degree discharge pattern. The discharge pattern can be adjusted in 3 fixed cone positions from horizontal to vertical throw.
 4. Border: Heavy extruded aluminum construction.
 5. Finish: #26 White.
- C. Type 'S3':
1. Model: Titus TMRA.
 2. Description: Steel - Adjustable round ceiling diffuser.
 3. Uniform 360 degree discharge pattern. The discharge pattern can be adjusted in 3 fixed cone positions from horizontal to vertical throw.
 4. Border: Heavy extruded aluminum construction.
 5. Finish: #26 White.
- D. Type 'S4':
1. Model: Titus S300FL.
 2. Description: Aluminum - Duct mounted supply register. Roll formed aluminum blades.
 3. Double deflection with aluminum opposed blade damper.
 4. Border: Rolled formed aluminum welded with counter sunk screw holes.
 5. Finish: #26 White.
- E. Type 'S5':
1. Model: Titus CT-541.
 2. Description: Aluminum - Linear bar grille with 15 degree blades spaced at 1/2" on center. Outlet core shall have extruded aluminum receiving bar. Blades shall run parallel to long dimension of grille. The support and receiving bars shall not exceed 8" on center.
 3. Border: Grille border shall be heavy duty extruded aluminum construction with precise mitered corners and reinforcing support bars for extra support for the core receiving bar.
 4. Grille Finish: #26 White.

2.03 RETURN AIR INLETS

- A. Type 'R1':
1. Model: Titus 50 F.
 2. Description: Aluminum 1/2"x1/2"x1" grids (egg crate core) with extruded aluminum border. Sized per schedule on drawings.
 3. Border: Type 3 for lay-in installation, Type 1 for surface mount. Panel mounting shall not be allowed.
 4. Provide with factory fabricated square to round adapter for connection to ductwork.
 5. Finish: #26 White.
- B. Type 'R2':
1. Model: Titus 350 FL.
 2. Description: Aluminum - Return grille with 35 degree deflection blades spaced at 3/4" on center. Outlet core shall have extruded aluminum blades mechanically locked into a heavy extruded aluminum border. Blades shall run parallel to long dimension of grille.
 3. Border: Grille border Type #1, shall be extruded aluminum construction with precise welded mitered corners. Surface mount to hard ceiling.
 4. Grille Finish: #26 White.
- C. Type 'R3':
1. Model: Titus 350 FL.
 2. Description: Aluminum - Return grille with 35 degree deflection blades spaced at 3/4" on center. Outlet core shall have extruded aluminum blades mechanically locked into a heavy extruded aluminum border. Blades shall run parallel to long dimension of grille.
 3. Border: Grille border Type #1, shall be extruded aluminum construction with precise welded mitered corners. Duct mounted.
 4. Finish: #26 White
- D. Type 'R4':

1. Model: Titus 350 RL.
2. Description: Aluminum - Return grille with 35 degree deflection blades spaced at 3/4" on center. Outlet core shall have extruded aluminum blades mechanically locked into a heavy extruded aluminum border. Blades shall run parallel to long dimension of grille.
3. Border: Grille border Type #1, shall be extruded aluminum construction with precise welded mitered corners. Surface mount to side wall.
4. Finish: #26 White.

2.04 EXHAUST AIR INLETS:

- A. Type 'E1':
 1. Model: Titus 350FL.
 2. Description: Aluminum - Return grille with 35 degree deflection blades spaced at 3/4" on center. Outlet core shall have extruded aluminum blades mechanically locked into a heavy extruded aluminum border. Blades shall run parallel to long dimension of grille.
 3. Border: Grille border Type #1, shall be extruded aluminum construction with precise welded mitered corners. Surface mount to ceiling.
 4. Finish: #26 White.

2.05 LOUVERS

- A. Manufacturers:
 1. Ruskin Company: www.ruskin.com/#sle.
 2. Greenheck: www.greenheck.com
- B. Type: 4 inch deep frame with drainable blades, heavy channel frame, 1/2 inch square mesh screen over intake or exhaust end.
- C. Fabrication: 16 gage, 0.0598 inch (1.52 mm) thick galvanized steel thick galvanized steel welded assembly, with factory prime coat finish.
- D. Color: To be selected by Architect from manufacturer's full range.
- E. Mounting: Furnish with masonry strap anchors for installation.

2.06 ROOF HOODS

- A. Fabricate air inlet or exhaust hoods in accordance with SMACNA (DCS).
- B. Fabricate of galvanized steel, minimum 16 gage, 0.0598 inch base and 20 gage, 0.0359 inch hood, or aluminum, minimum 16 gage, 0.0598 inch base and 18 gage, 0.0598 inch hood; suitably reinforced; with removable hood; birdscreen with 1/2 inch square mesh for exhaust and 3/4 inch for intake, and factory prime coat finish.
- C. Mount unit on minimum 18 inch high curb base with insulation between duct and curb.
- D. Make hood outlet area minimum of twice throat area.

2.07 GOOSENECKS

- A. Fabricate in accordance with SMACNA (DCS) of minimum 18 gage, 0.0598 inch galvanized steel.
- B. Goose neck duct to penetrate roof through a 18 inch high insulated roof curb. Provide curb cap and a weather tight boot to secure duct through curb cap to ensure water tight installation.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Comply with SMACNA (ASMM) for flashing/counter-flashing of roof penetrations and supports for roof curbs and roof mounted equipment.
- C. Check location of outlets and inlets and make necessary adjustments in position to comply with architectural features, symmetry, and lighting arrangement.
- D. Install diffusers to ductwork with air tight connection.

- E. Provide balancing dampers on duct take-off to diffusers, and grilles and registers, despite whether dampers are specified as part of the diffuser, or grille and register assembly.
- F. Paint ductwork visible behind air outlets and inlets matte black. Refer to Section 09 9123.

END OF SECTION

**SECTION 23 4000
HVAC AIR CLEANING DEVICES**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Disposable, extended area panel filters.

1.02 REFERENCE STANDARDS

- A. AHRI 850 (I-P) - Performance Rating of Commercial and Industrial Air Filter Equipment 2013.
- B. ASHRAE Std 52.2 - Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size 2017, with Errata (2020).
- C. UL 586 - High Efficiency, Particulate, Air Filter Units Current Edition, Including All Revisions.
- D. UL 900 - Standard for Air Filter Units Current Edition, Including All Revisions.

1.03 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements for submittal procedures.
- B. Product Data: Provide data on filter media, filter performance data, filter assembly and filter frames, dimensions, motor locations and electrical characteristics and connection requirements.

PART 2 PRODUCTS

2.01 FILTER MANUFACTURERS

- A. American Filtration Inc: www.americanfiltration.com/#sle.
- B. AAF International/American Air Filter: www.aafintl.com/#sle.
- C. The Camfil Group: www.camfilfarr.com/#sle.

2.02 DISPOSABLE, EXTENDED AREA PANEL FILTERS

- A. Media: UL 900 Class 1, pleated, lofted, non-woven, reinforced cotton fabric; supported and bonded to welded wire grid by corrugated aluminum separators.
 - 1. Frame: Non-flammable.
 - 2. Nominal size: As indicated in equipment specifications or drawing schedule .
 - 3. Nominal thickness: 2 inches or 4 inches as indicated in equipment specifications or drawing schedule.
- B. Minimum Efficiency Reporting Value (MERV): 14, when tested in accordance with ASHRAE Std 52.2.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install air cleaning devices in accordance with manufacturer's instructions.
- B. Prevent passage of unfiltered air around filters with felt, rubber, or neoprene gaskets.
- C. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing, with clean set.

END OF SECTION

This Page Intentionally Left Blank

**SECTION 23 5100
BREECHINGS, CHIMNEYS, AND STACKS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Double wall metal stacks.

1.02 REFERENCE STANDARDS

- A. NFPA 54 - National Fuel Gas Code 2021.
- B. NFPA 82 - Standard on Incinerators and Waste and Linen Handling Systems and Equipment 2019.
- C. NFPA 211 - Standard for Chimneys, Fireplaces, Vents, and Solid Fuel-Burning Appliances 2019.
- D. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible 2020.
- E. UL 103 - Factory-Built Chimneys for Residential Type and Building Heating Appliances Current Edition, Including All Revisions.
- F. UL 441 - Standard for Gas Vents Current Edition, Including All Revisions.
- G. UL 959 - Medium Heat Appliance Factory Built Chimneys Current Edition, Including All Revisions.

1.03 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide data indicating factory built chimneys, including dimensional details of components and flue caps, dimensions and weights, electrical characteristics and connection requirements.
- C. Shop Drawings: Indicate general construction, dimensions, weights, support and layout of breechings. Submit layout drawings indicating plan view and elevations where factory built units are used.

1.04 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. AMPCO by Hart & Cooley, Inc: www.ampcostacks.com/#sle.
- B. Metal-Fab, Inc: www.mtlfab.com/#sle.
- C. Selkirk Corporation: www.selkirkcommercial.com/#sle.

2.02 BREECHINGS, CHIMNEYS, AND STACKS - GENERAL REQUIREMENTS

- A. Regulatory Requirements:
 - 1. Comply with applicable codes for installation of natural gas burning appliances and equipment.

2.03 DOUBLE WALL METAL STACKS

- A. Provide double wall metal stacks, tested to UL 103 and UL listed with positive pressure rating, for use with building heating equipment, in compliance with NFPA 211.
- B. Fabricate with 1 inch minimum air space between walls and construct inner liner of AL29-4C stainless steel and outer jacket of 304 stainless steel.
 - 1. Protect aluminized steel surfaces exposed to the elements with a minimum of one base coat of primer and one finish coat of corrosion resistant paint suitable for outer jacket skin temperatures of the application.
- C. Accessories, UL labeled:

1. Ventilated Roof Thimble: Consists of roof penetration, vent flashing with spacers and storm collar.
2. Exit Cone: Consists of inner cone, and outer jacket, to increase stack exit velocity 1.5 times.
3. Stack Cap: Consists of conical rainshield with inverted cone for partial rain protection with low flow resistance.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install in accordance with NFPA 54
- C. Install breechings with minimum of joints. Align accurately at connections, with internal surfaces smooth.
- D. Support breechings from building structure, rigidly with suitable ties, braces, hangers and anchors to hold to shape and prevent buckling. Support vertical breechings, chimneys, and stacks at 12 foot spacing, to adjacent structural surfaces, or at floor penetrations. Refer to SMACNA (DCS) for equivalent duct support configuration and size.
- E. Pitch breechings with positive slope up from fuel-fired equipment to chimney or stack.
- F. Assemble and install stack sections in accordance with NFPA 82, industry practices, and in compliance with UL listing. Join sections with acid-resistant joint cement. Connect base section to foundation using anchor lugs.
- G. Level and plumb chimney and stacks.
- H. Clean breechings, chimneys, and stacks during installation, removing dust and debris.
- I. At appliances, provide slip joints permitting removal of appliances without removal or dismantling of breechings, breeching insulation, chimneys, or stacks.

END OF SECTION

**SECTION 23 5216
CONDENSING BOILERS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Manufactured units.
- B. Boiler construction.
- C. Boiler trim.
- D. Fuel burning system.
- E. Factory installed controls.
- F. Plate and Frame Type Heat Exchanger

1.02 RELATED REQUIREMENTS

- A. Section 03 3000 - Cast-in-Place Concrete.
- B. Section 23 5100 - Breechings, Chimneys, and Stacks.

1.03 REFERENCE STANDARDS

- A. AHRI Directory of Certified Product Performance - Air-Conditioning, Heating, and Refrigeration Institute (AHRI) Current Edition.
- B. ASHRAE Std 90.1 I-P - Energy Standard for Buildings Except Low-Rise Residential Buildings Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- C. ASME BPVC-IV - Boiler and Pressure Vessel Code, Section IV - Rules for Construction of Heating Boilers 2021.
- D. NBBI Manufacturer and Repair Directory - The National Board of Boiler and Pressure Vessel Inspectors (NBBI) Current Edition.
- E. NFPA 54 - National Fuel Gas Code 2021.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Natural Gas, Propane, or Combination Natural Gas/Propane for Indoor Applications:
 - 1. Aerco: www.aerco.com/#sle.

2.02 MANUFACTURED UNITS

- A. Factory assembled, factory fire-tested, self-contained, readily transported unit ready for automatic operation except for connection of water, fuel, electrical, and vent services.
- B. Unit: Metal membrane wall, fire tube, condensing boiler on integral structural steel frame base with integral fuel burning system, firing controls, boiler trim, insulation, and removable jacket, suitable for indoor application.

2.03 BOILER CONSTRUCTION

- A. Comply with the minimum requirements of ASME BPVC-IV and ANSI Z21.13 for construction of boilers.
- B. Assembly to bear the ASME "H" stamp and comply with the efficiency requirements of the latest edition of ASHRAE Std 90.1 I-P.
- C. Required Directory Listings:
 - 1. AHRI Directory of Certified Product Performance - Air-Conditioning, Heating, and Refrigeration Institute (AHRI); current edition at www.ahrinet.org.
 - 2. NBBI Manufacturer and Repair Directory - The National Board of Boiler and Pressure Vessel Inspectors (NBBI); current edition at www.nationalboard.org.
- D. Heat Exchanger: The heat exchanger shall be constructed of 439 stainless steel fire tubes and tubesheets, with a one-pass combustion gas flow design. The fire tubes shall be 1/2" or 5/8"

OD, with no less than 0.049" wall thickness. The upper and lower stainless steel tubesheet shall be no less than 0.25" thick. The pressure vessel/heat exchanger shall be welded construction. The heat exchanger shall be ASME stamped for a working pressure not less than 150 psig. Access to the tubesheets and heat exchanger shall be available by burner and exhaust manifold removal. Minimum access opening shall be no less than 8 inch diameter.

- E. Pressure Vessel: The pressure vessel shall be constructed of ASME SA53 carbon steel, with a 0.25 inch thick wall and 0.50 inch thick upper head. Inspection openings in the pressure vessel shall be in accordance with ASME Section IV pressure vessel code. The boiler shall be designed so that the thermal efficiency increases as the boiler firing rate decreases.
- F. Dual Returns: The boiler shall include dual return connections for low and high return temperature zones for added flexibility and thermal efficiency optimization. The boiler shall not have a minimum flow rate requirement through either return connection as long as the specified minimum flow of the boiler is met through a combination of the two return connections. Boilers with single return will be deemed unacceptable.
- G. Modulating Air/Fuel Valve and Burner: The boiler burner shall be capable of a 20:1 firing turndown ratios without loss of combustion efficiency or staging of gas valves. The burner shall not operate above 7.5% oxygen level or 55% excess air. The burner shall produce less than 13 ppm of NOx, under standard calibration, corrected to 3% excess oxygen when firing on natural gas. The burner shall be metal-fiber mesh covering a stainless steel body with spark or proven pilot ignition and flame rectification. All burner material exposed to the combustion zone shall be of stainless steel construction. There shall be no moving parts within the burner itself. A modulating air/fuel valve shall meter the air and fuel input. The modulating motor must be linked to both the gas valve body and air valve body with a single linkage. The linkage shall not require any field adjustment. A variable speed cast aluminum pre-mix blower shall be used to ensure the optimum mixing of air and fuel between the air/fuel valve and the burner.
- H. Fuel: Dual Fuel Capability. Dual fuel boiler (natural gas/propane) shall include a combustion system capable of operating on both Natural Gas and Propane. The boiler efficiency and turndown shall remain unchanged regardless of fuel source. The dual fuel system shall incorporate independent natural gas and propane gas trains and a fuel selector switch. This switching mechanism shall be such that it shall not be possible to flow both fuels simultaneously. The unit shall be calibrated to run on both fuel sources at start-up. No additional re-calibration shall be required when switching between fuel sources for a period of one year from the initial calibration.
- I. Exhaust Manifold: The exhaust manifold shall be of corrosion resistant cast aluminum or 316 stainless steel with a 8 inch diameter flue connection. The exhaust manifold shall have a collecting reservoir and a gravity drain for the elimination of condensation.
- J. Blower: The boiler shall include a variable-speed, DC centrifugal fan to operate during the burner firing sequence and pre-purge the combustion chamber.
 - 1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require a motor to operate in the service factor range above 1.0.
- K. Ignition: Ignition shall be via spark or proven pilot ignition with 100 percent main-valve shutoff and electronic flame supervision.
- L. Combustion Air: The boiler shall be designed such that the combustion air is drawn from the inside of the boiler enclosure, decoupling it from the combustion air supply and preheating the air to increase efficiency.
- M. Combustion Air Filter: The boiler shall be equipped with an automotive high flow air filter to ensure efficient combustion and unhindered burner components operation.
- N. Enclosure: The plastic and sheet metal enclosure shall be fully removable, allowing for easy access during servicing
- O. Provide adequate tappings, observation ports, removable panels, and access doors for entry, cleaning, and inspection.

2.04 BOILER TRIM

- A. ASME rated pressure relief valve.
- B. Flow switch.
- C. Electronic Low Water Cut-off: Complete with test light and manual reset button to automatically prevent firing operation whenever boiler water falls below safe level.
- D. Temperature and pressure gauge.
- E. Pressure Switches:
 - 1. High gas pressure.
 - 2. Low gas pressure.
 - 3. Air pressure.
- F. Manual reset high limit.
- G. Boiler Control Valve:
 - 1. Control Valve, factory supplied and sized for field installation to ensure minimum, circulation through boiler.

2.05 FACTORY INSTALLED CONTROLS

- A. The boiler shall have an integrated boiler control that is capable of operating the boiler and associated accessories including but not limited to: its pumps, valves and dampers.
 - 1. The control shall have a 5 inch color touch screen display as well as six function buttons that are separate from the display. User shall have the ability to navigate the menus via touchscreen or navigation buttons. Controls not equipped with navigation button options shall not be permitted.
 - 2. The control shall be equipped with a multi-color linear LED light to indicate the level of firing and/or air/fuel valve position.
 - 3. The control shall display two temperatures using two dedicated three-digit seven-segment displays.
 - 4. The control shall offer an Enable/Disable toggle switch as well as two buttons for Testing and Resetting the Low Water Cutoff.
- B. The Manager designated boiler control shall be capable of the following functions without the need for additional external controls:
 - 1. Sequence up to 16 boilers,
 - 2. Control boiler variable speed or single speed pumps and/or modulating motorized valves,
 - 3. Operate or modulate a variable or single speed system pump or rotate two system pumps,
 - 4. Control and communicate with up to 6 SmartPlate domestic water heaters and their domestic hot water pump.
 - 5. The control shall connect to other plant boiler controls using RS485 and communicate using Modbus protocol.
- C. Combination plant: The managing boiler control shall be capable of setting and managing a combination plant that consist of up to two groups of boilers, their swing boilers and swing valves. The control shall be capable of performing all the listed features without the need for any additional controls. The use of additional controls to achieve any of these functionalities shall be prohibited to simplify installation and plant management. The combination plant control shall have the following capabilities:
 - 1. The control shall operate one group of boilers for heating and another group of boilers for domestic hot water using plate heat exchangers or indirect tanks.
 - 2. The control shall manage and rotate the lead boiler in each of the two groups independent of the other group.
 - 3. The control shall be capable of managing one or two swing boilers and their motorized swing valves to direct the output of the swing boiler(s) to one of the two groups based on the plant priority settings. The control shall also connect to the header and return sensors for each of the two groups of boilers and use those values to manage the set point for each group.

4. The control shall offer two independent logics that run simultaneously managing each group of boilers. Each boiler group logic shall have its temperature values, setpoints, PID and feedback parameters that is independent of the other group settings and parameters.
- D. Valve Balancing: To help simplify installation and as part of a boiler plant, the control shall be capable of controlling an electronic modulating motorized valve for each of the boilers using the manager boiler control. It shall have a built-in logic to provide a maximum flow using an adjustable valve opening percentage point for each boiler. The control shall be capable of closing any valve that has an off boiler. If all boilers are off, the control shall keep at minimum one valve open to protect pumps.
- E. Building Automation: The control shall be able to communicate to Building Management Systems using BACnet and Modbus without the use of external gateways. The control shall be able to communicate over each of the two protocols using IP as well as RS485. The use of external gateways is not acceptable. The control shall be able to communicate to the building management system using:
 1. BACnet MS/TP and BACnet IP/Ethernet. When communicating over BACnet IP, the control shall offer an additional layer of IP security by mapping all control BACnet IP communication to the BACnet server's IP and MAC addresses. Not having this level of security shall deem the IP communication insecure and shall not be acceptable.

2.06 ELECTRICAL POWER

- A. Single-Point Field Power Connection: Factory-installed and factory-wired switches, motor controllers, transformers and other electrical devices shall provide a single-point field power connection to the boiler.

2.07 VENTING

- A. The boiler shall be capable of venting with AL 29-4C Stainless Steel venting material. The exhaust vent must be UL Listed for use with Category II, III and IV appliances and compatible with condensing flue gas service. UL-listed vents of AL 29-4C stainless steel must be used with boilers.
- B. Provide condensate neutralization tank and lime chips with each boiler.

2.08 SOURCE QUALITY CONTROL

- A. Provide factory tests to check construction, controls, and operation of unit.
- B. Manufacturer to conduct boiler inspection prior to shipment; submit copy of inspection report to Architect.

2.09 PLATE AND FRAME TYPE HEAT EXCHANGER

- A. Manufacturers:
 1. AERCO www.aerco.com
 2. Substitutions: See Section 01 6000-Product Requirements.
- B. Design and Construction:
 1. Each heater shall be of the counter-current flow stainless steel, brazed plate double wall heat exchanger designed and manufactured in accordance with ASME Code Section VIII, Div. 1 for 150 psig @ 250 °F or 300 psig @ 250 °F. The heat exchanger shall have an air gap between plate walls, enabling visible leak detection. The packaged heater shall be rated for not less than 150 psig on the service water side and the boiler water side. The plates shall be AISI 316 stainless steel.
- C. Electronic Control System
 1. The heater shall maintain +/- 4°F Max temperature fluctuation from setpoint at 0% to 100 % load at a constant load and +/- 4°F under normal diversified domestic load conditions. The system shall consist of a 3-way electronic control valve, control panel enclosure housing a PID temperature controller with digital indication of domestic hot water outlet temperature, domestic hot water inlet temperature, boiler water inlet temperature, digital over-temperature limit switch with audible alarm, domestic water pressure differential across the heat exchanger, and feed-forward flow meter. In an over-

temperature condition, the controller shall close the control valve. The system shall have the following additional characteristics:

- a. Controller temperature setpoint adjustable between 50°F to 180°F
- b. Accepts 120V/1PH/60Hz
2. The electronic control valve shall be of equal percentage flow characteristics. The valve shall have the following performance characteristics:
 - a. Electronic Actuator with Fail Closed Design, particularly on loss of power
 - b. Time to Full Open Position: 3 seconds
 - c. Time to Full Closed Position: 3 seconds
3. The PID temperature controller shall incorporate a feed-forward function and be password protected. The controller either shall be capable of RS-485 MODBUS communications protocol for interoperability with Building Automation Systems (BAS).
4. Standalone Controls interface with BACnet, Lonworks, and N2. The Communications Gateway shall be comprised of a microprocessor based control utilizing the MODBUS protocol to communicate with the temperature controller. Non-volatile backup of all point mappings and programs shall be internally provided as standard. Connection between Gateway and individual water heaters shall be "daisy chain" with shielded, twisted pair, low voltage wiring for ease of installation.
5. The following information shall be accessible locally at the controller or remotely via the communications port:
 - a. Unit Status
 - b. DHW Setpoint – can be changed remotely
 - c. DHW Outlet Temperature
 - d. DHW Inlet Temperature
 - e. DHW Flow
 - f. DHW Pressure Drop
 - g. Boiler Inlet Temperature
 - h. Valve Position
 - i. MODBUS Address
6. Each heater shall include a device to measure pressure differential across the domestic water side of the heat exchanger.
7. Each heater shall be supplied by the manufacturer ready to accept existing boiler water and domestic water lines, and furnished with the following accessories:
 - a. Y-strainers with blowdown valve for boiler water and domestic water.
 - b. ASME Section VIII bronze pressure relief valve, set at 150 PSIG
 - c. Bronze ball type isolation valves.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Install boiler and provide connection of natural gas service in accordance with requirements of NFPA 54 and applicable codes.
- C. Install boiler on concrete housekeeping base, sized 6 inches high minimum of 4 inches larger than boiler base around front and sides, flush with back of boiler in accordance with Section 03 3000.
- D. Pipe cooled condensate produced by the combustion process from the boiler condensate connection and/or flue stack with suitable piping material to neutralizer prior to discharging into nearest floor drain.

3.02 CLOSEOUT ACTIVITIES

- A. See Section 01 7800 - Closeout Submittals, for closeout submittals.
- B. See Section 01 7900 - Demonstration and Training, for additional requirements.
- C. Training: Train Owner's personnel on operation and maintenance of system.

1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
2. Provide minimum of two hours of training.
3. Instructor: Manufacturer's training personnel.
4. Location: At project site.

END OF SECTION

**SECTION 23 6423
SCROLL WATER CHILLERS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Factory-assembled packaged chiller.
- B. Charge of refrigerant and oil.
- C. Controls and control connections.
- D. Chilled water connections.
- E. Electrical power connections.

1.02 RELATED REQUIREMENTS

- A. Section 03 3000 - Cast-in-Place Concrete: Concrete housekeeping pads.
- B. Section 23 0593 - Testing, Adjusting, and Balancing for HVAC.
- C. Section 23 0800 - Commissioning of HVAC.
- D. Section 23 0993 - Sequence of Operations for HVAC Controls.
- E. Section 23 2113 - Hydronic Piping.
- F. Section 23 2114 - Hydronic Specialties.
- G. Section 26 0583 - Wiring Connections.

1.03 REFERENCE STANDARDS

- A. AHRI 550/590 (I-P) - Performance Rating of Water-chilling and Heat Pump Water-heating Packages Using the Vapor Compression Cycle 2020.
- B. ASHRAE Std 15 - Safety Standard for Refrigeration Systems 2019, with All Amendments and Errata.
- C. ASHRAE Std 90.1 I-P - Energy Standard for Buildings Except Low-Rise Residential Buildings Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.
- D. ASME BPVC-VIII-1 - Boiler and Pressure Vessel Code, Section VIII, Division 1: Rules for Construction of Pressure Vessels 2021.
- E. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum) 2020.
- F. UL 1995 - Heating and Cooling Equipment Current Edition, Including All Revisions.

1.04 ADMINISTRATIVE REQUIREMENTS

- A. Coordination: Coordinate physical size, weight and location of major pieces of equipment to be installed. Notify Architect of any major deviations from the equipment originally specified prior to ordering equipment.

1.05 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide rated capacities, weights, specialties and accessories, electrical requirements and wiring diagrams.
- C. Shop Drawings: Indicate components, assembly, dimensions, weights and loadings, required clearances, and location and size of field connections. Indicate equipment, piping and connections, valves, strainers, and thermostatic valves required for complete system.
- D. Manufacturer's Instructions: Submit manufacturer's complete installation instructions.
- E. Warranty: Submit manufacturer's warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Comply with manufacturer's written installation instructions for rigging, unloading, and transporting units.
- B. Deliver units to the job site completely assembled and charged with refrigerant and oil by manufacturer.

1.07 WARRANTY

- A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.
- B. Manufacturer's Warranty: Provide minimum five year warranty to include coverage for materials and labor for compressor.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Quantech: www.quantech.com/#sle.
- B. Daikin Applied: www.daikinapplied.com/#sle.
- C. Trane, a brand of Ingersoll Rand: www.trane.com/#sle.
- D. York International Corporation/Johnson Controls, Inc: www.york.com/#sle.

2.02 CHILLER APPLICATIONS

- A. Chiller: Air-Cooled.
 - 1. Evaporator:
 - a. Water Based Fouling Factor: 0.00010 sq ft hr degrees F per Btu.
 - b. Glycol Type: Propylene.
 - c. Glycol Concentration: [] percent.
 - 2. Packaged Air-Cooled Condenser:
 - a. Outdoor Ambient Temperature at Rated Capacity: 95 degrees F.

2.03 CHILLERS

- A. Chillers: Factory assemble and test chiller consisting of compressor(s), compressor motor(s), evaporator, condenser, enclosure, refrigeration circuits(s) and specialties, interconnecting piping, starters, and microprocessor-based controls.
 - 1. Rating: AHRI 550/590 (I-P).
 - 2. Safety: UL 1995 and ASHRAE Std 15.
 - 3. Construction & Testing: ASME BPVC-VIII-1 as applicable for construction type.
 - 4. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., testing firm acceptable to the Authority Having Jurisdiction, or [] as suitable for the purpose specified and indicated.
 - 5. Energy Efficiency: ASHRAE Std 90.1.
 - 6. Enclosures:
 - a. Frame:
 - 1) Heavy-gage steel.
 - 2) Factory apply hot-dipped galvanized or air-dried paint finish.
 - b. Steel Chiller Cabinets:
 - 1) Factory apply baked on enamel or baked on powder paint finish.
 - c. Electrical Equipment: NEMA 250 or UL 1995 as applicable.

2.04 COMPRESSORS AND EVAPORATOR

- A. Compressors: Hermetic scroll type.
 - 1. Unit: Fully hermetic type with multiple, direct drive compressors with discharge and suction service valves.
 - 2. Vibration Control: Factory installed internal isolators or field installed external isolators.
 - 3. Oil Lubrication System: Initial oil charge, oil sump, heater, oil level, and sight glass.
 - 4. Capacity Reduction System: Compressor staging with control down to 12 percent of full load without the activation of hot gas by-pass.

5. Motor: 3600 or 3500 rpm, suction gas-cooled, with thermal or current overload protection.
- B. Evaporator: Provide shell and tube or brazed plate type.
 1. Shell and tube type.
 - a. Shell, removable heads and tube support sheets constructed of carbon steel or [_____].
 - b. Tubes: Mechanically expand and fasten, seamless, externally or internally enhanced, copper tubes into intermediate tube support sheets along the length of shell to avoid contact and relative motion between tubes.
 - c. Refrigerant Working-Side Pressure Rating: 400 psig minimum.
 - d. Water Working-Side Pressure Rating: 150 psig minimum.
 - e. Provide with flanged or grooved connections.
 - f. Insulation for all cold surfaces.
 - 1) Insulation is factory, field, or [_____] installed on shell, connections, and suction piping.
 - 2) 0.75 inches minimum thick, closed cell, expanded polyvinyl chloride, polyurethane, or vinyl nitrate polymer insulation with a maximum k value of 0.28.
 - g. Provide factory installed vents and water drain connections on evaporator.
 - h. Provide factory installed fittings for temperature control sensors on evaporator.
 - i. Freeze Protection for Outdoor Locations: Provide thermostatically controlled electric heater to protect from freezing at ambient temperatures down to minus 20 degrees F.
 2. Brazed plate type.
 - a. Plate Material: 316 stainless steel.
 - b. Refrigerant Working-Side Pressure Rating: 430 psig minimum.
 - c. Water Working-Side Pressure Rating: 150 psig minimum.
 - d. Provide with flanged or grooved connections.
 - e. Insulation for all cold surfaces.
 - 1) Insulation is factory installed on evaporator, connections, and suction piping.
 - 2) 0.75 inches minimum thick, closed cell, expanded polyvinyl chloride, polyurethane, or Armaflex II insulation with a maximum k value of 0.28.
 - f. Provide factory installed vents and water drain connections on evaporator.
 - g. Provide factory installed fittings for temperature control sensors on evaporator.
 - h. Freeze Protection for Outdoor Locations: Provide thermostatically controlled electric heater to protect from freezing at ambient temperatures down to minus 20 degrees F.

2.05 AIR-COOLED CONDENSER AND FANS

- A. Provide finned-tube, brazed one-piece, or flat tube-plate-manifold type.
 1. Finned-tube type.
 - a. Mechanically bond aluminum fins to copper tubing and protect with corrosion resistant materials or coatings.
 - b. Clean, dehydrate and test.
 - c. Leak Test: 650 psig minimum.
 2. Brazed one-piece type.
 - a. Construct of same material to avoid galvanic corrosion.
 - b. Braze coils and headers as one assembly.
 - c. Clean, dehydrate and test.
 - d. Leak Test: 650 psig minimum.
 3. Flat tube-plate-manifold type.
 - a. Construct all components of same aluminum alloy to avoid galvanic corrosion.
 - b. Braze manifolds, flat tubes and fin-plates together to form single coil assembly.
 - c. Clean, dehydrate and test.
 - d. Leak Test: 656 psig minimum.
- B. Coil Guards: Provide corrosion proof, louvered panels, heavy gage wire panels, or grilles, factory installed. Provide coil protection for shipping by enclosing entire condenser coil with heavy plastic to prevent coil damage during shipping or rigging.

- C. Fans and Motors:
 - 1. Fans: Dynamically balance propeller, shrouded-axial, or airfoil type fans of reinforced polymer or glass fiber reinforced composite corrosion resistant construction equipped with sealed, permanently lubricated ball bearings.
 - 2. Discharge Fan Guards: Corrosion resistant, heavy gage, steel wire.
 - 3. Discharge Direction: Vertical.
 - 4. Motors: Direct drive, totally enclosed for outdoor use with current overload protection.

2.06 REFRIGERATION CIRCUITS

- A. Provide multiple independent refrigeration circuit(s) with multiple or one compressor(s) per circuit.
- B. Provide liquid line shut-off valve, filter-drier, expansion valve, and refrigerant relief device for each independent circuit.

2.07 INTEGRATED MICROPROCESSOR BASED DDC CONTROLS PACKAGE

- A. Pre-wire, assemble, factory mount, and test operating and safety control system consisting of a digital display or gages, on-auto-off switch, motor starters, disconnect switches, power and control wiring. Provide controls, monitoring, programmable set-points, alarms, and BAS as defined below:
 - 1. Automatic Adjustable Operating Controls:
 - a. Allow system start-up and system operation at all outdoor air temperatures down to minus 20 degrees F.
 - b. Temperature of chilled water leaving chiller.
 - c. Chiller system capacity control based on set-points and system load.
 - d. Compressor short-cycling prevention.
 - e. Lead/lag for multiple compressors.
 - f. Automatic reset on power source failure.
 - g. Load limiting.
 - h. Sequencing of condenser fans.
 - 2. Normal Operation Monitoring and Open Cover-less Displays:
 - a. Hours of operation.
 - b. Suction and discharge refrigerant pressures.
 - c. Automatic diagnostics.
 - d. Number of starts.
 - e. On/off compressor status.
 - f. Entering and leaving chilled water temperatures.
 - g. Status of operation.
 - h. Weekly purge cycle totalization if applicable.
 - i. Oil pressure.
 - 3. Set-Points:
 - a. Leaving chilled water temperature.
 - b. Date/time.
 - 4. Automatic Chiller Shut-Down Safety Controls and Alarm:
 - a. Automatic Reset:
 - 1) Chilled water flow interlock.
 - 2) Voltage protection (over/under).
 - 3) Phase reversal protection.
 - b. Manual Reset:
 - 1) Evaporator low pressure.
 - 2) High motor winding temperature.
 - 3) Low chilled water temperature.
 - 4) Low chilled water flow.
 - 5) High condenser refrigerant discharge pressure.
 - 6) Motor current overload and phase loss.

- 7) Low oil flow.
 - c. Remote Alarm: Activate remote, audible bell upon safety shutdown of chiller.
- 5. Building Automation System (BAS) Communications via BACNet:
 - a. Minimum Data Transmission to BAS:
 - 1) All system operating conditions.
 - 2) Capacity control information.
 - 3) Safety shutdown conditions.
 - b. Minimum Operating Commands from BAS:
 - 1) Remote unit start/stop.
 - 2) Remote chilled water reset.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Align chiller package on steel foundations.
- C. Install units on vibration isolators.
- D. Connect to electrical service.
- E. Connect to chilled water piping.
- F. Arrange piping for easy dismantling to permit tube cleaning and removal.

3.02 MANUFACTURER'S FIELD SERVICES

- A. Perform factory startup of the chiller by factory trained and authorized servicing technicians confirming equipment has been correctly installed prior to equipment becoming operational and covered under the manufacturer's warranty.
- B. Supply initial charge of refrigerant and oil if not completely factory charged.
- C. Demonstrate system operations and verify specified performance.

3.03 CLOSEOUT ACTIVITIES

- A. See Section 01 7800 - Closeout Submittals, for closeout submittals.
- B. See Section 01 7900 - Demonstration and Training, for additional requirements.
- C. Demonstration: Demonstrate operation of system to Owner's personnel.
 - 1. Use operation and maintenance data as reference during demonstration.
 - 2. Conduct walking tour of project.
 - 3. Briefly describe function, operation, and maintenance of each component.
- D. Training: Train Owner's personnel on operation and maintenance of system.
 - 1. Use operation and maintenance manual as training reference, supplemented with additional training materials as required.
 - 2. Provide minimum of two hours of training.
 - 3. Instructor: Manufacturer's training personnel.
 - 4. Location: At project site.

END OF SECTION

This Page Intentionally Left Blank

**SECTION 23 7223
PACKAGED AIR-TO-AIR ENERGY RECOVERY UNITS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Dedicated Outdoor Air System (DOAS Units)

1.02 REFERENCE STANDARDS

- A. ASHRAE Std 52.2 - Method of Testing General Ventilation Air-Cleaning Devices for Removal Efficiency by Particle Size 2017, with Errata (2020).
- B. ASHRAE Std 84 - Method of Testing Air-to-Air Heat/Energy Exchangers 2020, with Errata (2021).
- C. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems 2021.

1.03 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Manufacturer's installation instruction, product data, and engineering calculations.
- C. Shop Drawings: Show design and assembly of energy recovery unit and installation and connection details.

1.04 QUALITY ASSURANCE

- A. Manufacturer Qualifications:
 - 1. Firm regularly engaged in manufacturing energy recovery units.
 - 2. Products in satisfactory use in similar service for not less than five years.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Dedicated Outdoor Air System (DOAS):
 - 1. PETRA ENGINEERING: www.petra-eng.com/#sle. (Basis of Design)
- B. Cabinet:
 - 1. Materials: Formed and reinforced 2" double-wall insulated panels, with expandable poly-iso foam insulation, fabricated to allow removal for access to internal parts and components, with joints between sections sealed.
 - a. Units are to be painted with custom RAL color, to be chosen by architect.
 - b. Casing frame work will be a penta-post construction. Exterior panels shall be removable without affecting the structural integrity of the unit. Side and roof panels fastened and caulked to each other. All fasteners to be stainless steel.
 - c. Outside Casing: 18 gauge, G-90 galvanized with two (2) coats of electrostatic powder coating, oven baked.
 - d. Inside Casing: 20 gauge, G-90 galvanized, perforated in fan section, solid in all other sections.
 - e. Floor Plate: 20 gauge, G-90 galvanized.
 - f. Sloped roof canopies for proper rain and snow drainage.
 - 2. Unit Base:
 - a. Shall be constructed of welded 4" G-90 galvanized 10 gauge steel C-channel members on the full perimeter of the unit, with internal cross member supporting beams to support the internal components along the whole base length and width. Pedestal feet shall not be accepted.
 - b. The base shall be coated with a double epoxy coating.
 - 3. Cabinet Insulation: Comply with NFPA 90A or NFPA 90B.
 - a. Materials: ASTM C 1071 with coated surface exposed to air stream to prevent erosion of glass fibers.

- b. Thickness: 2" thick with expandable poly-iso foam.
- c. "R" value: 13.0 at 75 deg F mean temperature.
- d. Fire-Hazard Classification: Maximum flame-spread index of 25 and smoke-developed index of 50, when tested according to ASTM C 411.
- e. Liner Adhesive: Comply with NFPA 90A or NFPA 90B and ASTM C 916
- f. Location and Application: Encased between outside and inside casing.
- 4. Access Panels and Doors: Same materials and finishes as cabinet (interior and exterior), complete with hinges, latches, handles, and gaskets. Access panels and doors shall be sized and located to allow periodic maintenance and inspections as shown on these drawings. Provide access panels and doors in the following locations:
 - a. Fan Section: Hinged access door.
 - b. Access Section: Hinged access doors.
 - c. Coil Section: Inspection panel.
 - d. Damper Section: Hinged access door.
 - e. Filter Section: Hinged access door, to allow periodic removal and installation of filters.
- 5. Condensate Drain Pans: Formed sections of stainless steel insulated, sheet complying with requirements in ASHRAE 62. Fabricate pans with slopes in two planes to collect condensate from cooling coils (included coil piping connections and return bends) and humidifier when units are operating at maximum cataloged face velocity across cooling coil.
 - a. Double-Wall Construction: Fill space between walls with 3#/cu.ft. Density foam insulation and seal moisture tight.
 - b. Drain Connections: Both ends of the pan.
 - c. Pan-Top Coating: Elastomeric compound.
 - d. Units with stacked coil shall have an intermediate drain pan or drain trough to collect condensate from top coil.
 - e. Mechanical Contractor is responsible to furnish and install condensate trap and drain for all equipment.
- C. Fan Sections:
 - 1. Fan-Section Construction: Direct Drive SWSI Plenum fan assemblies consisting of fan wheel, fan motor and disconnect switch, drive assembly, and support structure and equipped with formed-steel channel base for integral mounting of fan, motor, and casing panels.
 - a. Mount fan with 1" spring vibration isolation.
 - b. Provide perforated inner liner in fan sections.
 - 2. Fan Assemblies: Statically and dynamically balanced and designed for continuous operation at maximum rated fan speed and motor horsepower.
 - 3. Airfoil-Fan Wheels: Steel construction with smooth-curved inlet flange, heavy backplate, and hollow die-formed airfoil-shaped blades continuously welded at tip flange and backplate; cast-iron hub riveted to backplate and fastened to shaft with set screws.
 - 4. Coatings: As required and/or specified
 - 5. Vibration Control: Install fans on 1" spring vibration isolation.
 - 6. Fan-Section Quality Control:
 - a. Sound Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Fans shall bear AMCA-certified sound ratings seal.
 - b. Factory test fans performance for flow rate, pressure, power, air density, rotation, speed, and efficiency. Establish ratings according to AMCA 210, "Laboratory Methods of Testing Fans for Rating."
- D. Motors:
 - 1. General: Comply with requirements in Division 23 Section "Motors".

2. Motors shall be premium efficient E+ with class B insulation
 3. Motor wiring shall be brought back to control panel located at the external on the external casing of the unit.
 4. Units will be provided with variable speed drives on motors. See "Specification 238505 - Variable Speed Drive System" for further details.
 5. Units will be provided with single point electrical connection with integral disconnect.
- E. Hot & Chilled Water Coils:
1. Coils shall be manufactured from seamless copper tubing, 0.020" wall thickness, 5/8" diameter tubing, and tested at 450 psi air pressure under water.
 2. Coil Sections: Common or individual, insulated, galvanized-steel casings for heating and cooling coils. Design and construct to facilitate removal and replacement of coil for maintenance and to ensure full airflow through coils. Retain one of three options listed below:
 - a. Piping Connections: Threaded
 - b. Tubes: Copper with minimum wall thickness of 0.020"
 - c. Fins Aluminum with 0.0075" thickness
 - d. Fin and Tube Joint: Silver brazed
 - e. Headers: Cast iron or copper with vents and drainable connection
 - f. Ratings: Design tested and rated according to ASHRAE 33 and ARI 410
 - g. Working-Pressure Ratings: 150psig
 - h. Source Quality Control: Test to 450 psig
 - i. Coil grommet - Where coil connections extend through the unit casing, a double grommet system shall be used to prevent air leakage. Maximum air leakage shall be no more than 25 CFM @ 3.0" W.C.
- F. Air-To-Air Energy Recovery Heat Wheels:
1. Casing:
 - a. Steel, with manufacturer's standard paint coating.
 - b. Integral purge section limiting carryover of exhaust air to between 0.05 percent at 1.6-inch wg and 0.20 at 4-inch wg differential pressure.
 - c. Casing seals on periphery of rotor, on duct divider, and on purge section.
 - d. Support rotor on great-lubricate ball bearings with extended grease fittings. Mount horizontal wheels on tapered roller bearing.
 2. corrosive, ION Absorption Type Exchange Resin. Construct media for passing maximum 500-micrometer solids.
 3. Drive: Fractional horsepower motor and gear reducer, with speed changed by variable frequency controller and self-adjusting multi link belt around outside of rotor.
 4. Controls:
 - a. Variable frequency controller, factory mounted and wired (exhaust air sensor by controls contractor)
 - b. Low leakage recirculation damper section to be provided for morning warm up function.
 - c. Speed Settings: Adjustable settings for maximum and minimum rotor speed limits.
- G. Outdoor- and Return-Air Dampers:
1. Low-leakage, double-skin, airfoil-blade, extruded-aluminum dampers with compressible jamb seals and extruded-vinyl blade edge seals in opposed blade arrangement with steel operating rods rotating in nylon bearings mounted in a single extruded-aluminum frame, and with operating rods connected with a common linkage. Leakage rate shall not exceed 5 cfm/sq. Ft. at 1-inch wg.
- H. Outside Air / Exhaust Air Hoods:
1. Units will be provided with OA/EA hoods where required. Intake hoods will have bird screens. Intake hoods are shipped loose for field installation.
 2. Units will be provided with gravity relief exhaust dampers where indicated.
 3. Units will be provided with powered exhaust dampers where indicated.

- I. Mixing Box Section:
 - 1. Where required units will be provided with mixing boxes. Mixing boxes will be provided with factory installed low leakage gear driven dampers. (Actuators will be provided by controls contractor) See below for damper requirements.
- J. Dampers (outside, exhaust, recirculation and by-pass dampers):
 - 1. General: Leakage rate, according to AMCA 500, "Laboratory Methods for Testing Dampers for Rating," shall not exceed 3% of air quantity at 2000-fpm face velocity through damper and 4-inch wg pressure differential.
 - 2. Damper Operators: Electric specified in Division 23 Section "HVAC Instrumentation and Controls".
 - 3. Low-Leakage Dampers: All dampers are to made of rigid aluminum frame with multi airfoil aluminum blades so as to reduce pressure drop and sound generated air. Opposed blade dampers rotation is achieved by PVC gears.
- K. Filter Sections:
 - 1. Filters: Comply with NFPA 90A.
 - 2. Filter Section: Provide filter holding frames arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side.
 - 3. Extended-Surface, Disposable Panel Filters: Factory-fabricated, dry, extended-surface filters with holding frames.
 - a. Media: Fibrous material formed into deep-V -shaped pleats and held by self-supporting wire grid or slide in track.
 - b. Filters shall have a minimum MERV-14 rating.
 - 4. Filter bank shall be furnished with a Dwyer Series 2000 magnehelic gauge.
- L. Electrical Requirements:
 - 1. Units will be provided with a single point power connection.
 - 2. Units will be provided with integral disconnect switch for ease of maintenance.
 - 3. Units will be provided with GFCI convenience receptacle.
- M. Controls:
 - 1. Controls will be by Temperature Controls Contractor.
- N. Roof Curbs:
 - 1. Provide 16ga, 2" insulated full perimeter roof curbs to surround the ductwork, piping and electrical connections. Curbs height to match the exact height of the structural steel dunage on the roof. Coordinate with the General Contractor.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that structure is ready for installation of unit, that openings in deck for ductwork, if required, are correctly sized and located, and that mechanical and electrical utilities supplying unit are of correct capacities and are accessible.

3.02 INSTALLATION

- A. Connections:
 - 1. Piping installation requirements are specified in other Division 23 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
 - 2. Hot-Water Piping: Comply with applicable requirement in Division 23 Section "Hydronic Piping." Connect to supply and return coil tapings with shutoff or balancing valve and union or flange at each connection. All hydronic coil accessories are to be located and installed within RTU for ease of service and maintenance.
 - 3. Condensate Piping: Mechanical contractor is responsible to furnish and install condensate traps and drains on all units. Drain to discharge on roof.
 - 4. 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 connections.

5. Electrical: comply with applicable requirements in Division Sections for power wiring, switches, and motor controls.
 6. Ground equipment according to Division Section "Grounding and Bonding".
 7. 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 UL486A and UL 486B.
- B. Startup:
1. Engage a factory-authorized service representative to perform supervision during startup.
 2. Final Checks before Startup: Perform the following:
 - a. Verify that shipping, blocking, and bracing are removed.
 - b. Verify that unit is secure on mounting and supporting devices and that connections to piping, ducts, and electrical systems are complete. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.
 - c. Perform cleaning and adjusting specified in this Section.
 - d. Disconnect fan drive from motor, verify proper motor rotation direction, and verify free fan wheel rotation and smooth bearing operations. Reconnect fan drive system, align belts, and install belt guards.
 - e. Lubricate bearings, pulleys, belts, and other moving parts with factory-recommended lubricants.
 - f. Set recirculation and bypass dampers to fully closed position.
 - g. Set outside- and return-air mixing dampers to minimum outside-air setting.
 - h. Comb coil fins for parallel orientation.
 - i. Install clean filters.
 - j. Verify that manual and automatic volume control and fire and smoke dampers in connect duct systems are in fully open positions.
 - k. Starting procedures for modular indoor air-handling units include the following:
 - l. Energize motor; verify proper operation of motor, drive system, and fan wheel. Adjust fan to indicated rpm. [Replace fan and motor pulleys as required to achieve design conditions]
 - m. Measure and record motor electrical values for voltage and amperage.
 - n. Manually operate dampers from fully closed to fully open position and record fan performance.
 3. Adjusting:
 - a. Adjust damper linkages for proper damper operation.
 4. Cleaning:
 - a. Clean modular outdoor rooftop air-handling units internally, on completion of installation according to manufacturer's written instructions. Clean fan interiors to remove foreign material and construction dirt and dust. Vacuum clean fan wheels, cabinets, and coils entering air face.
 - b. After completing system installation, testing, adjusting, balancing modular outdoor air-handling and air-distribution systems, clean filter housing and install new filters.
 5. Demonstration:
 - a. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain modular outdoor rooftop air-handling units

END OF SECTION

This Page Intentionally Left Blank

**SECTION 23 7313
AIR HANDLING UNITS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Air handling units.

1.02 RELATED REQUIREMENTS

- A. Section 23 0719 - HVAC Piping Insulation.
- B. Section 23 3100 - Ductwork.
- C. Section 23 3300 - Ductwork Accessories.

1.03 REFERENCE STANDARDS

- A. ABMA STD 9 - Load Ratings and Fatigue Life for Ball Bearings 2015.
- B. ABMA STD 11 - Load Ratings and Fatigue Life for Roller Bearings 2014.
- C. AHRI 260 - Sound Rating of Ducted Air Moving and Conditioning Equipment 2011.
- D. AHRI 410 - Forced-Circulation Air-Cooling and Air-Heating Coils 2001, with Addenda (2011).
- E. AHRI 430 (I-P) - Performance Rating of Central Station Air-handling Unit Supply Fans 2020.
- F. AMCA 300 - Reverberant Room Method for Sound Testing of Fans 2014.
- G. AMCA 301 - Methods for Calculating Fan Sound Ratings from Laboratory Test Data 2014.
- H. NEMA MG 1 - Motors and Generators 2018.
- I. NFPA 90 A & B - Installation of Air Conditioning and Ventilation Systems and Installation of Warm Air Heating and Air Conditioning Systems.
- J. SMACNA (DCS) - HVAC Duct Construction Standards - Metal and Flexible; Sheet Metal and Air Conditioning Contractors' National Association; 2005.
- K. UL 900 - Standard for Air Filter Units; Current Edition, Including All Revisions.

1.04 SUBMITTALS

- A. Product Data:
 - 1. Manufacturer's catalog sheets and drawings showing overall dimensions of complete assembly including clearance and access requirements, performance charts, sound power data, specifications, operating weights and support requirements, and installation instructions for each air handling unit.
 - a. Indicate shipping split locations, dimensions, and weights.
 - b. Indicate filter assembly and data for filter media and performance.
 - c. Electrical Requirements: Power supply wiring including wiring diagrams for interlock and control wiring, clearly indicating factory-installed and field-installed wiring.
- B. Contract Closeout Submittals:
 - 1. Operation and Maintenance Data: Deliver 2 copies, covering the installed products to the Owner's Representative.
- C. Maintenance Materials: Furnish the following for Owner's use in maintenance of project.
 - 1. See Section 01 6000 - Product Requirements, for additional provisions.
 - 2. Extra Filters: One set for each unit.
 - 3. Box and label filters, label belts. Store at site where directed by Owner's Representative.

1.05 QUALITY ASSURANCE

- A. NFPA Compliance
 - 1. Comply with applicable provisions NPFA 70 pertaining to construction and installation of electrically operated components of packaged air handling units.
- B. Flame-Smoke Ratings

1. Except as otherwise indicated, provide air handling unit thermal insulation with flame-spread rating of 25 or less, fuel-contributed of 50 or less, and smoke developed rating of 50 or less.
- C. AMCA Standards
 1. Comply with Air Movement and Control Association Standards as applicable to testing and rating fans, and testing louvers, dampers, and shutters.
- D. Damper Air Leakage Rate
 1. Except where more stringent limitation is indicated, provide dampers with leakage limited to 6 CFM per square foot at 4" static pressure differential.
- E. SMACNA Compliance
 1. Comply with Sheet Metal and Air Conditioning Contractors National Association ductwork construction standards as applicable to air handling units.
- F. Industry Standards
 1. Except as otherwise indicated, comply with ASHRAE recommendations pertaining to packaged air handling units.
- G. ARI Certification
 1. Provide central station packaged air handling units which comply with Air Conditioning and Refrigeration Institute Standard 430 and display ARI's certification symbols.
- H. UL Compliance
 1. Provide electric components for air handling units which have been listed and labeled by Underwriters' Laboratories.

1.06 DELIVERY, STORAGE, AND HANDLING

- A. Comply with manufacturer's installation instructions for rigging, unloading, and transporting units.
- B. Units shall ship fully assembled up to practical shipping and rigging limitations. Units not shipped fully assembled shall have tags and airflow arrows on each section to indicate location and orientation in direction of airflow. Each section shall have lifting lugs or shipping skid to allow for field rigging and final placement of section.
- C. Deliver units to jobsite with fan motor(s), sheave(s), and belt(s) completely assembled and mounted in units.

1.07 WARRANTY

- A. Provide a full parts warranty for one year from start-up or 18 months from shipment, whichever occurs first.

1.08 START-UP AND OPERATING REQUIREMENTS

- A. Do not operate units for any purpose, temporary or permanent, until ductwork is clean, filters are in place, bearings lubricated, condensate properly trapped, piping connections verified and leak-tested, belts aligned and tensioned, all shipping braces removed, bearing set screws torqued, and fan has been test run under observation.

PART 2 PRODUCTS

2.01 AIR HANDLING UNITS

- A. Manufacturers:
 1. PETRA Engineering Industries
- B. General:
 1. Provide factory built and tested modular air handling units designed for indoor installation, of sizes, configuration, and capacities as shown on contract drawings and specified herein.
 2. Provide unit mounting legs to support all sections of unit and raise unit for proper condensate trapping. Contractor shall verify with unit manufacturer that mounting legs are of sufficient height to properly trap unit. Contractor shall be responsible for providing a concrete housekeeping pad if unit is not provided with sufficient height mounting legs.

C. Casing:

1. Construction: Fabricate on complete channel frame and drain pan with removable panels secured by mechanical fasteners. All panels, access doors, and ship sections shall be sealed with permanently applied bulb-type gaskets. Gaskets shall be applied at the factory. Sections shall be bolted together.
 - a. Outside Casing:
 - 1) G90 Galvanized Steel: 0.0500 inch (18 USS gauge) with two(2) coats of electrostatic powder coating, oven baked.
 - b. Inside Casing:
 - 1) G90 Galvanized Steel: Solid, 0.0312 inch (22 USS gauge) with two(2) coats of electrostatic powder coating, oven baked.
 - c. Floor Plate:
 - 1) G90 Galvanized Steel: Solid, 0.0375 inch (20 USS gauge)
2. Leakage: Casing leakage rate shall not exceed 0.5 cfm per square foot of cabinet area at 5 inch water gage static pressure.
3. Structural Integrity: Construct unit casing sections capable of operating from -4 inch to +6 inch water gage with maximum deflection not exceeding L/240 at 5 inches water gage positive or negative static pressure.
4. Finish: Casing finish shall meet ASTM B 117 250 hour salt spray test.
5. Cabinet Insulation: Comply with NFPA 90A or NFPA 90B and weld pins .
 - a. Materials: ASTM C 1071 with coated surface exposed to air stream to prevent erosion of glass fibers.
 - b. Thickness: 2" thick with expandable poly-iso foam.
 - c. "R" value: 11.0 at 75 deg F temperature.
 - d. Fire-Hazard Classification: Maximum flame-spread index of 25 and smoke-developed index of 50, when tested according to ASTM C 916.
 - e. Liner Adhesive: Comply with NFPA 90A or NFPA 90B and ASTM C 916
 - f. Location and Application: Encased between outside and inside casing.
6. Access Panels and Doors: Same materials and finishes as cabinet (interior and exterior), complete with hinges, latches, handles, and gaskets. Access panels and doors shall be sized and located to allow periodic maintenance and inspections as shown on these drawings. Provide access panels and doors in the following locations:
 - a. Fan Section: Hinged access door.
 - b. Access Section: Hinged access doors.
 - c. Coil Section: Inspection panel.
 - d. Mixing Box / Damper Section: Hinged access door.
 - e. Filter Section: Hinged access door, to allow periodic removal and installation of filters.
7. Condensate Drain Pans: Formed sections of stainless steel insulated, sheet complying with requirements in ASHRAE 62. Fabricate pans with slopes in two planes to collect condensate from cooling coils (included coil piping connections and return bend) and humidifier when units are operating at maximum cataloged face velocity across cooling coil.
 - a. Double-Wall Construction: Fill space between walls with 3#/cu.ft. Density foam insulation and seal moisture tight.
 - b. Drain Connections: Both ends of the pan.
 - c. Pan-Top Coating: Elastomeric compound.
 - d. Units with stacked coil shall have an intermediate drain pan or drain trough to collect condensate from top coil.

D. Fan Section

1. Fan-Section Construction: Direct drive SWSI Plenum fans consisting of Fan wheel, motor and disconnect switch, drive assembly, and support structure and equipped with formed-steel channel base for integral mounting of fan, motor, and casing panels.
 - a. Mount fan with 1" open type spring vibration isolation.
 - b. Provide perforated inner liner in fan sections.

2. Centrifugal Fan Housings: Formed- and reinforced-steel panels to make curved scroll housing with shaped cutoff, spun-metal inlet bell, and access doors or panels to allow entry to internal parts and components.
 - a. Panel Bracing: Steel angle or channel-iron member supports for mounting and supporting fan scroll, wheel, motor, and accessories.
 - b. Performance Class: AMCA 99-2408, Class as required.
 3. Fan Assemblies: Statically and dynamically balanced and designed for continuous operation at maximum rated fan speed and motor horsepower.
 4. Airfoil-Fan Wheels: Steel construction with smooth-curved inlet flange, heavy backplate, and hollow die-formed airfoil-shaped blades continuously welded at tip flange and backplate; cast-iron hub riveted to backplate and fastened to shaft with set screws.
 5. Vibration Control: Install fans on 1" open type spring vibration isolation.
 6. Fan-Section Quality Control:
 - a. Sound Power Level Ratings: Comply with AMCA 301, "Methods for Calculating Fan Sound Ratings from Laboratory Test Data." Test fans according to AMCA 300, "Reverberant Room Method for Sound Testing of Fans." Fans shall bear AMCA-certified sound ratings seal.
 - b. Factory test fans performance for flow rate, pressure, power, air density, rotation, speed, and efficiency. Establish ratings according to AMCA 210, "Laboratory Methods of Testing Fans for Rating."
 7. Flexible Duct Connections: For separating fan and coil, and adjacent sections; refer to Section 23 3300.
- E. Motors
1. Motors shall be premium efficient E+ with class B insulation
 2. Motor wiring shall be brought back to control panel located at the external on the external casing of the unit.
 3. Units will be provided with variable speed drives on motors. See "Specification 238505 Variable Speed Drive System" for further details.
 4. Units will be provided with single point electrical connection with integral disconnect.
- F. Coils
1. Coils shall be manufactured from seamless copper tubing, 0.025" wall thickness, 5/8" diameter tubing, and tested at 450psi air pressure under water.
 2. Coil Sections: Common or individual, insulated, galvanized-steel casings for heating and cooling coils. Design and construct to facilitate removal and replacement of coil for maintenance and to ensure full airflow through coils. Retain one of three options listed below:
 - a. Hot and Chilled water coils Self-draining coils
 - 1) Coils to have face and bypass dampers for freeze protection sequence
 - 2) Arrangement: Horizontal coils
 - 3) Piping Connections: Threaded
 - 4) Tubes: Copper with minimum wall thickness of 0.025"
 - 5) Fins Aluminum with 0.0075" thickness
 - 6) Fin and Tube Joint: Silver brazed
 - 7) Headers: Cast iron or copper with vents and drainable connection
 - 8) Ratings: Design tested and rated according to ASHRAE 33 and ARI 410
 - 9) Working-Pressure Ratings: 150psig
 - 10) Source Quality Control: Test to 450psig
 - 11) Coil grommet - Where coil connections extend through the unit casing, a double grommet system shall be used to prevent air leakage. Maximum air leakage shall be no more than 25 CFM @ 3.0" W.C.
- G. Filters:
1. Filters: Comply with NFPA 90A.
 2. Filter Section: Provide filter holding frames arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side.

3. Extended-Surface, Disposable Panel Filters: Factory-fabricated, dry, extended-surface filters with holding frames.
 - a. Media: Fibrous material formed into deep-V -shaped pleats and held by self-supporting wire grid or slide in track.
 - b. Filters shall have a minimum MERV-14 rating.
- H. Dampers:
 1. General: Leakage rate, according to AMCA 500, "Laboratory Methods for Testing Dampers for Rating," shall not exceed 3% of air quantity at 2000-fpm face velocity through damper and 4-inch wg pressure differential.
 2. Damper Operators: Electric specified in Division 23 Section "Direct-Digital Control System for HVAC".
 3. Low-Leakage Dampers: All dampers are to made of rigid aluminum frame with multi airfoil aluminum blades so as to reduce pressure drop and sound generated air. Opposed blade dampers rotation is achieved by PVC gears.
- I. Mixing Box:
 1. Where required units will be provided with mixing boxes. Mixing boxes will be provided with factory installed low leakage gear driven dampers. (Actuators will be provided by controls contractor) See damper requirements.
- J. Electrical Requirements:
 1. Units will be provided with a single point power connection.
 2. Units will be provided with integral disconnect switch for ease of maintenance.
 3. Units will be provided with GFCI convenience receptacle.
- K. CONTROLS
 1. Controls will be by Temperature Controls Contractor.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in strict accordance with manufacturer's written instructions.
- B. Install flexible duct connections between fan inlet and discharge ductwork and air handling unit sections. Ensure that metal bands of connectors are parallel with minimum one inch flex between ductwork and fan while running.
- C. Install assembled unit on vibration isolators. Install isolated fans with resilient mountings and flexible electrical leads. Install restraining snubbers as required. Adjust snubbers to prevent tension in flexible connectors when fan is operating.
- D. Provide fixed sheaves required for final air balance.
- E. Make connections to coils with unions or flanges.
- F. Hydronic Coils:
 1. Hydronic Coils: Connect water supply to leaving air side of coil (counterflow arrangement).
 2. Provide shut-off valve on supply line and balancing valve with memory stop on return line.
 3. Locate water supply at bottom of supply header and return water connection at top.
 4. Provide manual air vents at high points complete with stop valve.
 5. Ensure water coils are drainable and provide drain connection at low points.
- G. Insulate Coil Headers Located Outside Air Flow as Specified for Piping: Refer to Section 23 0719.

END OF SECTION

This Page Intentionally Left Blank

**SECTION 23 7423
OUTDOOR MAKE-UP AIR UNITS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Hot water (Glycol) outdoor make-up air unit.
- B. Controls.

1.02 RELATED SECTIONS

- A. Section 23 0553 - Mechanical Identification.
- B. Section 23 0593 - Testing, Adjusting, and Balancing.
- C. Section 23 0713 - Duct Insulation.
- D. Section 23 0923 - Sequence of Operation.
- E. Section 23 3300 - Ductwork.

1.03 REFERENCES

- A. ASHRAE Std 90.1 - Energy Efficient Design of New Buildings Except Low-Rise Residential Buildings; American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.; 2004.
- B. NEMA MG 1 - Motors and Generators; National Electrical Manufacturers Association; 2003.
- C. NFPA 70 - National Electrical Code; National Fire Protection Association; 2005.
- D. NFPA 90A - Standard for the Installation of Air Conditioning and Ventilating Systems; National Fire Protection Association; 2002.

1.04 SUBMITTALS

- A. Product Data: Provide data with dimensions, duct and service connections, accessories, controls, electrical nameplate data, and wiring diagrams.
- B. Manufacturer's Instructions: Indicate rigging, assembly, and installation instructions.

1.05 WARRANTY

- A. Provide one year manufacturers warranty.

PART 2 PRODUCTS

2.01 HOT WATER (GLYCOL) OUTDOOR MAKE-UP AIR UNITS

- A. Manufacturers:
 - 1. Greenheck.
 - 2. Sterling/Mestek Technology Inc.
 - 3. Reznor.
- B. General:
 - 1. Unit with Integral Heating shall be fully assembled at the the factory and consist of an insulated metal cabinet, an outdoor air intake weatherhood with aluminum mesh, hot water coil, sensors, curb assembly, motorized intake damper, supply air blower assembly, electrical control center. All specified components and internal accessories factory installed and tested and prepared for single-point high voltage connection.
- C. Air Handling:
 - 1. Materials: Formed, double wall insulated metal cabinet, fabricated to permit access to internal components for maintenance.
 - a. Outside casing: 18 gauge, galvanized (G90) steel meeting ASTM A653 for components that do not receive a painted finish. Pre-painted components as supplied by the factory shall have polyester urethane paint on 18 gauge G60 galvanized steel. Base rail is 12 gauge, galvanized (G90) steel.
 - b. Internal assemblies: 24 guage, galvanized (G90) steel except for motor supports which shall be a minimum 14 guage galvanized (G90) stee

2. Cabinet Insulation: Comply with NFPA 90A and NFPA 90B and erosion requirements of UL 181.
 - a. Materials: Fiberglass insulation. If insulation other than fiberglass is used, it must also meet the Fire Hazard Classification shown below.
 - b. Thickness: 1 inch (25 mm)
 - c. Fire Hazard Classification: Maximum flame spread of 25 and smoke developed of 50, when tested in accordance with ASTM C 411.
 - d. Location and application: Floor of each unit shall be insulated with fiberglass insulation. Full interior coverage of entire cabinet to include walls and roof of unit shall be semi-rigid type and installed between inner and outer shells of all cabinet exterior components when double walls are specified.
 3. Access panels: Unit shall be equipped with insulated hinged access panels to provide easy access to all major components. Access panels shall be fabricated of 18 gauge galvanized G90 steel.
 4. Supply Air blower assembly options: Forward curve blower: Blower assembly consists of an electric motor and a belt driven, double width, and double inlet forward curve blower. Assembly shall be mounted on heavy gauge galvanized rails and further mounted on minimum 1.125 inch thick neoprene vibration isolators.
 5. Control center / connections:
 - a. Unit shall have an electrical control center where all high and low voltage connections are made. Control center shall be constructed to permit single-point high voltage power supply connections.
 6. Hot Water Coil: A water coil for heating shall be factory-installed in the unit for connection to a building steam source. Coil shall be Recognized Components per UL 1995, CAN/CSA C22.2 No. 236.05. Coil performance shall be calculated in accordance with AHRI 410. Coil shall be constructed of copper tubing, permanently bonded to aluminum fins and enclosed in a galvanized steel frame.
 7. Motorized Inlet Air Damper: to be of low leakage type and shall be factory installed.
 8. Sensors are considered to be part of various optional operational modes or device controllers and are to be factory supplied and installed as specified by the A/E.
 9. Curb Assembly: A curb assembly shall be made of galvanized steel provided by the factory for field assembly and installation as part of this division. The curb shall include a duct adapter(s) for supply air. The installing contractor shall be responsible for coordinating with roofing contractor to ensure curb unit is properly flashed to provide protection against weather/moisture penetration. Contractor shall provide and install appropriate insulation for the curb assembly.
 10. Frost Control for optional water coil.
- D. Blower:
1. Blower section construction, Supply Air: Belt drive motor and blower shall be assembled onto a minimum 14 gauge galvanized steel platform and must have neoprene vibration isolation devices, minimum of 1-1/8 inches thick.
 2. Blower assemblies: Shall be statically and dynamically balanced and designed for continuous operation at maximum rated fan speed and horsepower.
 3. Centrifugal blower housing: Formed and reinforced steel panels to make curved scroll housing with shaped cutoff.
 4. Forward curved blower (fan) wheels: Galvanized or aluminum construction with inlet flange and shallow blades curved forward in direction of airflow. Mechanically attached to shaft with set screws.
 5. Blower section motor source quality control: Blower performance shall be factory tested for flow rate, pressure, power, air density, rotation speed and efficiency. Ratings are to be established in accordance with AMCA 210, "Laboratory Methods of Testing Fans for Rating".
- E. Motors:
1. General: Blower motors greater than 3/4 horsepower shall be "NEMA Premium" unless otherwise indicated. Compliance with EPA minimum energy-efficiency standards for

single speed ODP and TE enclosures is not acceptable. Motors shall be heavy-duty, permanently lubricated type to match the fan load and furnished at the specified voltage, phase and enclosure. Drives shall be sized for a minimum of 150% of driven horsepower and pulleys shall be fully machined cast-type, keyed and fully secured to the fan wheel and motor shafts. Electric motors of ten horsepower or less shall be supplied with an adjustable drive pulley.

- F. Variable Frequency Drive (VFD):
 - 1. Unit shall have factory installed variable frequency drive for modulation of the supply air blower assembly. The VFD shall be factory-programmed for unit-specific requirements and shall not require additional field programming to operate.
- G. Operating Controls:
 - 1. Interlock operation of unit with the kitchen hood.
- H. Accessories:
 - 1. 18" high insulated roof curb.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Furnish Roof Curb to the Roofing Contractor for installation.

END OF SECTION

This Page Intentionally Left Blank

**SECTION 23 8126.13
SMALL-CAPACITY SPLIT-SYSTEM AIR CONDITIONERS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Air cooled condensing units.
- B. Indoor air handling (fan and coil) units for ductless systems.
- C. Controls.

1.02 REFERENCE STANDARDS

- A. AHRI 210/240 - Standard for Performance Rating of Unitary Air-Conditioning and Air-Source Heat Pump Equipment 2008, Including All Addenda.
- B. AHRI 520 - Performance Rating of Positive Displacement Condensing Units 2004.
- C. ASHRAE Std 15 - Safety Standard for Refrigeration Systems 2019, with All Amendments and Errata.
- D. ASHRAE Std 23.1 - Methods for Performance Testing Positive Displacement Refrigerant Compressors and Condensing Units that Operate at Subcritical Pressures of the Refrigerant 2019.
- E. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems 2021.
- F. NFPA 90B - Standard for the Installation of Warm Air Heating and Air-Conditioning Systems 2021.
- G. UL 207 - Standard for Refrigerant-Containing Components and Accessories, Nonelectrical Current Edition, Including All Revisions.

1.03 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide rated capacities, weights, accessories, electrical nameplate data, and wiring diagrams.
- C. Shop Drawings: Indicate assembly, required clearances, and location and size of field connections.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Samsung: www.samsung.com/#sle.

2.02 INDOOR UNITS FOR DUCTLESS SYSTEMS

- A. Indoor Units: Self-contained, packaged, factory assembled, pre-wired unit consisting of cabinet, supply fan, evaporator coil, and controls; wired for single power connection with control transformer.
 - 1. Location: High-wall.
 - 2. Fan: Line-flow fan direct driven by a single motor.
 - 3. Filter return air with washable, antioxidant pre-filter and a pleated anti-allergy enzyme filter.
- B. Evaporator Coils: Copper tube aluminum fin assembly, galvanized or polymer drain pan sloped in all directions to drain, drain connection, refrigerant piping connections, restricted distributor or thermostatic expansion valve.
 - 1. Construction and Ratings: In accordance with AHRI 210/240 and UL 207.
 - 2. Manufacturer: System manufacturer.

2.03 OUTDOOR UNITS

- A. Outdoor Units: Self-contained, packaged, pre-wired unit consisting of cabinet, with compressor and condenser.

1. Comply with AHRI 210/240.
 2. Refrigerant: Use only refrigerants that have ozone depletion potential (ODP) of zero and global warming potential (GWP) of less than 50.
 3. Refrigerant: R-410A.
 4. Cabinet: Galvanized steel with baked enamel finish, easily removed and secured access doors with safety interlock switches, glass fiber insulation with reflective liner.
 5. Construction and Ratings: In accordance with AHRI 210/240 with testing in accordance with ASHRAE Std 23.1 and UL 207.
- B. Compressor: Hermetic, 3600 rpm, AHRI 520 resiliently mounted integral with condenser, with positive lubrication, crankcase heater, high pressure control, motor overload protection, service valves and drier. Provide time delay control to prevent short cycling and rapid speed changes.
- C. Air Cooled Condenser: Aluminum fin and copper tube coil, AHRI 520 with direct drive axial propeller fan resiliently mounted, galvanized fan guard.
1. Condenser Fans: Direct-drive propeller type.
- D. Accessories: Filter drier, high pressure switch (manual reset), low pressure switch (automatic reset), service valves and gauge ports, thermometer well (in liquid line).
1. Provide thermostatic expansion valves.
- E. Operating Controls:
1. Control by room thermostat to maintain room temperature setting.
 2. Low Ambient Kit: Provide refrigerant pressure switch to cycle condenser fan on when condenser refrigerant pressure is above 285 psig and off when pressure drops below 140 psig for operation to -40 Degrees F.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturer's instructions and requirements of local authorities having jurisdiction.
- B. Install in accordance with NFPA 90A and NFPA 90B.
- C. Install refrigeration systems in accordance with ASHRAE Std 15.

END OF SECTION

**SECTION 23 8200
CONVECTION HEATING AND COOLING UNITS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. Finned tube radiation.
- B. Unit heaters.
- C. Cabinet unit heaters.
- D. Blower-coil units.
- E. Induction units.

1.02 RELATED REQUIREMENTS

- A. Section 23 0716 - HVAC Equipment Insulation.
- B. Section 23 0719 - HVAC Piping Insulation.
- C. Section 23 2113 - Hydronic Piping.
- D. Section 23 2114 - Hydronic Specialties.

1.03 REFERENCE STANDARDS

- A. AHRI Directory of Certified Product Performance - Air-Conditioning, Heating, and Refrigeration Institute (AHRI) Current Edition.
- B. AHRI 410 - Forced-Circulation Air-Cooling and Air-Heating Coils 2001, with Addenda (2011).
- C. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems 2021.

1.04 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide typical catalog of information including arrangements.
- C. Shop Drawings:
 - 1. Submit schedules of equipment and enclosures typically indicating length and number of pieces of element and enclosure, corner pieces, end caps, cap strips, access doors, pilaster covers, and comparison of specified heat required to actual heat output provided.

1.05 WARRANTY

- A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.

PART 2 PRODUCTS

2.01 HYDRONIC FINNED TUBE RADIATION

- A. Manufacturers:
 - 1. Sigma Corporation: www.sigmaproducts.com/#sle.
 - 2. Slant/Fin Corporation: www.slantfin.com/#sle.
 - 3. Zehnder Rittling: www.rittling.com/#sle.
- B. Required Directory Listing: AHRI Directory of Certified Product Performance - Air-Conditioning, Heating, and Refrigeration Institute (AHRI); current edition at www.ahrinet.org.
- C. Heating Elements: 3/4 inch ID seamless copper tubing, mechanically expanded into evenly spaced aluminum fins sized 4 by 4 inches, suitable for soldered fittings.
- D. Element Hangers: Quiet operating, ball bearing cradle type providing unrestricted longitudinal movement, on enclosure brackets.
- E. Enclosures: 18 gage, 0.0478 inch sheet steel up to 18 inches in height, 16 gage, 0.0598 inch sheet steel over 18 inches in height or aluminum as detailed, with easily jointed components for wall to wall installation.
- F. Finish: Factory applied baked primer coat.

- G. Damper: Where not thermostatically controlled, provide knob-operated internal damper at enclosure air outlet.
- H. Access Doors: For otherwise inaccessible valves, provide factory-made permanently hinged access doors, 6 by 7 inch minimum size, integral with cabinet.

2.02 HYDRONIC UNIT HEATERS

- A. Manufacturers:
 - 1. Sigma Corporation: www.sigmaproducts.com/#sle.
 - 2. Sterling Hydronics, a Mestek Company: www.sterlingheat.com/#sle.
- B. Coils: Seamless copper tubing, silver brazed to steel headers, and with evenly spaced aluminum fins mechanically bonded to tubing.
- C. Perform factory run test under normal operating conditions, water, and steam flow rates.
- D. Casing: Minimum 18 gage, 0.0478 inch thick sheet steel casing with threaded pipe connections for hanger rods for horizontal models and minimum 18 gage, 0.0478 inch thick sheet steel top and bottom plates for vertical projection models.
- E. Finish: Factory applied baked primer coat.
- F. Fan: Direct drive propeller type, statically and dynamically balanced, with fan guard; horizontal models with permanently lubricated sleeve bearings; vertical models with grease lubricated ball bearings.
- G. Air Outlet: Adjustable pattern diffuser on vertical projection models and two way louvers on horizontal projection models.
- H. Totally Enclosed Motors: Permanently lubricated sleeve bearings on horizontal models, grease lubricated ball bearings on vertical models.
- I. Electrical Characteristics:
 - 1. 120 volts, single phase, 60 Hz.

2.03 HYDRONIC CABINET UNIT HEATERS

- A. Manufacturers:
 - 1. Sigma Corporation: www.sigmaproducts.com/#sle.
 - 2. Sterling Hydronics a Mestek Company: www.sterlingheat.com/#sle.
- B. Provide products listed, classified, and labeled by Underwriters Laboratories Inc. (UL), Intertek (ETL), or testing firm acceptable to Authority Having Jurisdiction as suitable for the purpose indicated.
- C. Coils:
 - 1. Evenly spaced aluminum fins mechanically bonded to copper tubes.
 - 2. Heating Hot Water: Suitable for working temperatures up to a maximum not less than 200 degrees F.
- D. Cabinet: Minimum 16 gage, 0.0598 inch thick sheet steel front panel with exposed corners and edges rounded, easily removed panels, glass fiber insulation, integral air outlet, and inlet grilles.
- E. Finish: Factory applied baked primer coat on visible surfaces of enclosure or cabinet.
- F. Fans: Centrifugal forward-curved double-width wheels, statically and dynamically balanced, direct driven.
- G. Motor: Tap wound multiple speed permanent split capacitor with sleeve bearings, resiliently mounted.
- H. Control: Factory wired, solid state, infinite speed control, located in cabinet.
- I. Filter: Easily removed, 1 inch thick glass fiber throw-away type, located to filter air before coil.
- J. Electrical Characteristics:
 - 1. 120 volts, single phase, 60 Hz.

2.04 BLOWER-COIL UNITS

- A. Manufacturers:
 - 1. International Environmental Corp.: www.iec-okc.com/#sle.
- B. Performance Data and Safety Requirements:
 - 1. Coils rated and tested in accordance with AHRI 410.
 - 2. Provide products listed, classified, and labeled by Underwriters Laboratories Inc. (UL), Intertek (ETL), or testing firm acceptable to Authority Having Jurisdiction as suitable for the purpose indicated.
 - 3. Comply with NFPA 90A for unit construction, including filters and related equipment, for protection of life and property from fire, smoke, and gases resulting from conditions having manifestations similar to fire.
- C. Unit Casing:
 - 1. Fabricate from 18 heavy gage galvanized steel sheet.
 - 2. Insulate inside walls with 1 inch thick, closed cell insulation for thermal and acoustical control.
 - 3. Provide access panels allowing servicing of coils, drain pan, fan, motor, and drive.
 - 4. Provide knockouts or hanger rod holes at all four corners for suspended units.
- D. Air Coils:
 - 1. Aluminum fins mechanically expanded or bonded to 1/2 inch copper tubes having standard sweat connections.
 - a. Hot and Chilled Water: Manual, automatic or self-venting, designed to a working pressure and temperature of not less than 250 psig and 200 degrees F.
- E. Fans: Forward curved, centrifugal blower, dynamically balanced, direct drive with fan shaft supported by heavy-duty, permanently sealed ball bearings.
- F. Drain Pan: Cleanable, one-piece construction of stainless steel; with drain connection and sloped for positive drainage.
- G. Filters: Fully accessible, flat filter rack with a minimum of MERV-13 throw-away filters.
- H. Electrical:
 - 1. Provide a fused disconnecting means for main incoming power.
- I. Electrical Characteristics:
 - 1. 480 volts, three phase, 60 Hz.

2.05 INDUCTION AIR UNITS

- A. Manufacturers:
 - 1. NuClimate Air Quality Systems: www.nu.com/#sle.
- B. Induction beam unit shall be primary air flow units designed to induce a secondary airflow within the conditioned space using the primary conditioned air supply. Units shall be designed for ceiling installation with factory supplied hanging brackets.
- C. Units shall be equipped with a 8" round primary air intake connection, an air plenum with air induction nozzles, chilled/hot water coils, supply and return chilled water and hot water piping connections, one sloped 1-1/2 inch deep drainable condensate pan with a 3/4 inch condensate drain connection, and one combination supply/return air grille suitable for all-way blow coanda effect room air distribution. The grille shall have a hinged core to provide full access to the return air side of the coil. The unit shall be capable of inducing the secondary airflow within the conditioned space using the velocity pressure of the primary flow. This secondary air flow directly from the room to the unit and shall not use the ceiling as a return air plenum. Induction unit using the ceiling plenum as a return air path are not acceptable.
- D. A static pressure port is factory supplied on the aerodynamic inlet fitting so the balancing contractor can read via a pressure airflow gauge the inlet pressure to the induction unit and set the proper pressure to meet the airflow schedules on the drawings.

- E. Each unit shall be equipped with a multiple row water coil for chilled water and hot water.
- F. Each unit shall include one drain pan and one drain pan connection. This drain pan shall be 1-1/2 inches in depth and sloped in the direction of the condensate connection. The drain outlet connection shall be 3/4 inch copper FNPT fitting.
- G. Each unit shall contain an integral factory supplied supply/return diffuser to evenly distribute the mixed primary air in an all-way blow coanda effect air distribution pattern. The diffuser shall incorporate multiple louvers in each direction for the supply air to the space. The diffuser shall fit into a standard ceiling grid. The grille return section shall be egg crate. the grille shall be hinged for easy access to the interior of the unit without tools. Access to the interior shall occur through the grille face from within the occupied space.
- H. Casings
 - 1. The entire unit shall be constructed of 20 gauge galvanized sheet metal. The primary air plenum and nozzles shall be designed and configured to provide uniform air distribution with low noise operation to all nozzles.
- I. Exterior Cabinet Insulation
 - 1. The exterior of the unit cabinet and primary air plenum shall be insulated at the factory with Armacell model AP sheet insulation. Insulation shall be 1/4 inch thick and shall meet the following criteria:
 - a. Thermal conductivity of 0.27 BTU-in/hr. ft² F per ASTM C 177 Or C518.
 - b. Water vapor permeability of 0.08 (1.16 x 10⁻⁹) per ASTM E 96.
 - c. Water absorption % by volume of 0.2% per ASTM E 84.
 - d. Flame spread rating shall be 25 or less per ASTM E 84.
 - e. Smoke spread rating shall be 50 or less per ASTM E 84.
 - f. Upper temperature limit shall be 220F/105C.
 - g. Lower temperature limit shall be 70F/57C.
 - h. Specific compliance shall include ASTM C 534 Type II sheet grade 1, ASTM E 84, NFPA 255, UL 723, CAN/ULC S-102, UL94 5V-A, V-0, File E 55798, NFPA 90A, 90B, ASTM D 1056, 2B1, Mil-P-15280J Form S, Mil-C-3133C (Mil std 670B) Grade SBE 3, MEA 107-89-M, City of Los Angeles - RR 7642, CGSB Can 2-51.40-M80. ASTM C 1534.
- J. Lint Filter
 - 1. Lint filter shall be a disposable type supplied by the unit manufacture.
 - 2. Disposable panel filter shall be 1/2 inch thick fiberglass media complying with UL 217V.
- K. Induction Nozzles
 - 1. Induction nozzles shall be aerodynamically designed and made of DuPont Hytrel 4069 Engineering Polymers with a temperature range of -40 -122 degrees F and tested and rated by test method UL94 and UL746. Each nozzle shall incorporate a tapered design allowing the airflow to enter the nozzle more effectively and perform more efficiently without dirt build up.
- L. Water Coil Assembly
 - 1. Coils shall be of the hot and chilled water type utilizing aluminum fins and copper tubes. Coil shall be two or four pipe configuration as scheduled. Coils shall be mounted vertically not horizontally. Coil connections shall be 3/4 inch sweat connections or as indicated on drawings.
 - 2. Each coil must be one flat plate assemblies with no interconnecting joints to minimize leakage. Coils shall be built of minimum 1/2" seamless copper tubing. Copper tube wall shall be a minimum .016 thickness. Coils shall be factory leak tested at 350 PSI water. Each coil shall be of the fin plate design surrounding the copper tube wall via fin spacing of 11 fins per inch. Fins shall be mechanically bonded to copper tubes. Each coil shall be enclosed on the ends with sealed flanges to eliminate leakage around the coil.
- M. Additional height for gravity drain

1. To accommodate long drain line runs the Induction unit cabinet can be provided with an additional 1 to 6 inches of height. The additional height allows the drain pan connections to be 4.75 to 9.75 inches above the ceiling line instead of the standard 3.75 inch. Refer to equipment schedule on plans for which units require the extension.

PART 3 EXECUTION

3.01 EXAMINATION

- A. Verify that surfaces are suitable for installation.
- B. Verify that field measurements are as indicated on drawings.

3.02 INSTALLATION

- A. Install in accordance with manufacturer's recommendations.
- B. Install equipment exposed to finished areas after walls and ceilings are finished and painted.
- C. Finned Tube Radiation:
 1. Locate on outside walls and run cover continuously wall-to-wall unless otherwise indicated.
 2. Center elements under window with elements of equal length centered under each window for multiple windows.
 3. Install wall angles and end caps where units butt against walls.
- D. Unit Heaters:
 1. Hang from building structure, with pipe hangers anchored to building, not from piping or electrical conduit.
 2. Mount as high as possible to maintain greatest headroom unless otherwise indicated.
- E. Cabinet Unit Heaters:
 1. Install as indicated.
 2. Coordinate to ensure correct recess size for recessed units.
- F. Blower-Coil Units:
 1. Install in accordance with manufacturer's recommendations.
 2. General piping installation requirements are specified in other Sections and drawings indicate general arrangement of piping, fittings, and specialties.
 3. Connect hydronic, condensate drain, and overflow drain piping to unit.
- G. Induction Units:
 1. Follow manufacturer's installation instructions and recommendations for all equipment.
 2. Install Induction units in ceiling in such a manner as to allow easy access to all controls.
 3. Use the hanging brackets on each unit which are supplied by the manufacturer. Induction units shall be supported using field supplied threaded rod.
 4. Provide primary supply air connection and seal with duct sealer after installation. A volume control balancing damper shall be installed at the branch takeoffs for each induction unit for the air balancing contractor. A static pressure port is factory supplied on the aerodynamic inlet so the balancing contractor can read via a pressure airflow gauge the inlet pressure to the induction unit and set the proper pressure to meet the airflow schedules on the drawings.
 5. Provide water supply / return connection and install shut off valves and temperature control valves.
 6. Connect the condensate drain to available building drains if required on plans.

3.03 FIELD QUALITY CONTROL

- A. Provide manufacturer's field representative to test, inspect, instruct, and observe.

3.04 CLEANING

- A. After construction and painting is completed, clean exposed surfaces of units.

- B. Touch-up marred or scratched surfaces of factory-finished cabinets using finish materials furnished by the manufacturer.
- C. Install new filters.

3.05 CLOSEOUT ACTIVITIES

- A. See Section 01 7800 - Closeout Submittals, for closeout submittals.

END OF SECTION

**SECTION 23 8216
AIR COILS**

PART 1 GENERAL

1.01 SECTION INCLUDES

- A. WaterGlycol heating coils.

1.02 RELATED REQUIREMENTS

- A. Section 23 0719 - HVAC Piping Insulation.
- B. Section 23 2114 - Hydronic Specialties.
- C. Section 23 3100 - HVAC Ducts and Casings: Installation of duct coils.

1.03 REFERENCE STANDARDS

- A. SMACNA (DCS) - HVAC Duct Construction Standards Metal and Flexible 2020.

1.04 SUBMITTALS

- A. See Section 01 3000 - Administrative Requirements, for submittal procedures.
- B. Product Data: Provide coil and frame configurations, dimensions, materials, rows, connections, and rough-in dimensions.
- C. Shop Drawings: Indicate coil and frame configurations, dimensions, materials, rows, connections, and rough-in dimensions.

1.05 DELIVERY, STORAGE, AND HANDLING

- A. Protect coil fins from crushing and bending by leaving in shipping cases until installation, and by storing indoors.
- B. Protect coils from entry of dirt and debris with pipe caps or plugs.

PART 2 PRODUCTS

2.01 MANUFACTURERS

- A. Sigma Corporation: www.sigma.com/#sle.

2.02 WATER/GLYCOL HEATING COILS

- A. Tubes: 5/8 inch OD seamless copper arranged in parallel or staggered pattern, expanded into fins, silver brazed joints.
- B. Fins: Aluminum or copper continuous plate type with full fin collars.
- C. Casing: Die formed channel frame of 16 gage, 0.0598 inch galvanized steel with mounting holes on 3 inch centers. Provide tube supports for coils longer than 36 inches.
- D. Headers: Cast iron with tubes expanded into header.
- E. Testing: Air test under water to 200 psi for working pressure of 200 psi and 220 degrees F.
- F. Configuration: Drainable, with threaded plugs for drain and vent.

PART 3 EXECUTION

3.01 INSTALLATION

- A. Install in accordance with manufacturers written instructions.
- B. Install in ducts and casings in accordance with SMACNA (DCS).
 - 1. Support coil sections independent of piping on steel channel or double angle frames and secure to casings.
- C. Protect coils to prevent damage to fins and flanges. Comb out bent fins.
- D. Make connections to coils with unions and flanges.

END OF SECTION

This Page Intentionally Left Blank

SECTION 260010

BASIC ELECTRICAL REQUIREMENTS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. All drawings and general provisions of Contract, including all General and Supplementary Conditions, Division 1 Specification Sections, and Instructions to Bidders apply to this section and all other sections of Division 26, 27, & 28.

1.2 REGULATIONS AND CODE COMPLIANCE

- A. All work and materials shall conform to and be installed, inspected and tested in accordance with the 2014 National Electric Code and with the governing rules and regulations of federal, state and local governmental agencies.
- B. The following is a list of codes and standards that will apply to this project:
 - 1. 2015 International Building Code
 - 2. 2015 International Energy Conservation Code
 - 3. 2016 and 2017 Supplement to the New York State Energy Construction Code
 - 4. New York State Department of Labor Rules and Regulations
 - 5. New York State Department of Health
 - 6. New York State Education Department
 - 7. Federal Occupational Safety and Health Act - OSHA.
 - 8. National Electrical Code, NFPA 70
 - 9. Electrical Safety Requirements, NFPA 70E
 - 10. National Fire Alarm Code, NFPA 72
 - 11. Life Safety Codes NFPA 101
 - 12. NEMA Standards
 - 13. Factory Mutual or other Insurance Carrier.

1.3 LICENSING & PERMITS

- A. Provide certificate of inspection from Commonwealth Electrical Inspection Services Inc. for all electrical work prior to acceptance of each phase.
- B. Apply for and obtain all required permits and inspections, include costs for all fees and charges within bid. Provide third party inspection of all electrical work by a certified inspection agency or approved professional.
- C. Refer to General Conditions of the Contract for additional requirements.

1.4 GLOSSARY

ACI	American Concrete Institute
ADA	American Disabilities Act
AGCA	Associated General Contractors of America, Inc.
AIA	American Institute of Architects
AISC	American Institute of Steel Construction
ANSI	American National Standards Institute
ASTM	American Society for Testing Materials
AWSC	American Welding Society Code
FM	Factory Mutual Insurance Company
IEEE	Institute of Electrical and Electronics Engineers
ISO	International Standards Organization
NYBFU	New York Board of Fire Underwriters
NEC	National Electrical Code
NEMA	National Electrical Manufacturers' Association
NESC	National Electrical Safety Code
NFPA	National Fire Protection Association
NYS/DEC	New York State Department of Environmental Conservation
NYS/UFBC	New York State Uniform Fire Prevention and Building Code
OSHA	Occupational Safety and Health Administration
UFPO	Underground Facilities Protective Organization
UL	Underwriter's Laboratories, Inc.

1.5 DEFINITIONS

Approved / Approval	Written permission to use a material or system.
As Called For	Materials, equipment including the execution specified/shown in the contract documents.
Code Requirements	Minimum requirements.
Concealed	Work installed in pipe and duct shafts, chases or recesses, inside walls, above ceilings, in slabs or below grade.
Design Equipment	Refer to the article, BASIS OF DESIGN.
Design Make	Refer to the article, BASIS OF DESIGN.
Equal or Equivalent	Equally acceptable as determined by Owner's Representative
Exposed	Work not identified as concealed.
Final Acceptance	Owner acceptance of the project from Contractor upon certification by Owner's Representative.
Furnish	Supply and deliver to installation location.

Furnished by Others	Receive delivery at job site or where called for and install.
Inspection	Visual observations by Owner's site Representative.
Install	Mount and connect equipment and associated materials ready for use.
Labeled	Refers to classification by a standards agency.
Make	Refer to the article, BASIS OF DESIGN.
Or Approved Equal	Approved equal or equivalent as determined by Owner's Representative.
Owner's Representative	The Prime Professional
Prime Professional	Architect or Engineer having a contract directly with the Owner for professional services.
Provide	Furnish, install and connect ready for use.
Relocate	Disassemble, disconnect, and transport equipment to new locations, then clean, test, and install ready for use.
Replace	Remove and provide new item.
Review	A general contractual conformance check of specified products.
Rough-in	Pipe, duct, conduit, equipment layout and installation.
Satisfactory	As specified in contract documents.
Site Representative	Construction Manager or Owner's Inspector at the work site.
Refer to General Conditions of the Contract for additional definitions.	

1.6 BASIS OF DESIGN

- A. The contract documents are prepared on basis of one manufacturer as "design equipment," even though other manufacturers' names are listed as acceptable makes. If Contractor elects to use one of the listed makes other than "design equipment," submit detailed drawings, indicating proposed installation of equipment. Show maintenance clearances, service removal space required, and other pertinent revisions to the design arrangement. Make required changes in the work of other trades, at no increase in any contract. Provide larger electrical feeders, circuit breakers, equipment, additional control devices and other miscellaneous equipment required for proper operation, and assume responsibility for proper location of rough-in and connections by other trades. Remove and replace door frames, access doors, walls ceilings or floors required to install other than design make equipment. If revised arrangement submittal is rejected, revise and resubmit specified "design equipment" item which conforms to contract documents.

1.7 INTENT OF DRAWINGS

- A. The drawings are diagrammatic, unless detailed dimensioned drawings are included. Drawings show approximate locations of equipment, fixtures, panelboards, conduits, and wiring devices. Exact locations are subject to the approval of the Owner's Representative. The general run of electrical feeders, branch circuits, and conduits, indicated on the drawings, is not intended to be the exact routing. Circuit designations, in the form of "Home Runs" on branches, indicate the designation of the branch circuit, the size and the quantity of branch circuit conductors, and the panelboard or interconnection box from which the branch circuit is served.

1.8 QUALITY ASSURANCE

- A. Manufactures of equipment shall be firms regularly engaged in the production of factory

fabricated systems and equipment whose products have been in satisfactory use in similar service for not less than three (3) years.

- B. Suppliers of equipment must have factory trained and authorized personnel for the service of all equipment provided.

1.9 ABSENCE OF SPECIFICATION

- A. Where the drawings or the specifications do not name a particular brand or manufacturer of any item, these items are still part of the Work. This Contractor shall provide all such items that may be fairly and reasonably judged throughout the construction industry to be the most appropriate and best quality item for the intended application. Provide submittals for proposed items to the Architect for review and approval.

1.10 DISCREPANCY IN DRAWINGS AND/OR SPECIFICATIONS

- A. Where the drawings and/or the specifications pose a conflict in design intent requirements, quality of work, or equipment the contractor must submit an RFI for clarification during the bid process in compliance with the front end specifications to provide resolution or provide the greater of the conflicting equipment or workmanship after the submission of bid, or cutoff date for RFI's.

PART 2 - PRODUCTS

2.1 SUBSTITUTIONS

- A. The Materials, products and equipment described in the Bidding Documents establish a standard of required quality, functions, dimensions and appearance that must be met by any proposed substitution.
- B. Proposed substitutions must be submitted to the Architect/Engineer a minimum of ten (10) days prior to the date for receipt of Bids. Each request shall include the name of the proposed material equipment being substituted, cut sheets, installation drawings, performance and test data and warranties. At that time the equipment or will be evaluated and if determined to be acceptable an Addendum will be issued to all bidders.
- C. Requests for substitution shall be made only by a Bidder. Requests for substitution from sales representatives, vendors or suppliers are not acceptable.

2.2 MATERIALS

- A. All materials, unless otherwise specified, shall be new and be the standard products of the manufacturer. Used equipment or damaged material will be rejected.
- B. The listing of a manufacturer as "acceptable" does not indicate acceptance of a standard or catalogued item of equipment. All equipment and systems conform to the

Specifications.

2.3 U.L. LISTING

- A. Equipment shall bear the Underwriter's Laboratories (UL), or other approved agency listing label. This listing requirement applies to the entire assembly. Any modifications to equipment to suit the intent of the specifications shall be performed in accordance with the National Electric Code and listed by U.L.

2.4 SHOP DRAWINGS/PRODUCT DATA/SAMPLES

- A. Submit Shop Drawings on all items of equipment and materials to be furnished and installed. Submission of Shop Drawings and samples shall be accompanied by a transmittal letter, stating name of project and contractor, number of drawings, titles, and other pertinent data called for in individual sections. Shop Drawings Shall Be Dated and Contain: Name of project; name of prime professional; name of prime contractor; description or names of equipment, materials and items; and complete identification of locations at which materials or equipment are to be installed. Incomplete submittals will not be accepted. All products specified in an individual Division 26, 27, and 28 specification sections shall be submitted at the same time and each separate section shall have its own submittal. Number each submittal and do not combine multiple specification sections into a single submittal. Indicate deviations from contract requirements on Letter of Transmittal. Corrections or comments made on the Shop Drawings during the review do not relieve Contractor from compliance with requirements of the drawings and specifications. The Contractor is responsible for confirming and correcting all quantities; checking electrical characteristics and dimensions; selecting fabrication processes and techniques of construction; coordinating his work with that of all other trades; and performing his work in a safe and satisfactory manner.

PART 3 - EXECUTION

3.1 COORDINATION DRAWINGS

- A. Before construction work commences, Contractors for all trades shall submit Coordination Drawings in the form of reproducible transparencies drawn at not less than 1/4" = 1'-0" scale. Coordination Drawings are required throughout all areas for all trades. These drawings shall identify and show resolutions of trade conflicts. Mechanical Equipment Rooms shall be drawn early in the Coordination Drawing process, simultaneous with all other congested areas. Prepare Coordination Drawings As Follows:
 - 1. HVAC Contract will prepare the base plan Coordination Drawings showing all ductwork and all pertinent piping and equipment. These drawings may be sepia of the required ductwork Shop Drawings. The drawings shall be coordinated with cable tray, lighting fixtures, sprinklers, air diffusers, other ceiling mounted items, ceiling heights, structural work, maintenance clearances, electric code clearance, reflected ceiling plans, and other contract requirements. Reposition proposed locations of work after coordination drawing review by the Construction Manager and the Architect. Provide adjustments to exact size, location and offsets of ducts, pipes, conduit, etc., to achieve reasonable appearance objectives. Provide these adjustments as part of Base Bid Contracts.

Minor revisions need not be redrawn.

2. HVAC Contract will provide sepia transparencies and/or prints and submit the base plan to all major trades' Contractors.
3. Electrical, Plumbing and Fire Protection Contracts will draft location of piping and equipment on the base plan, indicating areas of conflict and suggested resolutions.

3.2 ROUGH-IN

- A. Due to small scale of Drawings, it is not possible to indicate all offsets, fittings, changes in elevation, etc. Verify final locations for rough-ins with field measurements and with the equipment being connected. Verify exact location and elevations at work site prior to any rough-in work. **DO NOT SCALE PLANS.** If field conditions, details, changes in equipment or shop drawing information require a significant change to the original documents, contact the owners representative for approval before proceeding.
- B. All equipment locations shall be coordinated with other trades to eliminate interference with required clearances for equipment maintenance and inspections.
 1. Coordinate work with other trades and determine exact routing of all duct, pipe, conduit, etc., before fabrication and installation. Coordinate with Architectural Drawings. Verify with Owner's Representative exact location of all equipment in finished areas, such as thermostat, fixture and switch mounting heights, and equipment mounting heights. Coordinate all work with the architectural reflected ceiling plans and/or existing Architecture. Mechanical and electrical drawings show design arrangement only for diffusers, grilles, registers, air terminals, lighting fixtures, sprinklers, speakers and other items. Do not rough-in contract work without reflected ceiling location plans.
 2. Before rough-in for equipment furnished by Owner or in other contracts, obtain from Architect and other Contractors, approved rough-in drawings giving exact location for each piece of equipment. Do not "rough-in" services without final layout drawings approved for construction. Cooperate with other trades to insure proper location and size of connections to insure proper functioning of all systems and equipment. Obtain written authorization from the Owners representative or other contractor for any "rough-ins" that, due to project schedule, are required before approved coordination drawings are available. Any work installed without written authorization or approved coordination drawings, causing a conflict will be relocated by the electrical contractor at no expense to the Owner.
 3. For equipment and connections provided in this contract, prepare rough-in drawings as follows:
 - a. Existing equipment being relocated: Measure the existing equipment and prepare drawings for installation in new location.
 - b. New equipment: Obtain equipment rough-in drawings and dimensions,

then prepare rough-in drawings.

- c. Where more than one trade is involved in an area, space or chase, all shall cooperate and install their own work to utilize the space equally between them in proportion to their individual requirements. In general, ductwork shall be given preference except where grading of piping becomes a problem, followed by piping then electrical wiring. If, after installation of any equipment, piping, ducts, conduit, and boxes, it is determined that ample maintenance and passage space has not been provided, rearrange work and/or furnish other equipment as required for ample maintenance space. Any changes in the size or location of the material or equipment supplied, which may be necessary in order to meet field conditions or in order to avoid conflicts between trades, shall be brought to the immediate attention of the Owner's Representative and approval received before such alterations are made.
- C. Provide easy, safe, and code mandated clearances at controllers, motor starters, valve access, and other equipment requiring maintenance and operation. Contractor shall relocate existing work in the way of new construction. VISIT SITE BEFORE BIDDING TO DETERMINE SCOPE OF WORK. Provide new materials, including new piping and insulation for relocated work.

3.3 EXISTING SYSTEMS AND CONDITIONS

- A. Prior to beginning work inspect and test all existing electrical systems that will be affected by the work in this contract. Provide a report to the Owner indicating any problems or defects found. If no problems or system defects are submitted, the contractor shall be responsible for correcting problems found at the completion of the project that are determined to be caused by the work of this contract.
- B. Inspect the entire work area for defects in the existing construction such as scratches, holes etc. Submit a complete list and photographs of existing damage, to the owner prior to beginning work. If existing damage is not documented the contractor shall repair all damage to like new condition, that is determined to have been caused by the work in this contract.

3.4 ELECTRICAL INSTALLATIONS

- A. All installations shall comply with the following requirements:
 - 1. Coordinate electrical systems, equipment, and materials installation with other building components. Be responsible for any changes in openings and locations necessitated by the equipment installed.
 - 2. The architect shall control the placement of all wall and ceiling mounted electrical equipment and devices in all rooms with the exception of mechanical and electrical equipment rooms. When drawing details are not available, consult with the Architects representative for actual location.
 - 3. Verify all dimensions with field measurements.

4. Arrange for all chases, slots and openings in other building components that are not indicated on drawings, to allow for electrical installations.
5. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.
6. Coordinate ordering and installation of all equipment with long lead times or having a major impact on work by other trades so as not to delay the job or impact the construction schedule. Pay close attention to equipment that must be installed prior to building enclosure.
7. Where mounting heights are not detailed or dimensioned, install systems, materials and equipment to provide the maximum headroom possible.
8. Install systems, materials and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer the conflict to the Architect.
9. Store Materials on dry base, at least 6" above-ground or floor. Store so as not to interfere with other work or obstruct access to buildings or facilities. Provide waterproof/windproof covering. Remove and provide special storage for items subject to moisture damage. Protect against theft or damage from any cause. Replace items stolen or damaged, at no cost to Owner.
10. Set all equipment to accurate line and grade, level all equipment and align all equipment components.
11. All tolerances in alignment and leveling, and the quality of workmanship for each stage of work shall be as required by the manufacturer and subject to approval by the owners representative.
12. All finished equipment surfaces damaged during construction shall be brought to "as new" condition by touch up or repainting. Any rust shall be removed and primed prior to repainting.
13. Workmanship shall be as called for in the "Standard of Installation" published by the National Electrical Contractors Association (NECA).
14. Provide all scaffolding, rigging, hoisting and services necessary for erection and delivery of equipment and apparatus furnished into the premises. These items shall be removed from premises when no longer required.
15. No electrical equipment shall be hidden or covered up prior to inspection by the owners representative. All work that is determined to be unsatisfactory shall be corrected immediately.

16. All electrical work shall be installed level and plumb, parallel and perpendicular to other building systems and components.
17. Conceal all contract work above ceilings and in walls, below slabs, and elsewhere throughout building. If concealment is impossible or impractical, notify Owner's Representative before starting that part of the work and install only after his approval. In areas with no ceilings, install only after Owner's Representative reviews and comments on arrangement and appearance.
18. Install access panel or door where units are concealed behind finished surfaces.

3.5 UTILITY COMPANY SERVICES

- A. Make arrangements with **Orange & Rockland Utilities, Inc.** for electric service to the Owner's distribution equipment. Provide underground electric service as called for and transformers, meter sockets or meter compartments as required by the Utility Company. Coordinate all activities between the Owner and Utility Company. The installation of the electric service shall comply with the published Utility Company standards. **PAY ALL UTILITY COMPANY CHARGES; INCLUDE CHARGES IN THE BASE BID.**
- B. Make arrangements with **Verizon** for telephone service to the Owner's distribution system. Provide services to the buildings as required by the Utility Company. Coordinate all activities between the Owner and Utility Company. The installation of the telephone service shall comply with the published Utility Company standards. **PAY ALL UTILITY COMPANY CHARGES; INCLUDE CHARGES IN THE BASE BID.**
- C. Make arrangements with current cable provided for discontinuation of service and removal of service back to demark location on utility pole. Coordinate all activities between the Owner and Utility Company. **PAY ALL UTILITY COMPANY CHARGES; INCLUDE CHARGES IN THE BASE BID.**

3.6 PAINTING

- A. This Contract Includes the following :
 1. Painting for all cut and patch work performed as part of Division 26, 27, and 28 contract.
 2. Painting required for touch-up of surfaces damaged due to the installation of electrical work.
 3. Painting as required to repair finish of equipment furnished.
 4. Painting of all surface mounted raceways in finished areas.

3.7 ELECTRICAL EQUIPMENT CONNECTIONS

- A. Provide complete power connections to all electrical equipment. Provide control connections to equipment where indicated on the drawings. Provide disconnect ahead of each piece of equipment. Ground all equipment in accordance with the latest version of

the National Electrical Code.

- B. Provide all power wiring, electric equipment, control wiring, switches, lights, receptacles, and connections as required for proper equipment operation of Owner-Furnished Equipment and Equipment furnished by other contracts,
- C. Refer to Manufacturer's drawings/specifications for requirements of special equipment. Verify connection requirements before bidding and confirm prior to rough-in.

3.8 CLEANING

- A. After all tests are made and installations completed satisfactorily:
 - 1. Thoroughly clean entire installation, both exposed surfaces and interiors.
 - 2. Remove all debris caused by work.
 - 3. Remove tools, surplus, materials, when work is finally accepted.

3.9 TEMPORARY FACILITIES

- A. Refer to Division 0 and 1 specifications for temporary facility requirements of this contract.

3.10 CONTINUITY OF SERVICES

- A. The building will be in use during construction operations. Maintain existing systems in operation within all rooms of building at all times. Refer to "General Conditions of the Contract for Construction" for temporary facilities for additional contract requirements. Schedules for various phases of contract work shall be coordinated with all other trades and with Owner's Representative. Provide, as part of contract, temporary mechanical and electrical connections and relocation as required to accomplish the above. Obtain approval in writing as to date, time, and location for shut-down of existing mechanical/electrical facilities or services.

3.11 START UP AND OWNER INSTRUCTIONS

- A. Before acceptance of the work, furnish necessary skilled labor to operate all systems by seasons. Instruct the Owners designated personnel on the proper operation and maintenance of systems and equipment. Obtain written acknowledgment from person instructed prior to acceptance repeat the instructions if asked to do so. Contractor is fully responsible for systems until acceptance, even though operated by Owner's personnel, unless otherwise agreed in writing. Provide, operating, maintenance and starting precautions and procedures to be followed by the Owner for operating systems and equipment. Mount the instruction in clear plastic holder on or adjacent to the equipment.
- B. Where supervision by a manufacturer is called for, provide manufacturer's certified technician or engineer to supervise the startup, testing and adjustment of the equipment or system. Where two or more manufacturers are involved (i.e., variable frequency drive and air handling unit) both manufacturer's shall be present at start up. The manufacturer shall provide a written report detailing the testing and start-up including problems that occurred and their method of resolution.
- C. Refer to Division 01 SpecificationsSection 019113 – Commissioning Requirements for additional startup and Contract Closeout requirements.

3.12 OPERATION AND MAINTENANCE MANUALS

- A. Provide Operation and Maintenance Manuals. Include one copy each of approved Shop Drawings, wiring diagrams, piping diagrams, spare parts lists, as-built drawings and manufacturer's instructions. Include typewritten instructions, describing equipment, starting/operating procedures, emergency operating instructions, seasonal changeover, freeze protection, precautions and recommended maintenance procedures. Include name, address, and telephone number of supplier manufacturer Representative and service agency for all major equipment items. Bind above items in a three ring binder with name of project on the cover. Provide required number of hard copies and disk(s) containing pdf files of all documents and deliver to Owner's Representative before request for acceptance.

3.13 RECORD DOCUMENTS

- A. Prepare record or as-built documents in accordance with Division 01 Specifications. In addition to those requirements provide the following:
 - 1. Document the routing major raceway systems, location of control devices, branch circuit numbers for all devices and equipment and fuse and circuit breaker sizes for major equipment and branch circuit home runs.
 - 2. Provide stamp on each drawings including: Company Name, Date and "Record Drawings"
 - 3. Refer to each Division 26, 27 and 28 section for additional items to be included in the record drawings.
 - 4. Provide required number of hard copies and disk(s) containing pdf files of all

documents.

3.14 REMOVALS

- A. Where existing equipment removals are called for, submit complete list to Owner's Representative. All items that Owner wishes to retain that do not contain asbestos or PCB Material shall be delivered to location directed by Owner. Items that Owner does not wish to retain shall be removed from site and legally disposed of. Removal and disposal of material containing asbestos and/or PCB's shall be in accordance with Federal, State and Local law requirements. Where equipment is called for to be relocated. Contractor shall carefully remove, clean and recondition, then reinstall. Remove all abandoned piping, wiring, equipment, lighting, ductwork, tubing, supports, fixtures, etc. Visit each room, crawl spaces and roofs to determine total Scope of Work.
- B. Completely remove all piping, conduit, controls, and other devices associated with the equipment not to be reused in the new work. This includes all equipment, conduit, junction boxes, devices, panels, and all hangers, including the top connection and any fastenings to building structural systems. Patch, paint and seal all removals, openings and other penetrations in roof, walls, ceilings, floors, in an approved manner and in accordance with plans and specifications where specifically covered. Structural integrity of the building system shall be maintained. Reference shall also be made to the architectural, structural, mechanical, site, and electrical drawings and specifications for additional facilities to be demolished or handled.

3.15 ASBESTOS RECOGNITION AND PRECAUTIONS

- A. The contractor shall be responsible for coordination of all required removal work, coring, cutting and patching with the owners asbestos management plan. Prior to performing such work identify areas containing asbestos. Notify the Owner so that they may make arrangements for abatement and/or containment prior to work proceeding. The contractor shall be responsible for cleaning all areas where asbestos is released due to the failure to coordinate with the asbestos management plan. Refer to Division 1 sections for further requirements.
- B. The disturbance or dislocation of asbestos-containing materials causes asbestos fibers to be released into the building's atmosphere, thereby creating a health hazard to workmen and building occupants. Consistent with Industrial Code Rule 56 and the content of recognized asbestos-control work, the Contractor shall apprise all of his workers, supervisory personnel, subcontractors, Owner and Consultants who will be at the job site of the seriousness of the hazard and of proper safeguards and work procedures which must be followed, as described in New York State Department of Labor Industrial Code Rule 56.
- C. Refer to division 2 sections for further requirements.

END OF SECTION 260010

SECTION 260100

BASIC MATERIALS AND METHODS

PART 1 - GENERAL

1.1 SCOPE

- A. Minimum composition requirements and/or installation methods for the following materials and work are included in this section:
 - 1. Miscellaneous Supports
 - 2. Access Doors and Panels
 - 3. Fire Stopping
 - 4. Boxes and Cabinets
 - 5. Equipment Pads, Bases and Supporting Devices
 - 6. Identification
 - 7. Potential and Arc Flash Hazard Labeling

1.2 SUBMITTALS

- A. Product data for:
 - 1. Boxes and cabinets
 - 2. Fire Stopping Materials
 - 3. Coordination drawings for sleeves, access panels, and door locations.

1.3 QUALITY ASSURANCE

- A. The contractor shall engage the services of a qualified installer for the installation and application of joint sealers, flashing, access panels, and cutting and patching.
- B. All work shall be done in a neat and workmanlike manner. All methods of construction, details of workmanship, that are not specifically described or indicated in the contract documents, shall be subject to the control and approval of the Owner's Representative. Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based upon the acceptable manufacturers listed. Where "approved equal" is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to approval.

- C. Materials specified herein shall comply with the applicable requirements of :
 - 1. The following Articles of the National Electric Code (NFPA 70)
 - a. 314 - Outlet, Device, Pull and Junction Boxes, Conduit bodies and fittings
 - b. 312 - Cabinets, Cutout Boxes and Meter socket Enclosures

PART 2 - PRODUCTS

2.1 MISCELLANEOUS SUPPORTS

- A. Metal bars, plates, tubing, etc. shall conform ASTM standards:
 - 1. Steel plates, shapes, bars, and grating - ASTM A 36
 - 2. Cold-Formed Steel Tubing - ASTM A 500
 - 3. Hot - Rolled Steel Tubing - ASTM A 501
 - 4. Steel Pipe - ASTM A 53, Schedule 40, welded
- B. Metal Fasteners shall be Zinc-coated (type, grade and class as required)

2.2 ACCESS DOORS AND PANELS

- A. Steel access doors and frames shall be factory fabricated and assembled units, complete with attachment devices and fasteners ready for installation. Joints and seams shall be continuously welded steel, with welds ground smooth and flush.
- B. Construction:
 - 1. Frames:
 - a. 16 gage steel with 1 inch wide exposed perimeter flange and adjustable masonry anchors for units installed in masonry, pre-cast, cast in place concrete, ceramic tile.
 - b. 16-gage steel, perforated flanges with bead for gypsum or plaster wall board.
 - c. 16-gage steel with galvanized expanded metal lath and exposed casing bead, welded to perimeter of frame for full bed plaster applications.
 - 2. Access Doors:
 - a. Provide 14 gage sheet steel flush panel doors with concealed continuous piano hinge factory installed, primed and painted, set to open 175 degrees.

- b. Provide fire rated, insulated flush panel doors, with continuous piano hinge and self-closing mechanism rated for 1 ½ hour "B" labeled, in fire rated partitions.
- C. Provide flush, screwdriver operated cam locks on all access doors.

2.3 FIRE STOPPING

- A. Fire-stopping for Openings Through Fire and Smoke Rated Walls and Floor Assemblies shall be listed or classified by an approved independent testing laboratory for "Through-Penetration Fire-Stop Systems." The system shall meet the requirements of "Fire Tests of Through-Penetration Fire-Stops" designated ASTM E814.
- B. Acceptable Manufacturers:
 - 1. Dow Corning Fire-Stop System Foams and Sealants.
 - 2. Nelson Electric Fire-Stop System Putty, CLK and WRP.
 - 3. Thomas & Betts - S-100 FS500/600.
 - 4. Carborundum Fyre Putty.
 - 5. Hilti Firestop Systems.

2.4 BOXES AND CABINETS

- A. Outlet Boxes and Covers
 - 1. General Use Boxes shall be galvanized steel, not less than 1-1/2" deep, 4" square or octagonal, with knockouts. Outlet boxes exposed to moisture, exterior, wet or damp locations shall be cadmium cast alloy complete with threaded hubs and gasketed screw fastened covers. Minimum box size shall be as indicated in Article 314 of the National Electrical Code for the conductors and devices installed. Boxes shall be approved for the environmental condition of the location where they will be installed.
 - 2. Boxes installed in damp or wet locations shall be of rain tight construction with gasketed cover and threaded conduit hubs. In no case shall boxes be sized smaller than as indicated in Article 314 of the National Electrical Code for conduit and conductor sizes installed. Boxes shall be approved for the environmental condition of the location where they will be installed.
 - 3. Acceptable manufacturers:
 - a. Steel City
 - b. Raco
 - c. Appleton

d. Crouse Hinds

B. Flush Floor Outlet Boxes

1. For in slab new construction locations - Provide flush cover service for power or communications/data as called for. Boxes shall be suitable for carpet or tile applications. Stamped steel, concrete tight, fully adjustable box with interior and exterior leveling screws, and with 1/2", 3/4" and 1" knockouts. Provide with larger knockouts where called for on applicable detail. Complete with expandable cap to prevent ingress of concrete during pour. Provide integrated carpet plate/duplex floor plate and duplex receptacle where called for.
2. For above grade applications - Provide UL listed 2-hour rated poke-thru service with power/data/low-voltage outlets. Cover shall have leveling screws with floor flange. Shall include separate metal sleeve for low-voltage and power. Provide with integrated power and low-voltage connectivity jacks where called for on applicable detail.
3. Design Make: Hubbell, Legrand, Wiremold

C. FIRE-RATED, POKE-THROUGH ASSEMBLIES

1. Performance Criteria:
 - a Description: Factory-fabricated assembly of below-floor junction box with multichannel, through-floor raceway/firestop unit with receptacles or communications outlets installed below floor surface level.
 - b Standards:
 - i Listed and labeled in accordance with UL 514A for metallic boxes, or in accordance with UL 514C for nonmetallic boxes, including scrub-water exclusion requirements.
 - ii Provide separate paths for management of telecommunications and power cables.
 - iii Listed and labeled in accordance with NFPA 70 and NEMA 250 for intended location and use.
 - c Fire Rating: Provide unit listed and labeled for fire rating of floor-ceiling assembly.
- 2 Source Limitations: Obtain products from single manufacturer designed for use as complete, matching assembly of raceways and receptacles.
- 3 Recessed -Type, Fire-Rated, Poke-Through Assembly:
 - a Provide products by: Legrand
 - b Product Description: Through-floor power assembly with included raceways, box for power connections, and internal space for power and communications/data outlets. Assembly shall maintain floor fire rating.

- c Description: Modular, recessed-type, dual-service units suitable for wiring method used, with cover flush with finished floor.
- d Service Plate, Flaps and Cover: Round, solid brass with satin finish.
- e Core Size: as indicated on drawings, selected to fit nominal 4-inch, 6-inch, 8-inch cored holes in floor and matched to floor thickness.
- f Closure Plug: Close unused cored opening and reestablish fire rating of floor.
- g Feed Conduits: Provide connection points for conduits as indicated on Drawings or required for conductors shown. Provide minimum 1-1/2 inch conduits for communications cables.
- h In "Power Outlets" Subparagraph below, indicate the quantity and receptacle outlet type using the same terminology specified in Section 262726 "Wiring Devices."
- i Power Outlets: One (1) 20Amp gray finish, unless otherwise indicated, in accordance with Section 262726 "Wiring Devices."
- j Telephone and Data Outlets: As indicated on drawings. modular, keyed, color-coded, 8PSJ jacks in accordance with Div. 17 specifications.
- k Audio and Video Outlets: Blank cover with bushed cable opening.

D. Pull and Junction Boxes

1. Shall be constructed of not less than 14 gauge galvanized steel with trim for flush or surface mounting in accordance with the location to be installed. Provide screw-on type covers. Boxes installed in damp or wet locations shall be of rain tight construction with gasketed cover and threaded conduit hubs. In no case shall boxes be sized smaller than as indicated in Article 314 of the National Electrical Code for conduit and conductor sizes installed. Boxes shall be approved for the environmental condition of the location where they will be installed.
2. Acceptable manufacturers:
 - a. Hoffman
 - b. Keystone
 - c. Cooper B-Line
 - d. Custom fabricated per. NEC and UL guidelines
3. Flush floor junction boxes shall be recessed cover boxes designed for flush mounting in masonry. Provide checkered plate gasketed cover suitable for foot traffic. Make: O.Z. Gedney Type YR or approved equal.

E. Terminal and Equipment Cabinets:

1. Terminal and Equipment Cabinets shall be code gauge galvanized steel with removable endwalls. Fronts shall be of code gauge steel, flush or surface type (as

indicated) with concealed trim clamps, concealed hinges, flush lock, and grey baked enamel finish. Boxes and front shall be U.L. listed and shall be minimum 35"H x 24"W x 6"D. Provide removable insulated plywood terminal board mounted on inside back wall of cabinet.

2. Acceptable manufacturer:
 - a. Square D "Mono-Flat"
 - b. Approved equal

2.5 EQUIPMENT BASES, PADS AND SUPPORTING DEVICES

- A. Supports, support hardware and fasteners shall be protected with zinc coating or treatment of equivalent corrosion resistance using approved alternative treatment, finish or inherent material characteristic. Products used for outdoor applications shall be hot dipped galvanized.
- B. Provide clevis hangers, riser clamps, conduit straps, threaded c clamps with retainers, ceiling trapeze hangers, wall brackets and spring steel clamps as applicable.
- C. 14 gauge U-Channel systems with 9/16 inch diameter holes at a minimum of 1 7/8 inches on center in the top surface. Provide fittings and accessories that match and mate channel.
- D. Provide carbon steel or wedge or sleeve type expansion anchors, steel spring head toggle bolts and heat treated steel power driven threaded stud fastening equipment as required by construction types.
- E. Provided field fabricated supporting devices such as angles, channels, pipe supports, etc. All fabricated supports shall be of metal construction.
- F. Acceptable Manufacturers:
 1. Allied Tube
 2. American Electric
 3. B-Line
 4. Unistrut Diversified Products
 5. Cooper Industries
 6. Killark Electric Mfg. Co.
 7. O/Z Gedney
 8. Spring City Electrical Mfg. Co.

9. Thomas & Betts Corporation

2.6 ROOF PENETRATION FLASHING AND SEALING

- A. Opening through roofs shall be flashed in manner not to affect roof guarantee or bond. Engage qualified Roofing Contractor licensed by the Roofing Manufacturer, as part of contract. Provide non-ferrous flashing pieces, EDPM skirts, EDPM hoods and collars as required to make ducts, pipes, conduits, and other penetrations watertight. Where curbs are called for with respect to rectangular openings in new roofs, flashing will be done by others unless specifically indicated otherwise. Caulk and waterproof with additional material so as to seal airtight and watertight.
- B. Design Equipment: RPS.
- C. Acceptable Manufacturers: Pate, Shipman & Son.

2.7 IDENTIFICATION

- A. Equipment Labeling
 - 1. Provide adhesive marking labels for raceway and metal-clad cable. The labels shall indicate voltage and service, and be located above ceilings every 75 feet and on wall mounted conduit in mechanical and equipment rooms.
 - 2. Provide colored self-adhesive vinyl tape, minimum 3 mils thick by 1 inch wide for all phase marking on cable.
 - 3. Provide 6-inch wide bright colored continuously printed, plastic tape compounded for direct-burial services. Printing shall indicate service below.
 - 4. Provide engraved, plastic laminated labels, signs and instruction plates. Engraving stock melamine plastic laminate. Use 1/16-inch minimum thick for signs up to 20 square inches or 8 inches in length. Use 1/8 inch thick for larger sizes. Engraved legend in white letters on black face and punched for mechanical fasteners. Emergency equipment shall have red face.

2.8 POTENTIAL AND ARC FLASH HAZARD LABELING

- A. Provide multi-colored self-adhesive vinyl label, minimum dimension 5" wide x 3" high.
- B. Shall designate the potential and arc flash hazard for equipment according to NFPA-70E.
- C. Label shall include the following information:
 - 1. "ARC FLASH & SHOCK HAZARD APPROPRIATE PPE REQUIRED"
 - 2. Flash Hazard Category
 - 3. Flash protection Boundary

4. List of required personal protective equipment (PPE)
 5. Voltage of max. present shock hazard
 6. Limited, Prohibited, and Restricted approach boundaries
- D. Acceptable Manufacturers:
1. W.H. Brady Co.
 2. Markal Corp.
 3. National Band & Tag Company
 4. Panduit Corporation
 5. Cole-Flex Corporation

PART 3 - EXECUTION

3.1 ACCESS DOORS AND PANELS

- A. Install access doors, sized to permit complete access for any concealed and/or inaccessible junction boxes, control and monitoring devices, duct mounted fire alarm detectors and other electrical equipment requiring access for maintenance or operation.
- B. Set frames accurately in position and securely attach to supports with face panels plumb and level in relation to adjacent finish surfaces.
- C. Adjust hardware and panels after installation for proper operation.

3.2 FIRE STOPPING

- A. Installation of Fire-stopping for Openings Through Fire and Smoke Rated Walls and Floor Assemblies shall be as follows:
 1. Provide fire-stop system seals at all locations where piping, tubing, conduit, electrical busways/cables/wires, ductwork and similar utilities pass through or penetrate fire rated wall or floor assembly. Provide fire-stop seal between sleeve and wall for dry wall construction.
 2. The minimum required fire resistance ratings of the wall or floor assembly shall be maintained by the fire-stop system. The installation shall provide an air and watertight seal.
 3. The methods used shall incorporate qualities that permit the easy removal or addition of electrical conduits or cables without drilling or use of special tools. The product shall adhere to itself to allow repairs to be made with the same material and permit the vibration, expansion and/or contraction of any items passing through the penetration without cracking, crumbling and resulting

reduction in fire rating.

4. Provide rigid steel sleeves where non-armored cables pass through fire rated walls and barriers.

3.3 BOXES AND CABINETS

- A. Consider location of outlets shown on drawings as approximate only. Study architectural, process piping, mechanical, plumbing, structural, roughing-in, etc., drawings and note surrounding areas in which each outlet is to be located. Locate outlet so that when fixtures, motors, cabinets, equipment, etc., are placed in position, outlet will serve its desired purpose. Where conflicts are noted between drawings, contact Owner's Representative for decision prior to installation. Comply with Article 314 of National Electrical Code relative to position of outlet boxes in finished ceilings and walls.
- B. Outlet boxes in separate rooms shall not be installed "back-to-back" without the approval of the Owner's Representative.
- C. Outlet boxes shall be sized to accommodate the wiring device(s) to be installed.
- D. Outlet boxes installed in plaster, gypsum board or wood paneled walls shall be installed with raised plaster covers or raised tile covers.
- E. Outlet boxes installed in tile, brick or concrete block walls shall be installed with extra-deep type raised tile covers or shall be 3-1/2" deep boxes with square corners and dimensions to accommodate conductors installed.
- F. Surface ceiling mounted outlet boxes shall be minimum 4" square, 1-1/2" deep, galvanized sheet metal.
- G. Surface wall mounted outlet boxes shall be cast type boxes having threaded or compression type threadless hubs. Exterior boxes shall be cast type with threaded hubs and gasketed cover plates secured by non-ferrous screws.
- H. Floor outlet boxes shall be installed flush with finished floor, adjust level and tilt as required. Where finished floor is terrazzo, provide boxes specifically designed for installation in terrazzo. Where floors are to receive carpet or tile, provide floor outlet with proper flange.
- I. Install junction and pull boxes in readily accessible locations. Access to boxes shall not be blocked by equipment, piping, ducts and the like. Provide all necessary junction or pull boxes required due to field conditions and size as required by the National Electrical Code.

3.4 OUTLET BOX ROUGH-IN HEIGHTS:

- A. Unless otherwise noted, mount devices and equipment at heights measured from finished floor to device/equipment centerline, except fire alarm as follows:

1. Toggle switches

46"

2.	Receptacle outlets	18"
3.	Receptacle outlets, above hot water or steam baseboard heaters.	
	Do not install receptacle outlets above electric baseboard heaters.	30"
4.	Receptacle outlets, hazardous areas	48"
5.	Receptacle outlets, weatherproof, above-grade	24"
6.	Clock outlets	90"
7.	Telephone outlets	18"
8.	Telephone outlets, wall mounted	46"
9.	T.V. outlet	18"
10.	Fire alarm manual station	46"
11.	Fire alarm audio/visual (bottom of device)	80"
12.	Branch circuit panelboards, to top of backbox	72"
13.	Distribution panelboards, to top of backbox	72"
14.	Terminal cabinets, control cabinets	72"
15.	Disconnect switches, motor starters, enclosed circuit breakers	48"
16.	Where structural or other interference's prevent compliance with mounting heights listed above, consult Owner's Representative for approval to change location before installation.	

3.5 EQUIPMENT PADS, BASES AND SUPPORTING DEVICES

A. Hangers and Supports:

1. Provide steel angles, channels and other materials necessary for the proper support and erection of motor starters, distribution panelboards, large disconnect switches, pendant-mounted lighting fixtures, etc.
2. Panelboards, cabinets, large pull boxes, cable support boxes and starters shall be secured to ceiling and floor slab and not supported from conduits. Small panelboards, etc., as approved by Owner's Representative, may be supported on walls. Racks for support of conduit and heavy electrical equipment shall be secured to building construction by substantial structural supports.

3. Provide concrete bases for all floor mounted equipment. Provide 3,000 lb. concrete, chamfer edges, trowel finish, and securely bond to floor by roughening slab and coating with cement grout. Provide a minimum of one ½" rebar dowel for every 2 sq. ft. of base area, anchored 2" into floor and base, to eliminate movement. Bases shall be 4" high (unless otherwise indicated); shape and size to accommodate equipment, to extend 4" beyond equipment footprint in all directions. Set anchor bolts in sleeves before pouring. After anchoring and leveling, fill equipment bases with grout

3.6 IDENTIFICATION

- A. Provide engraved lamicoid identification nameplates on main switchboard and on all panelboards using designation shown in panelboard schedule.
- B. Provide engraved lamicoid identification nameplates for each circuit breaker in the main distribution panel listing the panelboard or equipment connected to each device.
- C. Provide engraved lamicoid identification nameplate on individual circuit breaker enclosures, motor starters and disconnect switches, listing the equipment connected to the particular device, feeder panelboard and feeder circuit number.
- D. Provide complete type written directory for each panelboard listing room number, function, etc., for each circuit breaker. Provide type written updated panelboard directories for existing panelboards affected by this work.
- E. Panelboard nameplates shall be engraved black, with white core, with Helvetica medium 3/16" lettering.
- F. Identify junction and pullboxes for particular service such as power, lighting, fire alarm, telephone, intercom, public address, nurse call, etc. using stencil lettering on cover.
- G. Provide a tape label on all receptacle and switch coverplates, power poles, etc. listing panel designation and circuit number. Tape shall be attached to outside of receptacle or switch coverplates.
- H. Provide potential and arc hazard labeling on all new switchboards, panelboards, industrial control panels, motor control centers.

3.7 ELECTRICAL VOLTAGE AND ARC FLASH HAZARDS AND LABELING

- A. Contractor shall review all existing conditions regarding flash and potential hazards at panelboards, switchboards, motor control equipment, starters, and safety switches. All personal shall be trained and suited in proper protective clothing and equipment suitable for installation.
- B. Provide potential hazard and arc flash hazard labeling of all new and modified panelboards, switchboards, motor control equipment, starters, and safety switches.

3.8 FLASHING AND SEALING

- A. Opening through roofs shall be flashed in manner not to affect roof guarantee or bond. Engage qualified Roofing Contractor licensed by the Roofing Manufacturer, as part of contract. Provide non-ferrous flashing pieces, EDPM skirts, EDPM hoods and collars as required to make ducts, pipes, conduits, and other penetrations watertight. Where curbs are called for with respect to rectangular openings in new roofs, flashing will be done by others unless specifically indicated otherwise. Caulk and waterproof with additional material so as to seal airtight and watertight.

3.9 CUTTING AND PATCHING

- A. Work shall be in accordance with Section 017329 - Cutting and Patching.
- B. In addition to the requirements of Section 017329 the following requirements apply:
 - 1. Perform cutting, fitting and patching of electrical equipment in all following cases:
 - a. To uncover work for installation of poorly coordinated or ill-timed electrical work.
 - b. To remove and replace defective work.
 - c. To remove and replace work not conforming to requirements of the Contract Documents.
 - 2. Remove samples of installed work as specified for testing.
 - 3. Install equipment and materials in existing structures.
 - 4. Cut, remove and legally dispose of all electrical equipment, components, and materials as called for and all other items not indicated on plans but made obsolete by the installation of new work.
 - 5. Protect the structure, furnishings, finishes and adjacent materials not being removed and maintain temporary

END OF SECTION 260100

SECTION 260513

MEDIUM-VOLTAGE CABLES

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Provide all labor, materials, tools, and equipment required for the complete installation of work called for in the Contract Documents

1.2 SCOPE

- A. This section includes minimum requirements for the following:
 - 1. Medium Voltage Conductors
 - 2. Connectors and Terminations
 - 3. Test Reports

1.3 SUBMITTALS

- A. Provide product data for the following:
 - 1. Medium Voltage Conductors
 - 2. Connectors and Terminations
 - 3. Test Reports

1.4 QUALITY ASSURANCE

- A. All conductors 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's Representative. Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based upon the acceptable manufacturers listed. Where "approved equal" is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to approval.
- B. Medium Voltage cable shall be installed, terminates, and tested by qualified individuals.
- C. Materials specified herein shall comply with the applicable requirements of :
 - 1. The following Articles of the National Electric Code (NFPA 70)
 - a. 300 - Wiring Methods
 - b. 310 - Conductors for General Wiring
 - c. 328 - Type MV Medium Voltage Cable

2. The following U.L. Standards:
 - a. UL 1072 Medium-Voltage Power Cables

PART 2 - PRODUCTS

2.1 MEDIUM VOLTAGE CONDUCTORS

A. Construction:

1. Cable shall consist of single-conductor, shielded, ethylene propylene rubber (EPR) insulated, polyvinyl chloride (PVC) jacketed, rated for 15,000 volts, ungrounded neutral, 133 percent insulation level service.
2. Conductor shall be Class B, compressed or compact, soft copper stranding per ASTM B8, B496. The conductor shall be covered with a layer of extruded semiconducting compound completely covering the conductor and firmly bonded to the EPR insulation.
3. Shielding shall consist of a semi-conducting insulating shield applied over the EPR insulation, and a 5 mil thick bare copper tape with a minimum 12.5 percent overlap applied over this shield. A non-hydroscopic separator tape may be applied over the copper tape as necessary. Insulation thickness shall be in accordance with ICEA S-97-682 and UL 1072.
4. Cable and insulation shall be rated for 105 degree C temperature, with an emergency rating of 140 degree C.
5. Printing on outer jacket indicating manufacturer, conductor size, material, voltage rating, and date of manufacture.
6. All cable shall comply with the following standards: ASTM B8, ASTM B496, ICEA S-97-682, ICEA S-93-639, UL 1072 and AEIC CS8.

B. Acceptable manufacturers:

1. Kerite
2. Southwire
3. General Cable
4. Okonite
5. Prysmian

2.2 MEDIUM VOLTAGE TERMINATIONS AND SPLICES

A. Terminations and splicing for Medium Voltage Cables:

1. Cable Splicing / Termination Kits, at rated voltage, shall be provided for all cable splices and terminations. Do not field fabricate "T" splices. Kits shall include a high dielectric constant stress relief tube for maximum distribution of the electrical field, Silicone rubber terminations, mechanical ground strap assembly, shielding tape, semi conducting tape, silicone rubber tape, silicone grease and cable preparation kit.
2. The sealant between main and tap conductors shall be a heat-activated mastic to eliminate taping. A complete wraparound heat-shrinkable jacket with mechanically interlocked jacket shall surround and protect the finished splice.
3. Splicing kit shall also include the following:
 - a. Provide with manufacturer recommended crimp connectors to bond conductors.
 - b. Provide with manufacturer recommended grounding shields, braid, and accessories.
 - c. Stress relief shielding and control tube between conductors.
4. "Y" Splice Design Make: Tyco Raychem HVSY series or Approved Equal

B. Lug Type Terminations

1. Electro-tin plated copper body
2. Internally beveled barrel end
3. Crimp areas clearly marked for hydraulic or power operated crimping tool
4. Rated for 600V thru 35 kV
5. #8 AWG to #2/0 AWG - Long barrel, compression type, one hole lug
6. #3/0 AWG and larger - Long barrel, compression type, two hole lug
7. Design Make: Burndy "Hylug" or Approved Equal

C. Termination Hardware Acceptable Manufacturers:

1. Burndy
2. Elastimold
3. General Electric

4. 3-M Company
5. PLM Industries

D. End Caps

1. Heat-shrinkable tubing available to accommodate cable sizes from #4 AWG thru 1000 KCM in 15kV and 25kV cables.
2. Design Make: Tyco Raychem or Approved Equal

PART 3 - EXECUTION

3.1 MEDIUM VOLTAGE WIRE AND CABLE

A. GENERAL

1. Install cables in raceway as called for after the entire raceway system has been completed.
2. Install splices and connections in accessible outlet, pull, and junction boxes.
3. Insulate all splices and connections with UL listed assemblies.
4. All wiring systems shall be properly grounded and continuously polarized throughout, following the color coding specified.
5. Provide insulated grounding conductor in each raceway or splice kit to combine internal grounding conductors in medium voltage conductors where cable type allows.
6. Feeder conductors shall be continuous from point of origin to load termination without splice. If this is not practical, contact the Owner's Representative and receive written approval for splicing prior to installation of feeder(s). Where feeder conductors pass through junction and pull boxes, bind and lace conductors of each feeder together. For parallel sets of conductors, match lengths of conductors.
7. Where multiple conductors are installed in a common raceway they shall be pulled simultaneously. Use of pulling compound or lubricant shall be avoided unless absolutely necessary. Where pulling lubricant is required, use UL approved compounds approved for cable type. Lubricant shall meet all OSHA and Toxic Control Act standards.

APPLICATION	CABLE TYPES	DESIGN MAKE
General purpose Construction & Maintenance	Rubber, Neoprene, Nylon, PVC, High Density, XLP, Hypalon	Ideal – Yellow 77
High Temperature	Rubber, Neoprene, Nylon, PVC,	Ideal – Yellow

Construction & Maintenance	High Density, XLP, Hypalon, Low Density Polyethylene, Semiconducting Jacket	190
Utility Construction & Maintenance	Rubber, Neoprene, Nylon, PVC, High Density, XLP, Hypalon, Low Density Polyethylene, Semiconducting Jacket	Aqua-Gel II
Cold Weather Construction & Maintenance	Rubber, Neoprene, Nylon, PVC, High Density, XLP, Hypalon, Low Density Polyethylene, Semiconducting Jacket	Aqua-Gel CW

8. Use pulling means including fish tape, cable, rope and basket type grips which will not damage cables or raceways.
9. Color code all conductors at all pullboxes, enclosures, and terminations.

3.2 TYPE MV MEDIUM VOLTAGE CABLE

- A. Provide heat-shrink end caps on all medium voltage cable for transport, storage, and during pulling. Any water egress into cables shall be completely eliminated prior to use.
- B. Cable ends shall be properly sealed against ingress of moisture and mechanically protected against damage until splices and terminations are completed (time period between cable pull and make-up of splices and terminations). Apply caps immediately after stripping to prevent the entrance of moisture.
- C. Pull cable in accordance with manufacturer's recommendations, do not exceed 80 percent of maximum pulling tension.
- D. When splicing cable, provide appropriate kits to bond to existing separate equipment grounding conductor or concentric neutral assembly in insulated cables.
- E. Clean and flush conduit and ducts prior to pulling in cable.
- F. Do not exceed manufacturer's recommendations for bending cable.
- G. Train cables at termination points with slight curvature to take stress associated with thermal dimensional changes.
- H. Neatly support cables at all locations and by racks in manholes. Each rack shall have cable support insulators. Secure conductors to racks with heavy duty nylon tie-wraps or other approved means.
- I. Repair damage to existing cables and to electrical system that may occur due to working in or on existing manholes, as part of the contract. Clean existing cables prior to any splicing per. manufacturer requirements.
- J. Cable shall be supported at four foot intervals with racks, straps, hangers or similar

fittings in accordance with the manufacturer's requirements. Properly support terminations and splices; provide manhole support racks at each splice.

- K. Bend radius shall not be less than five times the external diameter for cable up to and including $\frac{3}{4}$ " and not less than ten times the external diameter for cables greater than $\frac{3}{4}$ " in diameter.
- L. Clean and prepare conductors to manufacturer requirements prior to any splicing or connector installations.
- M. All medium voltage terminations shall be installed by trained contractor experienced with the method and product manufacturer. All damaged cables and/or terminations shall be repaired with approved medium voltage repair kit or replaced.

3.3 TESTS

A. Medium Voltage Feeders

1. Disconnect cable to be tested from switchgear, transformers, etc., at each end to apply voltage only to cable being tested.
2. Apply a 500 volt megger to ensure the cable is free from grounds.
3. Set Hypot sensitivity to the minimum.
4. Connect high voltage output lead to conductor and ground lead to the cable shield drain wire.
5. Raise the DC voltage in 5kV steps for 15kV cable. After each step, wait until the charging current dissipates and a steady leakage current level is reached.
6. Record the leakage current for each voltage step and plot current versus voltage. Provide a separate curve for each cable.
7. Repeat steps 5 and 6 until the manufacturers recommended test voltage is reached.
8. Leakage current should plot as a relatively flat curve. If a large change appears in the slope of the curve, reduce the voltage by 2kV for 5kV cable, and then bring the voltage back up in 500 volt increments.
9. If an unacceptable bend is found, and/or the tester trips, clean the terminations and repeat the test. If the test result is not improved, a problem exists in the cable.
10. If the cable tests to the recommended voltage level, hold the cable at this voltage for 15 minutes and plot leakage current versus time. Take reading at 0, 15, 30, 45 and 60 seconds, and then at 1 minute intervals for 15 minutes.
11. Ground conductor prior to disconnecting leads, as recommended in the hypot tester's manual.

12. Replace all new cable, terminations, and splices found faulty as part of the contract.
13. Document test results and submit for approval prior to energizing cables.

END OF SECTION 260513

This Page Intentionally Left Blank

SECTION 260519

LOW-VOLTAGE CABLES

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Provide all labor, materials, tools, and equipment required for the complete installation of work called for in the Contract Documents

1.2 SCOPE

- A. This section includes minimum requirements for the following:
 - 1. Low Voltage Conductors
 - 2. Type MC Metal Clad Cable
 - 3. 2-Hour Rated Cables
 - 4. Connectors and Terminations

1.3 SUBMITTALS

- A. Provide product data for the following:
 - 1. Low Voltage Conductors
 - 2. Type MC Metal Clad Cable
 - 3. Connectors and Terminations

1.4 QUALITY ASSURANCE

- A. All conductors 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's Representative. Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based upon the acceptable manufacturers listed. Where "approved equal" is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to approval.
- B. Materials specified herein shall comply with the applicable requirements of :
 - 1. The following Articles of the National Electric Code (NFPA 70)
 - a. 300 - Wiring Methods
 - b. 310 - Conductors for General Wiring

- c. 330 - Type MC Metal Clad Cable
 - d. 332 – Mineral Insulated Type MI
 - e. 400 - Flexible Cords and Cables
 - f. 402 - Fixture Wires
2. The following U.L. Standards:
- a. UL 83 Thermoplastic-Insulated Wires and Cables
 - b. UL 44 Thermoset-insulated Wires and Cables
 - c. UL 486A Wire Connectors and Soldering Lugs for Use with Copper Conductors.
 - d. UL 854 Service Entrance Cable
 - e. UL 1277 Electrical Power and Control Tray Cables
 - f. UL 6, 1981 Rigid Metal Electrical Conduit
 - g. All Other Applicable Standards

PART 2 - PRODUCTS

2.1 LOW VOLTAGE CONDUCTORS

- A. General purpose feeder and branch circuit and control wiring:
- 1. Annealed Copper, 98% conductivity.
 - 2. Minimum wire size:
 - a. #12 AWG for branch circuits
 - b. #14 AWG for control and signal circuits
 - 3. Wire shall be stranded per ASTM B8.
 - 4. 600 volt insulation for all wiring above 50 volts.
 - 5. 300 volt insulation permitted for all wiring below 50 volts.
 - 6. Thermal plastic with PVC insulation with nylon jacket.
 - 7. Suitable for wet or dry locations, THHN/THWN-2 90 degree Celsius.
 - 8. 90 degree C maximum operating temperature rating.
 - 9. UL 83 Listed

B. Flexible Power Cords:

1. Shall be Type SOOW, designed for extra hard use.
2. Manufactured using tinned flexible stranded Class K copper conductors, and heat, moisture and oil resistant EPDM Black rubber insulated Jacket. Rated - 40°C to 90°C
3. 90°C, 600 Volts. Flexible Stranding. Water Resistant 60°C
4. Available from 2 to 5 conductors, 14AWG to #6AWG
5. Design Make: General Cable Carol Brand
6. Acceptable Manufacturers:
 - a. Southwire
 - b. Allied
 - c. Approved Equal

C. Color Coding

1. All circuits shall be color coded according to the following schedule:

Voltage	A PHASE	B PHASE	C PHASE	NEUTRAL
208Y/120V, 3 Phase	Black	Red	Blue	White
480Y/277V, 3 Phase	Brown	Orange	Yellow	Gray
240/120V, 1 Phase	Black	Red		White

*ALL GROUNDING CONDUCTORS SHALL BE GREEN

*ALL ISOLATED GROUNDING CONDUCTORS SHALL BE GREEN WITH YELLOW STRIPE

2. All isolation panel branch circuits shall be color coded according to the following schedule:

Voltage	Isolated Cond. 1	Isolated Cond. 2	Isolated Cond. 3
1-ø circuit	Orange w/ stripe*	Brown w/ stripe*	N/A
3-ø circuit	Orange w/ stripe*	Brown w/ stripe*	Yellow w/ stripe*

*STRIPE COLOR IN ACCORDANCE WITH NEC ARTICLE 517.160

3. #6 AWG and smaller shall have insulation continuously colored as called for above.
4. #4 AWG and larger may be identified using a minimum 3" tape band.
5. Color code all conductors at all pullboxes, enclosures, and terminations.

6. Switched legs shall be identified with the same color insulation as the phase leg.

D. Acceptable Manufacturers:

1. General Cable
2. Southwire
3. Okonite
4. Prysmian

2.2 TYPE MC METAL CLAD CABLE

A. Construction:

1. Stranded or solid copper conductors, each individually insulated, and enclosed in an armor of flexible metal tape.
2. Suitable for wet or dry locations.
3. Suitable for cable tray installations.
4. Do not install direct buried, in concrete, or in the presence of corrosive vapors.
5. Provide with separate integral grounding conductor.
6. Support every 6 feet.
7. MC cable listed for Health Care facilities use per. NEC Article 517.
8. Manufactured and installed in accordance with NEC Article 330.
9. Design Make: Same as building wire.

2.3 LOW VOLTAGE CONNECTORS AND TERMINATIONS

A. Straight Splices, #26 AWG To #10 AWG

1. Nylon Insulated compression butt-splices.
2. 600 volt, 90 degree C rated.
3. Make: Burndy "Insulink", T&B "Sta-Kon", or approved equal

B. Straight Splices, #8 AWG and Larger

1. Two way, long barrel, compression type, copper
2. Provide heat shrink tubing over splice.

3. 600 volt rated.
 4. Make: Burndy “Hylink”, T&N 54800 Series, or approved equal.
- C. Pigtail Splices, #26 AWG to #10 AWG
1. Twist type pressure connector.
 2. 600 volt rated, 105 degree C.
 3. Size as required for number and size of conductors used.
 4. Make: T&B Scotchlock, or approved equal
- D. Three Way Splices, #8 AWG and Larger
1. Three way, long barrel, compression type, copper.
 2. Provide tape or heat shrink tubing over splice.
 3. 600 volt rated.
 4. Make: Burndy “Hylink”, T&B 54700 Series, or approved equal.
- E. Lug Terminations for Control and Signal Wiring.
1. Nylon insulated fork with compression termination of #26 AWG to #10 AWG.
 2. Nylon insulated ring with compression termination for #8 AWG and larger.
 3. 300 volt rated.
 4. Make: Burndy “Insulug”, T&B “Sta-Kon”, or approved equal.
- F. Lug Terminations for Power Wiring
1. Long barrel, compression type, copper body, on hole for #8 AWG to #2/0 AWG.
 2. Long barrel, compression type, copper body, two hole, for #3/0 AWG and larger.
 3. 600 volt rated.
 4. Make:
 - a. One-hole lug: Burndy “Hylug”, T&B 54900 Series, or approved equal.
 - b. Two-hole lug: Burndy “Hylug”, T&B 54800 Series, or approved equal.

PART 3 - EXECUTION

3.1 LOW VOLTAGE WIRE AND CABLE

A. GENERAL

1. Install cables in raceway as called for after the entire raceway system has been completed.
2. Install splices and connections in accessible outlet, pull, and junction boxes.
3. Insulate all splices and connections with UL Labeled plastic tape, heat shrink tubing, or plastic molded caps.
4. All wiring systems shall be properly grounded and continuously polarized throughout, following the color coding specified.
5. Provide insulated green jacket grounding conductor in each raceway.
6. Provide dedicated white jacket insulated neutral conductor for each individual branch circuit. Shared neutrals are not acceptable.
7. Provide isolated grounding conductor for multi-wire computer panel "CP" branch circuits and dedicated neutral for each computer panel "CP" branch circuit.
8. Adhere to NEC de-rating requirements for raceway fill.
9. Provide stranded wire to motors, transformers, equipment, and vibrating machinery.
10. Feeder conductors shall be continuous from point of origin to load termination without splice. If this is not practical, contact the Owner's Representative and receive written approval for splicing prior to installation of feeder(s). Where feeder conductors pass through junction and pull boxes, bind and lace conductors of each feeder together. For parallel sets of conductors, match lengths of conductors.
11. Where multiple conductors are installed in a common raceway they shall be pulled simultaneously. Use of pulling compound or lubricant shall be avoided unless absolutely necessary. Where pulling lubricant is required, use UL approved compounds approved for cable type. Lubricant shall meet all OSHA and Toxic Control Act standards.

Application	Cable Types	Design Make
General Purpose Construction & Maintenance	Rubber, Neoprene, Nylon, PVC, High Density XLP, Hypalon	Ideal – Yellow 77
High Temperature Construction & Maintenance	Rubber, Neoprene, Nylon, PVC, High Density XLP, Hypalon, Low Density Polyethylene, Semiconducting Jacket	Ideal – Yellow 190

Utility Construction & Maintenance	Rubber, Neoprene, Nylon, PVC, High Density XLP, Hypalon, Low Density Polyethylene, Semiconducting Jacket	Aqua – Gel II
Cold Weather Construction & Maintenance	Rubber, Neoprene, Nylon, PVC, High Density XLP, Hypalon, Low Density Polyethylene, Semiconducting Jacket	Aqua – Gel CW

12. Use pulling means including fish tape, cable, rope and basket type grips which will not damage cables or raceways. Use approved mechanical pullers for feeders and branch circuits as required for #6 AWG cable and larger. Do not use mechanical means to pull conductors No. 8 or smaller.
13. Branch circuit conductors installed in panelboards, and control conductors installed in control cabinets and panels shall be neatly bound together using "Ty-Raps" or equivalent.
14. Reconnect branch circuit wiring at panelboards as required to obtain a balanced three phase load on the feeders.
15. Provide conduit seals in explosion proof areas as called for on the plans and as required by the National Electrical Code.

3.2 TYPE MC METAL CLAD CABLE

- A. MC cable shall only be permitted for use in 6-feet max. whips from junction boxes above accessible ceiling areas to recessed light fixtures.
- B. Type MC cable may not be used for home runs to panelboards.
- C. Type MC cable may not be used for and emergency branch circuits per. Article 517 in the NEC.
- D. Support cable per. NEC. Secure the cable to fixture hangers using nylon or plastic ties.
- E. Bending radius shall comply with Article 330.24 of the NEC.
- F. Provide insulating bushing at all termination points between the metal sheath and outlet or junction box.
- G. Type MC cable shall not be installed exposed.

3.3 CONNECTORS AND TERMINATIONS

- A. Cover un-insulated splices, joints, and free ends of conductor with rubber friction tape or PVC electrical tape. Plastic insulating caps may serve as insulation.

3.4 TESTS

A. Low Voltage Feeders

1. After low voltage feeders are pulled in, and before being connected, test feeders with a 1000 volt, 60 Hz insulation tester for one minute to determine that the conductor insulation to ground is greater than that recommended by the manufacturer.

END OF SECTION 260519

SECTION 260526

GROUNDING

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Provide a complete grounding system meeting or exceeding the requirements of Article 250 of the latest National Electrical Code. Install all raceway systems, including metal conduit, wireways, pullboxes, junction boxes, bus ducts, enclosures, and motors, to provide a continuous ground path with the lowest possible impedance.

1.2 DESCRIPTION OF WORK

- A. This section includes minimum requirements for the following:
 - 1. Conductors
 - 2. Ground Rods
 - 3. Molded Fusion Welds
 - 4. Hardware

1.3 QUALITY ASSURANCE

- A. All grounding systems 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's Representative. Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based upon the acceptable manufacturers listed. Where "approved equal" is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to approval.
- B. Materials specified herein shall comply with the applicable requirements of:
 - 1. The National Electrical Code, Article 250.

1.4 SUBMITTALS

- A. Provide product data for the following:
 - 1. Ground Rods
 - 2. Grounding System Test Reports.

PART 2 - PRODUCTS

2.1 CONDUCTORS

- A. Exposed grounding conductors such as bars, straps, cables, flexible jumpers, braids, shunts, etc., shall be bare copper unless otherwise called for.
- B. Conductors shall be copper, as called for in Specification Section 260519 - Low Voltage Cables.
- C. Provide conductors with THHN/THWN insulation. Sizes #10 AWG and smaller shall be green in color. Conductor sizes #8 AWG and larger may have green taped bands at each end, and in all pullboxes.
- D. Acceptable Manufacturers:
 - 1. Same as for low-voltage conductors. Refer to Specification Section 260519 – Low Voltage Cables.

2.2 GROUND RODS

- A. Solid copper or copper clad steel cylindrical rods, 5/8 in. minimum diameter, minimum 8 ft. long.
- B. Acceptable Manufacturers:
 - 1. Erico or Approved Equal

2.3 CONNECTORS, CLAMPS, TERMINALS

- A. General: Connectors specified are part of a system. Furnish connectors and components, and use specific tools and methods as recommended by connector manufacturer to form complete connector system.
- B. Splices:
 - 1. Spring Type (for #10AWG conductors and smaller only):
 - a. Rated 105° C, 600V; Buchanan/Ideal Industries Inc.'s B-Cap, Electrical Products Div./3M's Scotchlok Type Y, R, G, B, O/B+, R/Y+, or B/G+, or Ideal Industries Inc.'s Wing Nuts or Wire Nuts.
 - 2. Indent Type with Insulating Jacket:
 - a. Rated 150° C, 600V; Ideal Industries Inc.'s High Temperature Wire-Nut Model 73B, 59B.
 - b. Indent Type with Insulating Jacket: Rated 105° C, 600V; Buchanan/Ideal Industries Inc.'s Crimp Connectors, Ideal Industries Inc.'s Crimp Connectors, Penn-Union Corp.'s Penn-Crimps, or Thomas & Betts Corp.'s STA-KON.
 - c. Indent Type (Uninsulated): Anderson/Hubbell's Versa-Crimp, VERSAtile, Blackburn/T&B Corp.'s Color-Coded Compression

Connectors, Electrical Products Div./3M's Scotchlok 10000, 11000 Series, Framatome Connectors/Burndy's Hydent, Penn-Union Corp.'s BCU, BBCU Series, or Thomas & Betts Corp.'s Compression Connectors.

3. Connector Blocks: NIS Industries Inc.'s Polaris System, or Thomas & Betts Corp.'s Blackburn AMT Series.
4. Resin Splice Kits: Electrical Products Div./3M's Scotchcast Brand Kit Nos. 82A Series, 82-B1 or 90-B1, or Scotchcast Brand Resin Pressure Splicing Method.
5. Heat Shrinkable Splices: Electrical Products Div./3M's ITCSN, Raychem Corp.'s Thermofit Type WCS, or Thomas & Betts Corp.'s SHRINK-KON Insulators.
6. Cold Shrink Splices: Electrical Products Div./3M's 8420 Series.
7. Gutter Taps: Anderson/Hubbell's GP/GT with GTC Series Covers, Blackburn/T&B Corp.'s H-Tap Type CF with Type C Covers, Framatome Connectors/Burndy's Polytap KPU-AC, H-Crimpit Type YH with CF-FR Series Covers, ILSCO's GTA Series with GTC Series Covers, Ideal Industries Inc.'s Power-Connect GP, GT Series with GIC covers, NSI Industries Inc.'s Polaris System, OZ/Gedney Co.'s PMX or PT with PMXC, PTC Covers, Penn-Union Corp.'s CDT Series, or Thomas & Betts Corp.'s Color-Keyed H Tap CHT with HTC Covers.
8. Lugs:
 - a. Single Cable (Compression Type Lugs): Copper, one or 2 hole style (to suit conditions), long barrel; Anderson/Hubbell's VERSAtile VHCL, Blackburn/T&B Corp.'s Color-Coded CTL, LCN, Framatome Connectors/Burndy's Hylug YA, Electrical Products Div./3M Scotchlok 31036 or 31145 Series, Ideal Industries Inc.'s CCB or CCBL, NSI Industries Inc.'s L, LN Series, Penn-Union Corp.'s BBLU Series, or Thomas & Betts Corp.'s 54930BE or 54850BE Series.
 - b. Single Cable (Mechanical Type Lugs): Copper, one or 2 hole style (to suit conditions); Blackburn/T&B Corp.'s Color-Keyed Locktite Series, Framatome Connectors/Burndy's Qiklug Series, NSI Industries Inc.'s Type TL, Penn-Union Corp.'s VI-TITE Terminal Lug Series, or Thomas & Betts Corp.'s Locktite Series.
9. Acceptable Manufacturers:
 - a. Burndy
 - b. T & B
 - c. Erico

2.4 MOLDED FUSION WELDS

- A. Provide fusion welds designed for size and type of cable, rods, or assembly. Solder prohibited for connections.
 - 1. Acceptable Manufacturers:
 - a. Erico Cadweld
 - b. Metalweld
 - c. Thermoweld

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Service Entrance
 - 1. Solidly ground the electrical service at the service entrance. Provide a grounding electrode conductor from the service entrance ground bus to all of the following grounding electrodes:
 - a. Metal water pipe, ahead of the meter.
 - b. Building steel
 - c. Made grounding electrode grid.
 - d. Concrete encased electrode (steel rebar in foundation)
 - 2. For a grounded electric service, solidly connect the grounded (neutral) conductor to the service entrance ground bus. Do NOT make any grounding connections to any grounded conductors on the load side of the service disconnecting means.
 - 3. Provide a bare, copper, #4/0 bonding jumper across the water meter.
- B. Raceway Systems:
 - 1. All metal supports, cable trays, frames, sleeves, brackets, braces, etc. for the raceway system, panelboards, switchboards, switches, enclosures, starters, controls, etc., which are not rigidly secured to and in contact with the raceway system, or which are subject to vibration and loosening, shall be bonded to the raceway system. Size the bonding conductor in accordance with NEC Article 250, Table 250-122.
 - 2. Terminate rigid conduit at all boxes, cabinets, and enclosures tightly with two locknuts and a bushing.

3. Conduit which runs to or from all boxes, cabinets, or enclosures having concentric or eccentric knockouts which partially perforate the metal around the conduit and hence impair the continuity of system ground circuits shall be provided with bonding jumpers sized in accordance with NEC Article 250, Table 250-122. Connect the bonding jumper between a grounding type bushing on the conduit and a ground bus or stud inside the box, cabinet, or enclosure.
4. Provide bonding jumpers sized in accordance with NEC Article 250, Table 250-122 for all conduit expansion joints.
5. Provide a grounding conductor in all flexible metallic conduit and liquid-tight conduit, sized in accordance with NEC Article 250, Table 250-122.
6. Provide a grounding conductor in all nonmetallic runs of conduit and raceway, sized in accordance with NEC Article 250, Table 250-122.
7. Provide isolated ground conductors of systems as called for on the plans.

C. Ground Grid:

1. Provide 3 ground rods, 8 feet long, driven on 10 foot centers, with top of rod 12 inches below finished grade, and located as called for on plans.
2. Connect with size #4/0 AWG copper conductors as called for.
3. Connecting conductors shall be located within 6 inches of the top of the ground rod.
4. Provide two size #4/0 AWG grounding conductors from the ground grid to the service entrance ground bus.
5. Provide one size #4/0 AWG grounding conductor from the ground grid or service entrance ground bus to the service side of nearest metallic cold water and/or sprinkler main.
6. Provide one size #4/0 AWG grounding conductor from the ground grid or service entrance ground bus to building steel.
7. Provide molded fusion welds for all below grade connections. Molds shall be new, unused, and shall be replaced when worn or broken.
8. Required ground grid resistance to earth shall be 25 ohms maximum.

D. Primary Electrical Equipment:

1. Transformers:
 - a. Provide two bare #4/0 AWG conductors, one from each of two ground buses, to ground.

- b. Provide one size #4/0 AWG conductor from each air terminal chamber to ground bus.
- c. Provide a grounding conductor from the neutral bushing or bushings to system ground, sized as called for, or in accordance with NEC Table 250-122, whichever is of greater capacity.
- d. System ground conductors, usually run with phase conductors, shall be connected to the ground bus.

2. Metal Enclosed Switchgear:

- a. Two size #4/0 AWG grounding conductors from the ground bus to ground or one size #4/0 AWG ground circuit from ground bus to ground for each two compartments in continuous line-up equipment, whichever is the greater number.
- b. System ground conductors, usually run with phase conductors, shall be connected to the ground bus.
- c. Where metal enclosures are pierced or penetrated to accommodate ground conductors, seal opening around ground conductor to metal enclosure with "Duxseal" to maintain enclosure integrity.

E. Secondary Electrical Systems:

- 1. Solidly ground all transformer neutral conductors and enclosures to building steel, or a cold water pipe 1" or larger in size as called for in Table 250-122 of the National Electrical Code.
- 2. Provide an equipment grounding conductor from the point of termination back to the ground bus of the serving panelboard, switchboard, or transformer. Do not splice equipment grounding conductors.
- 3. Provide an equipment grounding conductors from the point of termination back to the ground bus of the serving panelboard, switchboard, transformer, or switchgear.
- 4. The grounding conductors contained in the interstices of interlocked armor cable shall be connected to the ground bus at every equipment termination point and to each other and to system ground; ground at every splice location.

F. Medium Voltage Conductors:

- 1. The grounding conductors contained in the interstices of interlocked armor cable shall be connected to the ground bus at every equipment termination point and to each other and to system ground; ground at every splice location.
- 2. The grounding conductor contained in raceway systems shall be connected to the ground bus at every equipment termination point and to each other and to system

ground; ground at every splice location.

3. The grounding shield tape or concentric wire shields on cables shall be circuited to system ground; ground at each splice and termination.

G. Power Company Requirements:

1. Grounding conductor from service entrance equipment to meter enclosure per. utility standards.
2. One 5/8" diameter by 8' long ground rod and size #4/0 AWG grounding conductor at each riser pole.
3. Additional requirements per. latest power company published standards.

3.2 TESTS

A. Grounding:

1. Grounds and grounding systems shall have a resistance to solid earth ground not exceeding following values:
 - a. For grounding of 5 KV equipment, enclosures,
and cable shields: 10 Ohms
 - b. For grounding secondary service neutral: 25 Ohms
 - c. For grounding non-current carrying metal parts associated with
secondary distribution system: 25 Ohms
2. Providing grounding tests to verify the above values. Add additional ground rods or connections in order to meet these values.

END OF SECTION 260526

This Page Intentionally Left Blank

SECTION 260533

RACEWAYS

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Provide all labor, materials, tools, and equipment required for the complete installation of work called for in the Contract Documents

1.2 DESCRIPTION OF WORK

- A. This section includes minimum requirements for the following:

1. Galvanized Rigid Steel Conduit (GRS)
2. Electrical Metallic Tubing (EMT)
3. Flexible Metal Conduit
4. Liquidtight Metal Flexible Conduit
5. Innerduct/Electrical Non-Metallic Tubing (ENT)
6. Rigid Non-Metallic Conduit
7. Electrical Nonmetallic Tubing
8. Fittings and Conduit Bodies
9. Expansion Fittings
10. Surface Metal Raceway
11. Wireways
12. Cable Tray
13. Cable Hangers

1.3 QUALITY ASSURANCE

A. All raceways 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's Representative. Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based upon the acceptable manufacturers listed.. Where "approved equal" is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to approval.

B. Materials specified herein shall comply with the applicable requirements of:

1. The following Articles of the National Electric Code (NFPA 70)

- a. Wiring Methods
- b. Cable Trays
- c. Electrical Nonmetallic Tubing
- d. Nonmetallic underground conduit with conductors
- e. Rigid metal conduit
- f. Rigid nonmetallic conduit
- g. Electrical metallic tubing
- h. Flexible metallic tubing
- i. Flexible metal conduit
- j. Liquidtight Flexible metal conduit and Liquidtight flexible nonmetallic conduit.
- k. Surface Metal Raceways
- l. Metal wireways and nonmetallic Wireways
- m. Outlet, Device, Pull and Junction Boxes, Conduit Bodies and Fittings
- n. Auxiliary gutters

2. The following National Electrical Manufacturers Association (NEMA) Standards:

- | | |
|--------------------|--|
| NEMA, RN1 | PVC Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit. |
| NEMA, TC 3 | PVC fittings for use with Rigid PVC Conduit and tubing. |
| NEMA, TC 6 & TC 8 | PVC Plastic Utilities for Underground Installation. |
| NEMA, TC 9 & TC 10 | Fittings for PVC Plastic Utilities Duct for Underground Installation. |

3. The following American National Standards Institute (ANSI) standards:

ANSI-C80.1	Electric Rigid Steel Conduit
ANSI-C80.3	Specification for Electrical Metallic Tubing, Steel
4. The following U.L. Standards:

UL 1	Flexible Metal Electrical Conduit
UL 3	Flexible Nonmetallic Tubing for Electric Wiring
UL 5	Surface Metal Raceways and Fittings
UL 6	Electrical Conduit Rigid Metal Conduit, Steel
UL 360	Liquidtight Flexible Metal Conduit
UL 514B	Conduit, Tubing and Cable Fittings
UL 651	Schedule 40, 80, Type EB and A Rigid PVC
UL 797	Electrical Metallic Tubing, Steel
UL 870	Wireways, Auxilliary Gutters and Associated

1.4 SUBMITTALS

- A. Provide product data for the following:
 1. Surface Raceway
 2. Cable Trays
 3. Cable Hangers

PART 2 - PRODUCTS

2.1 CONDUIT

- A. Galvanized Rigid Steel Conduit
 1. Shall be hot-dipped galvanized steel, including threads.
 2. Acceptable manufacturers:
 - a. LTV Steel
 - b. Triangle
 - c. Allied Tube
 - d. Steel Duct
 - e. Wheatland
- B. Electrical Metallic Tubing
 1. Electrical Metallic Tubing shall be electro-galvanized steel.

2. Acceptable manufacturers:

- a. Triangle
- b. Wheatland
- c. Allied Tube
- d. Steel Duct
- e. LTV Steel

C. Flexible Metal Conduit

1. Flexible Metal Conduit shall be constructed of one continuous length of spirally wound, interlocked, zinc coated strip steel. Interior surface shall be free from burrs or sharp edges.

2. Acceptable manufacturers:

- a. Anaconda
- b. American Flexible Conduit Co.
- c. O-Z/Gedney
- d. Thomas and Betts

D. Liquidtight Flexible Metal Conduit

1. Flexible Metal Conduit shall be constructed of one continuous length of spirally wound, interlocking zinc coated strip steel. Interior surfaces shall be free from burrs and sharp edges. Provide with a liquid-tight jacket of flexible polyvinyl chloride (PVC).

2. Acceptable Manufacturers:

- a. Allied
- b. American Flexible Conduit
- c. Carlon
- d. Thomas and Betts

E. Innerduct/Electrical Non-Metallic Tubing (ENT)

1. This may also be referenced as Innerduct in the contract documents.

2. Size: 1 ¼" diameter corrugated wall flexible tubing unless otherwise indicated on drawings.

3. Shall be UL Listed type CMP (plenum rated), CMR (riser rated), or CMG (general purpose) as required for the installation.
4. Acceptable Manufacturers:
 - a. Carlon
 - b. Dura - Line
 - c. Arnco
 - d. VikiMatic

F. Rigid Non-Metallic PVC Conduit

1. Extra-Heavy wall conduit: Schedule 80, constructed of polyvinyl chloride, rated for use with 90 degree C conductors, and UL listed for direct burial and normal above ground use.
2. Heavy wall conduit: Schedule 40, constructed of polyvinyl chloride, rated for use with 90 degree C conductors, and UL listed for direct burial and normal above ground use.
3. Acceptable manufacturers:
 - a. Carlon
 - b. Thomas & Betts
 - c. Certainteed
 - d. Condux

G. Fittings

1. Rigid galvanized steel fittings shall be fully threaded and shall be of the same material as the respective raceway system.
2. Fittings for electrical metallic tubing shall be single screw indenter fittings for conduits up to 2" and double screw indenter fittings for conduits 2" and larger.
3. Fittings for flexible metal conduit shall be center stopped, insulated throat, U.L. E-11852 listed.
4. Fittings for liquidtight flexible metal conduit shall have zinc plated steel ferrule, compression type with sealing ring.
5. Fittings for rigid non-metallic conduit shall be solvent cemented in accordance with the manufacturer's instructions.
6. Fittings for PVC coated rigid galvanized steel conduit shall be threaded, hot

dipped galvanized, and coated inside and outside with a urethane coating.

7. Fittings for electrical metallic tubing shall be interlocking compression type zinc coated steel in dry locations, fittings in damp locations shall have internal sealing ring and knockout gasket.
8. Connectors shall have insulated throat up to and including 1" size. For sizes 1-1/4" and larger, provide plastic insulating bushing.
9. Die-cast or pressure cast fittings are not permitted.
10. Provide conduit bodies types, shapes and sizes as required to suit application and NEC requirements. Provide matching gasketed covers secured with corrosion-resistant screws.
11. Acceptable manufacturers:
 - a. O.Z. Gedney
 - b. Steel City
 - c. Thomas & Betts
 - d. Crouse-Hinds
 - e. Carlon

H. Expansion Fittings

1. Galvanized steel expansion joints for RGS or EMT conduit, PVC for PVC conduit.
2. Minimum 4" movement in either direction.
3. Weatherproof for outdoor applications.
4. At expansion joints in concrete pours, provide Deflection/Expansion fittings capable of movement of 3/4" in all directions from the normal.
5. Design Make: O.Z./Gedney, Type "AX" (exposed), "DX" (Concrete Pour)
6. Acceptable manufacturers:
 - a. O.Z./Gedney
 - b. Crouse-Hinds
 - c. Appleton

I. Underground Ductbank Materials

1. Refer to Specification Section 260543 - Exterior Pathways for Underground Ductbank Materials.

2.2 SURFACE METALLIC RACEWAY

- A. Single channel suitable for up to (9) #12 AWG conductors or (11) 0.2" O.D. Cables
 1. Color shall be ivory.
 2. Two piece raceway with single compartment, length as indicated on the drawings. Nominal 1-29/32" x 7/8" with snap on cover.
 3. Provide tee and corner fittings suitable for cat. 6A and fiber optic bend radius.
 4. Design Make: Wiremold V2400 series with "FO" series tees and corners
- B. Two channel with devices suitable for up to (48) #12 AWG conductors or (50) 0.2" O.D. Cables.
 1. Color shall be ivory.
 2. Two piece raceway with divider for power and communications, length as indicated on the drawings. Nominal 4-3/4" x 1-3/4" with 7/16" raised, snap on cover.
 3. Provide devices in the raceway as shown on plans
 4. Provide tee and corner fittings suitable for cat. 6A and fiber optic bend radius.
 5. Design Make: Wiremold V4000 with "FO" series tees and corners
- C. One-piece raceway
 1. Color shall be ivory
 2. Size race way as required based on the following:
 - a. .040" steel suitable for (8) #12 AWG conductors or (2) 0.2" O.D. cables
 3. Design Make: Wiremold V700 Series
- D. Provide miscellaneous boxes, fittings and supports designed and manufactured by the raceway manufacturer as required making a complete job.
- E. Cat.6A and optical fiber installations:
 1. Cable entrance fittings shall include 1" minimum knockouts.
 2. Provide 2" minimum radius fittings.
- F. Acceptable Manufacturers:

1. Panduit
2. B-Line Systems, Inc.
3. Mono-Systems

2.3 WIREWAYS

- A. Wireway shall be steel, enclosed type. Provide hinged, JIC sectional NEMA dust resistant, oil tight type where subjected to moisture, in Pump Rooms, Mechanical, Electric and Fan Rooms, exterior walls, Maintenance Shops, and similar locations. Size to meet NEC fill requirements or larger as noted on Contract Documents. Provide knockouts along runs. Provide all elbows, tees, pullboxes, fittings, hangers, reducers, supports, etc., to meet installation requirements.
- B. Cover: Hinged Screw cover with full gasketing.
- C. Connector: Slip-in Flanged.
- D. Fittings: Lay-in type with removable top, bottom, and side; captive screws drip shield.
- E. Finish: Electro-coated ASA-49 Gray Epoxy Paint over Phosphate Primer.
- F. Acceptable manufacturers:
 1. Square D "Square Duct"
 2. General Electric
 3. Hoffman
 4. Keystone/Rees, Inc.

2.4 CABLE TRAY

- A. Wire Basket Tray shall be constructed of heavy gauge steel wire mesh, all joints shall be welded. All welds shall be smooth and free of burrs. Maximum mesh size of 2" x 4" openings.
- B. All cable tray and accessories shall be electro-plated zinc.
- C. Inside dimensions of cable tray shall be 12" wide x 4" depth.
- D. Provide manufacturer supports for loading rating of 74 lbs/ft. for 118" section with supports 6-feet on center.
- E. Tray shall be supported on 6-0" center spaced 3/8" threaded rod and stiffener bars and shall support a total load of 75 pounds per linear foot.
- F. Wire mesh cable tray shall allow cutting for custom field horizontal and vertical offsets.

- G. Provide exterior grounding strap at expansion joints, crossovers and all other locations where tray continuity is interrupted.
- H. Design Make: Legrand Cablofil
- I. Acceptable manufacturers:
 - 1. Mono-Systems Mono-Mesh Cable Tray Series
 - 2. Cooper B-Line Wire Basket
 - 3. Snake Tray

2.5 CABLE HANGERS

- A. Provide prefabricated, zinc coated, carbon steel hangers UL listed to support category 5, 6, 6A, optical fiber cable, and innerduct installations.
- B. Hangers shall have open top, rolled edges and a 2" diameter loop, J-hook style.
- C. Provide beam clamps, rod fasteners, flange clips and brackets as job conditions require.
- D. Design Make: Erico CADDY CABLECAT CAT32 series.

PART 3 - EXECUTION

3.1 GENERAL

- A. Size raceways as indicated on the drawings. Where sizes are not indicated, raceways shall be sized as required by the National Electrical Code in accordance with the quantity, size, type and insulation of conductors to be installed.
- B. Minimum 3/4" trade size for branch circuit and fire alarm wiring.
- C. Minimum 3/4" trade size for voice/data outlets, television outlets, and branch circuit "Home Runs" to panelboards.
- D. Where cable quantities are identified on drawings provide telecom conduit sleeves and raceways according to the below schedule (Note this table is an estimate and the actual quantity is dependent on the installed cable diameter):

Cat. 6A & RG-6 Cable Qty.	Conduit Trade Size
2 Cables	3/4" Conduit
4 Cables	1" Conduit
6 Cables	1 1/4" Conduit
10 Cables	1 1/2" Conduit
20 Cables	2 1/2" Conduit
70 Cables	4" Conduit

*Refer to specification section 271000 for maximum outside diameter of Cat.6A cabling.

- E. Support raceways from building structure and wall construction. Do not support raceways from ceiling systems ductwork, piping, or equipment hangers. Do not support raceways from pre-existing conduit runs, banks, racks, hangers, etc.
- F. Support outlet, pull, and junction boxes independently from building structure and wall construction. Do not support from raceways.
- G. Install raceways parallel or perpendicular to building walls, floors and ceilings.
- H. Install raceways concealed except in the following areas:
 - 1. Mechanical Rooms
 - 2. Electric Rooms
 - 3. Manufacturing areas
 - 4. Garage or maintenance areas
 - 5. Unfinished basements or crawl spaces
- I. Provide a code compliant ground path between all outlets and the established electrical system ground.
- J. Cut raceways square, ream ends to remove burrs, and bush where necessary.
- K. Coordinate all raceway runs with other trades.
- L. Do not install raceways adjacent to hot surfaces or in wet areas.
- M. Provide expansion fittings with external grounding straps at building expansion joints.
- N. Do not install conduit horizontally in concrete block or dry wall partitions.
- O. Arrange neatly to permit access to the raceway, outlet, pull, and junction boxes, and work installed by other trades.
- P. If it is necessary to burn holes through webs of beams or girders, call such points to the attention of the Owner's Representative and receive written approval both as to location and size of hole before proceeding with work. All holes shall be burned no larger than absolutely necessary.
- Q. Core drill, sleeve, and fire stop all penetrations through existing floors.
- R. Support all raceways with malleable iron pipe clamps or other approved method. In exterior or wet locations, provide minimum ¼" air space between raceway and wall. Secure raceway within 3 ft. of each outlet box, junction box, cabinet or fitting.
- S. Provide conduit seals and explosion proof devices as indicated on the plans and as dictated by the National Electrical Code for all hazardous locations indicated on the drawings.

- T. Provide green ground wire in all EMT, flexible conduit, and non-metallic conduit.
- U. Do not install voice and data cabling in any surface metal raceway smaller than Wiremold V2400, except single voice outlets where cable runs straight down and no bends occur in raceway.

3.2 CONDUIT

- A. Install with a minimum of bends and offsets. Bends shall not kink or destroying the interior cross section of the raceway. Factory made bends shall be used for raceways 1" trade size and larger.
- B. Provide at least one junction or pullbox for each 360 degrees of bends.
- C. Plug the ends of each roughed-in raceway with an approved cap or disc to prevent the entrance of foreign materials during construction.
- D. Provide U.L. approved rain-tight and concrete-tight couplings and connectors.
- E. Secure within three feet of each outlet box, junction box, cabinet or fitting.
- F. Provide a #14 AWG fish wire in all "Spare" or "Empty" conduit runs to facilitate future installation of conductors.
- G. Install raceways in concrete floor slabs as follows:
 - 1. All conduit in concrete floor slabs shall be rigid galvanized steel with concrete tight threaded fittings.
 - 2. Provide expansion fittings where conduits cross building expansion joints.
 - 3. Install conduit below the reinforcing mesh.
 - 4. Locate conduits to provide a minimum of 1" of concrete around conduit.
 - 5. Obtain approval from the Owner's Representative prior to installing conduit larger than 1" trade size in concrete slabs.
- H. Wherever a cluster of four (4) or more conduits rise out of floor exposed, provide neatly formed 4 in. high concrete envelope, with chamfered edges, around raceways.
- I. Provide conduit supports based on the following table:

Conduit Trade Size	Type of Run	Horizontal Spacing in Feet	Vertical Spacing in Feet
½", ¾"	Concealed	7	10
1", 1-¼"	Concealed	8	10
1-½" & larger	Concealed	10	10
½", ¾"	Exposed	5	7
1", 1-¼"	Exposed	7	8
1-½" & larger	Exposed	10	10

- J. Where conduits puncture roof, install pitch pockets as required in order that the roof warranty is maintained.
- K. Provide 4 spare 3/4-in. raceways from each flush mounted panelboard or cabinet to an area above the nearest accessible ceiling space. Make 90° turn above the ceiling, arranged for further continuation of raceway, and cap.
- L. Conduit System Installation:
 - 1. Wiring above 600 volts in indoor or exterior, above grade locations:
 - a. Rigid Galvanized Steel
 - 2. Wiring below 600 volts, interior locations:
 - a. Electrical Metallic Tubing
 - b. Rigid Galvanized Steel in mechanical rooms, electrical rooms, garages, maintenance areas, and manufacturing areas.
 - 3. Wiring below 600 volts, exterior, above grade locations and hazardous locations:
 - a. Rigid Galvanized Steel
 - 4. Wiring below 600 volts, exterior, above grade locations and hazardous locations:
 - a. Rigid Galvanized Steel
 - b. Seal-tight Flexible Conduit (connection whips only)

3.3 INNERDUCT/ELECTRICAL NON-METALLIC TUBING (ENT)

- A. Provide complete UL listed innerduct raceway system for all fiber optic cable installations.
- B. Provide ENT raceway system for all other communication cable and conductor installations as called for in the contract documents.
- C. Provide UL firestop assembly where ENT raceway passes thru fire rated assemblies.
- D. Each Innerducts UL fire-resistance rating shall match the contained communications cable plenum, riser, or general purpose jacket listing. Always use the most fire-resistant Innerduct type where the work requires adherence to two or more NEC Article 770 and Article 800 installation guidelines.
 - 1. Provide type CMP Innerduct in all duct and plenum installations.
 - 2. Provide type CMR Innerduct in all vertical pathways where the installation pass thru a floor.
 - 3. Provide type CMG or CM Innerduct in all single floor installations, basements,

and attics not used by plenum air systems.

3.4 SURFACE RACEWAYS

- A. Support with expansion anchors, concrete inserts, masonry inserts or toggle bolts as field conditions require. Provide supports at five foot centers.
- B. Install a separate green ground conductor in raceway from the junction box where surface raceway begins to the ground terminal of the device, fixture or equipment being supplied.
- C. Provide all fittings, connectors, elbows, tees, boxes etc. as required for the installation.
- D. Submit factory drawings detailing the installation. Include a complete part list.
- E. Paint all surface mounted raceways in finished areas as directed by Owners representative.

3.5 CABLE TRAYS

- A. Hang Cable tray using threaded, galvanized rod hangers, with rods extended through support steel and double-nutted. Size support member within load rating of member section; and without visible deflection. Install cable tray level and straight.
- B. Provide aluminum body expansion connectors at building expansion joints. Minimum 4 in. movements, greater if expansion movement conditions warrant.
- C. Provide external grounding strap at expansion joints, sleeves, crossovers and at other locations where tray continuity is interrupted.
- D. Provide necessary elbows, tees, crosses, risers, offsets, fittings, reducers, connectors, clamps, rod suspension, trapeze hangers, etc., as required to make a complete job, coordinate with the manufacturer.
- E. Provide conduit to tray fitting at each conduit entrance to tray.
- F. Install divider in trays where conductors of different systems are carried in the same tray.
- G. Provide (1) 6" long piece of ½" EMT conduit on each threaded rod hanger to prevent scoring of cable insulation when cable is pulled in.
- H. Install fire stop wall frames around cable tray at penetrations through fire rated walls, and where called for. Seal these openings with pliable fire resistant sealant.

END OF SECTION 260533

This Page Intentionally Left Blank

SECTION 260543

EXTERIOR PATHWAYS

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Provide all labor, materials, tools, and equipment required for the complete installation of work called for in the Contract Documents.
- B. Cut, excavate, and patch existing asphalt parking lot and grass areas for new underground conduit installations as called for on the drawings.

1.2 SCOPE

- A. Minimum composition requirements and/or installation methods for the following materials and work are included in this section:
 - 1. Trenching and Excavation
 - 2. Ordinary Fill and Crushed Stone
 - 3. Asphalt Paving
 - 4. Underground Duct
 - 5. Manholes, Vaults and Handholes
 - 6. Overhead Aerial Lashing and Messenger Wire
- B. Refer to section 260533 Raceways for raceway requirements.

1.3 SUBMITTALS

- A. Product data for:
 - 1. Precast manholes, handholes.
 - 2. Asphalt Pavement Supplier and aggregate composition

1.4 QUALITY ASSURANCE

- A. The installation shall comply with the applicable sections of the BICSI "Customer Outside Plant Design Manual."
- B. The contractor shall engage the services of a qualified installer for all excavation and restoration work.

- C. All work shall be done in a neat and workmanlike manner. All methods of construction, details of workmanship, that are not specifically described or indicated in the contract documents, shall be subject to the control and approval of the Owner's Representative. Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based upon the acceptable manufacturers listed. Where "approved equal" is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to approval.

1.5 PROJECT CONDITIONS AND REQUIREMENTS

- A. The following conditions apply to excavation:
1. Identify and maintain and protect existing building services which cross the excavation area.
 2. Protect utilities, sidewalks, structures, pavements and other facilities from damage caused by settling, lateral movements, undermining, washouts and other hazards created by excavation work.
 3. Locate and verify existing underground utilities in excavation areas. If utilities are indicated to remain, support and protect services during excavation operations.
 4. Verify subsurface conditions prior to excavation work.
- B. Obtain as built drawings from the owner for all previous underground work done on the campus. Field verify location of the existing underground utilities and cabling that is shown on these plans. Use tracing equipment as required.
- C. The contractor shall be responsible for the repair all existing utilities that are identified on existing as built drawings or construction documents that are damaged during the installation of contract work.
- D. The contractor shall sub contract a qualified mechanical or plumbing contractor to repair any underground piping that is damaged as a result of the installation of contract work.

PART 2 – PRODUCTS

2.1 TRENCHING AND EXCAVATION FILL

- A. Sand: Clean, coarse, free of organic matter.
- B. Type 1 Fill (NYSDOT Type 1 / Granular Fill) graduation requirements:

Sieve No.	Percent Passing Maximum	Percent Passing Minimum
3 in.		100%
2 in.	90%	100%
¼” in.	30%	65%

#40	5%	40%
#200	0%	7%

C. Type 2 Fill (NYSDOT Type 2 / Crushed Ledge Rock Stone) graduation requirements:

Sieve No.	Percent Passing Maximum	Percent Passing Minimum
2 in.		100%
1/4" in.	25%	60%
#40	5%	40%
#200	0%	7%

D. Gravel Fill: Well-graded natural inorganic sand and gravel conforming to following graduations:

Sieve No.	Percent Passing Maximum	Percent Passing Minimum
4 in.		100%
1 in.	100%	60%
#4	85%	25%
#16	60%	10%
#50	30%	4%
#200	5%	

E. Pea Gravel: Rounded stone, 3/4 in. maximum diameter, and 1/8 in. minimum diameter. Stone crushings of 1/8 in. to 1/2 in. meeting ASTM C33, Paragraph 9.1 may also be used.

F. Ordinary Fill: Well-graded, natural inorganic soil, meeting the following requirements:

1. Free of organic and other compressible materials, debris and frozen materials, and of stones larger than 4 in. maximum dimension.
2. Be of such nature and character that it can be compacted to the specified densities.
3. Free of highly plastic clays, of materials subject to decay, decomposition, or dissolution, and of cinders, ash and other corrosive materials.
4. Maximum dry density of not less than 115 lbs. per cu. ft.
5. Material from excavation on the site may be used as ordinary fill if it meets the above requirements.

2.2 ASPHALT PAVING

A. Use locally available materials exhibiting satisfactory record of previous installations.

- B. Provide paving fabric where used over existing paving. Fabric shall be non-woven polypropylene fabric precoated with rubberized asphalt and protected by release sheet. Design Make: Phillips Fibers Corp. "Petrotac precoated Nonwoven Fabric" or Approved equal.
- C. Asphalt Requirements:
 - 1. Foundation Course: Provide 6" layer compacted in 3" increments. Material shall comply with NYS DOT Standard Type 1 Fill.
 - 2. Base Course: Provide 2" compacted layer or additional material until movement in front of roller ceases. Material shall comply with NYS DOT Standard Type 2 Fill.
 - 3. Tack Coat: Emulsified asphalt, slow setting type, NYS DOT Designation 702-3601 (SS-1h) or 702-4501 (CSS-1h).
 - 4. Asphalt Cement Filler: NYS DOT Designation 702-05.
 - 5. Asphalt Concrete Binder Course: Provide minimum 3" binder course. Material shall be hot plant mixed asphalt concrete complying with NYS DOT Type 3 Binder.
 - 6. Asphalt Concrete Top Course (over existing paving): Provide minimum 1 ½" top course up to 3" to achieve level surface. Material shall be hot plant mixed asphalt concrete complying with NYS DOT Type 7 Top.
- D. Painting:
 - 1. Pavement marking paint shall comply with NYS DOT standard 727-01.
- E. Compaction Equipment:
 - 1. Provide Compaction equipment in suitable size and number, and in satisfactory working condition to complete construction on schedule.
 - 2. Use Self-propelled tandem roller with minimum 10-ton weight. Hand held compactor may be used in areas inaccessible to rollers when approved in advanced by engineer.

2.3 MANHOLES, VAULTS AND HANDHOLES

- A. Provide pre-cast or cast-in-place reinforced concrete designed for H-20 loading.
- B. Shall have angled corners, cut on 45 degrees for optimum cable racking.
- C. Covers and frames shall be cast iron, with a minimum opening of 27" suitable for H-20 loading. Covers shall have pick holes and have "Communications"," cast in 2" high lettering on the cover.

- D. Floors shall be 6 inches thick with a 12" diameter sump hole. In wet soil, provide reinforced floor with 5/8" bars, 8 inches on center.
- E. Provide two courses of bricks with all joints fully filled with mortar both inside and outside the collar. Provide layer of mortar on top course for bricks.
- F. Provide cable racks with "T" slots for attaching support hooks. Provide two per wall.
- G. Provide pulling irons on each wall 12" below duct.
- H. Refer to details on drawings for additional information.
- I. Acceptable Manufacturers: Lakelands Precast or approved equal.

2.4 EXTERIOR DUCT

- A. Underground straight length conduit sections shall be 4" trade size Sch. 80 PVC.
- B. Provide 45-degree and 90-degree Galvanized Rigid Steel (GRS) large radius (36") sweeps at bend locations. Provide PVC to GRS adapters as required.
- C. Underground communication raceways size 4-inch shall each include (3) 1" I.D. general purpose PVC smooth wall innerducts. Innerduct color scheme shall be white and red and blue.
- D. Innerducts shall be pre-lubricated to meet Belcore GR356-CORE coefficient of friction requirements. Innerduct assembly alignment shall be maintained by internal spacers.
- E. Couplings shall be mechanically or chemically sealed water tight.
- F. Provide deflection joint to allow $\frac{3}{4}$ " movement in all axis, and a total bend of up to 30 degrees. Provide fixed galvanized steel bends or flexible metal conduit bends to allow changes in direction. Fixed or flexible bends shall be provided with factory installed reverse spin coupling. Fixed or flexible bends shall have Nylon 6 innerduct to prevent "burn through" due to friction when tapes, ropes, or cables are installed.

PART 3 - EXECUTION

3.1 EXCAVATION AND TRENCHING

- A. Preparatory Work:
 - 1. Build lines to grade and elevations shown. Provide stakes, grade boards, cleats, nails, instruments. Locate and stake each new run for its entire length. Verify elevations given. Start excavation at low point. Notify Engineer of elevation discrepancies. Protect marks and stations. Before excavating work, coordinate with Owner's Site Representative and other trades. Furnish schedule of operations to Owner and each trade. Provide and maintain temporary bridges, walks and bridges over excavations where underground utility lines, sewers, water lines, etc., cross access roads, walks, and streets. Make necessary arrangement with authorities having jurisdiction.

2. Examine substrates, areas and conditions, with the installer present, for compliance with requirements for installation tolerances and other conditions affecting installation. Do not proceed with installation until unsatisfactory conditions have been corrected.

B. Protection:

1. Provide bracing, shoring, sheathing and other work for: protection of personnel, the contract work, excavations, trees, shrubs, existing structures, and surrounding properties. Slope sides of excavations to comply with local codes and ordinances. Provide, erect, and maintain barricades, warning signs, flags, and lights to provide protection for work, workmen, public, and property. Plank walks, pavements, and curbs to be crossed by equipment. Protect adjacent property, existing fences, trees, shrubs, roads, curbs, sidewalks, manholes, hydrants, and other items:
2. Restore, repair, rebuild or replace any such items damaged or destroyed to condition equal to that existing before such damage occurred.
3. Establish conditions, before starting work, by taking photographs to determine state to which existing conditions must be restored. Submit such photographs notarized, identified and dated for record.

C. Existing Utilities:

1. There are existing underground district electric and telephone utilities. Obtain the districts existing site utility plans for each building prior to beginning work. Identify utilities shown on the plans.
2. The existing district owned telephone cables are not documented. Prior to beginning any excavation work, identify the path of the existing cables using cable tracing equipment.
3. If existing telephone or electric cables are broken during the new installation the contractor shall repair to new condition.
4. Report immediately any utility lines encountered.
5. Notify Underground Facilities Protection Organization (UFPO), where same exists, before starting work. Phone (800)-962-7962 for information and location of nearest organization address and telephone number. Verify exact location of existing utility lines where work crosses existing utilities and where connections are to be made by test hole before starting work. Notify utility companies, municipalities, and other involved jurisdictions when excavation occurs within vicinity of existing underground service such as sewers, water, electric, gas, telephone, including such services owned by Owner.

6. If existing service lines, utilities and utility structures which are to remain in service are uncovered or encountered during this excavation, they shall be protected from damage, and securely supported as directed and approved by the involved jurisdiction. Comply with Section 1918 of Penal Law of State of New York with regard to work in vicinity of combustible gas piping. Immediately report damage or injury to utility lines to Owner's Representative and involved jurisdiction. Repair or replace utility lines damaged or injured as directed and approved by the involved jurisdiction. Excavate by hand in proximity to existing underground utility lines; take extreme care when excavating around ductbanks carrying energized cable. Remove plug or cap inactive or abandoned utilities encountered during construction operations. The location of such utilities shall be noted on the record drawings. Verify "inactivity" of services with involved jurisdiction before start of work.

D. Cutting and Patching

1. Before starting work, obtain necessary permits and pay fees and charges for same. Cut paved areas as called for, perpendicular to surface and in straight saw-cut lines. Replace pavements, roadways, streets, blacktop areas, walks, disturbed by excavating operations with materials equal to adjacent pavements.

E. Methods

1. Provide for buried work in contract both inside and outside of building. Excavate to proper depth and width for installation work as called for and comply with rules set forth by New York State Department of Labor. Remove materials including masonry work, rubble, earth, brickwork, concrete, sand, debris, abandoned pipe lines, drains and sewers, rocks, boulders, and concrete, all of which is considered "earth excavation." Provide for legal disposition of excess excavated materials. Make allowance for gravel fill, sand bases, form work, floor slabs, manholes, anchor and thrust blocks, sheet piling, drainage pumps, and work space. Start excavation at rough grade and provide form work and sheet piling where required.
2. Trench excavation:
 - a. By open cut, to proper depth and grade no wider than required for placement of work and not more than 100 ft. in advance of utility being installed.
 - b. Should trench bottom be wet, unstable, and/or otherwise incapable of supporting the contract work, immediately report same to Owner' Representative. Should it be deemed unsuitable, excavate to depth as directed and back fill with gravel to trench depth, or provide concrete cradling.
 - c. Should rock be encountered, excavate 6 in. deeper and fill space between trench bottom and pipe with coarse sand, well tamped to form firm bed.

F. Shoring, bracing, sheathing:

1. In addition to governing codes, protect sides of excavations with sheeting and bracing where necessary to prevent sliding or caving of banks and to protect adjacent structures. Remove as back fill is placed.
2. Provide at locations adjacent to existing manholes, hydrants, and similar items.

G. Backfill

1. Provide bedding around piping with coarse sand from 6 in. below to 8 in. above. Apply by hand and compact under and at sides by mechanical means
2. Piping, jackets and sand bed must be inspected and tested prior to backfill of any nature. Provide necessary anchors, thrust blocks, for testing.
3. Fill remainder of trench in 12 in. layers, use ordinary fill material, except as otherwise specified. Do not use frozen material. Remove boulders, stones, broken rock, wood, bricks, blocks, and debris from fill material before backfill operation.
4. Under roadways, manholes, drives, parking areas, walks, slabs, on grade and at utility entrance to building provide backfill in 6 in. layers with gravel or crushed stone, free from organic or other unsuitable material, to grade. Thoroughly compact each layer.
5. Compaction to not less than 95% density compared to maximum laboratory tests by weight, per modified ASTM D1557-64T, latest editions, method "A" under slab on grade, roadways, drives, and other paved areas and 85% for general grading. Submit certified results of tests by an approved soil testing laboratory.

H. Paving

1. Compact each individual material layer as specified.
2. Adjust grading of finish coat to match surrounding surfaces.
3. Finished surface shall be free from depressions, footprints, or imperfections that may collect water or are clearly visible.
4. Repair and repaint of traffic control and parking lot lines to match existing.

I. Removal of water

1. Provide pumps, hoses, pipe, labor and fuel, necessary to keep excavations free of water accumulation. Maintain and operate equipment. Discharge water in manner not interfering with any trade's work and not to undermine or disturb existing or adjacent structures or land. Grade to prevent surface water from flowing into all excavations and trenches. Do not discharge dirt, backfill, debris, into sanitary or storm drainage systems.

J. Rock Excavation

1. Rock Excavation defined as:
 - a. Ledge rock requiring blasting or air hammer for removal.
 - b. Boulders in excess of 1-1/2 cu. yds. in size. Demonstrate that material in question cannot be removed with a 1-1/2 yd. backhoe or shovel.
 - c. Procedure: Should rock be encountered, remove only upon written order of the Owner's representative.
2. Measurement of rock excavation, for purpose of payment to Contractor, will be taken 1 ft. wider than ductbank, manhole, pipe or conduit being installed. No allowance made for additional rock taken out accidentally or for convenience of Contractor beyond amount required for installation of work. Rock excavation claimed must be measured each day and verified by Owner's Representative. Maintain daily accounting. No claim for extra compensation honored except through procedures outlined above.
 - a. Blasting:
 - 1) Should rock be encountered which cannot be removed with a 3/4 cu. yd. capacity power shovel without drilling and blasting, blasting shall be done by a licensed Contractor. Work shall be accomplished entirely at the Contractor's risk and he shall accept liability for resultant damage. The transportation, handling, storage, and the use of explosives shall be performed in accordance with the provisions of local and state laws and authorities having jurisdiction, and in accordance with ANSI A10.2.

K. Job completion:

1. On completion of the work, clean the entire site, remove surplus earth, large stones and debris, to off-site legal disposal. Remove tools and equipment and leave the entire area in a neat condition.
2. Rough grade to 6 in. below finished grade. Scarify subsoil to depth of 2 In. to achieve bond between topsoil and subsoil.
3. Repave, reseed and completely restore the area to the condition prior to the start of excavation and trenching work

3.2 MANHOLES, VAULTS AND HANDHOLES

- A. Locate to avoid unnecessary hazards and cause minimum interference with normal traffic flow. Locate outside traveled parts of road wherever possible.

- B. Where possible conduits entering manholes shall be splayed. Use center conduit entrances only where splaying is not possible. Refer to table 3-27 of the BICSI "Customer Outside Plant Design Manual." for options. Use the first choice wherever possible.
- C. Seal all conduits watertight after conduits or ductbanks are complete.

3.3 UNDERGROUND DUCTBANKS

- A. Where ductbanks penetrate foundation, footings or outside walls, rigid metallic conduits with expandable rubber shields shall be used.
- B. Where ducts enter manholes they shall be centered as nearly as possible to the center between roof and floor and end walls.
- C. Securely tie raceways in place to prevent floating.
- D. Pull iron-shod mandrel not more than ¼" smaller than bore of raceway to remove concrete and other obstructions. Clean raceway by drawing cylindrical brushes through duct.
- E. Provide metallic elbows where conduits rise out of ground.
- F. Provide nylon pull strings in all innerducts and individual pathways inside raceways.
- G. Seal all conduits watertight prior to backfill.
- H. Provide bushings at each conduit termination.
- I. In locations where non-metallic raceways are used, change to heavy wall metallic conduit of same internal diameter before rising out of ground; provide metallic conduit elbows at conduit rise.
- J. Place conduit in straight lines. Place direct-bury conduit tier-by-tier method, backfilling each layer to achieve proper spacing. Elbows shall have a minimum radius of 36 in. Follow proper low temperature installation procedures as recommended by PVC conduit vendor. Repair or replace all existing utilities and facilities damaged, due to ductbank installation, as part of contract.
- K. Provide a bushing at each conduit termination unless fitting at box where conduit terminates has hubs designed in such a manner to afford equivalent protection to conductors. Provide grounding type insulated bushings on all conduit sizes 1-1/4" trade size and larger, and on all feeder raceways regardless of size.

END OF SECTION 260543

SECTION 26 0573

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.

1.2 SUMMARY

- A. Coordination study shall be completed for all new breakers supplying distribution panelboards, general panelboards, and large 3 phase equipment. Coordination study shall be performed from first upstream device of new overcurrent protection device to last distribution point on new feeder/branch circuit.
- B. 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. Coordination of series-rated devices is not permitted.
 - 2. Arch flash results from coordination study shall be utilized for labeling all new work. Refer to specification section 260100 – Basic Materials and Methods.

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.
 - 1. Coordination-study input data, including completed computer program input data sheets.
 - 2. Study and Equipment Evaluation Reports.
 - 3. Coordination-Study Report.

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: An entity experienced in the application of computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.
 - 1. Professional engineer, licensed in the state where Project is located, shall be responsible for the study. All elements of the study shall be performed under the direct supervision and control of engineer.
- C. Comply with IEEE 242 for short-circuit currents and coordination time intervals.
- D. Comply with IEEE 399 for general study procedures.

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. Easy Power

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

PART 3 – EXECUTION

3.1 EXAMINATION

- A. Examine Project overcurrent protective device submittals for compliance with electrical distribution system coordination requirements and other conditions affecting performance. Devices to be coordinated are indicated on Drawings.
 - 1. Proceed with coordination study only after relevant equipment submittals have been assembled. Overcurrent protective devices that have not been submitted and approved prior to coordination study may not be used in study.

3.2 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.
 - 3. Electrical Distribution System Diagram: In hard-copy and electronic-copy formats, showing the following:
 - a. Circuit-breaker and fuse-current ratings and 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. The calculation shall be for a current immediately after initiation and for a three-phase bolted short circuit at each of the following:
 - 1. Switchgear and switchboard bus.
 - 2. Medium-voltage controller.
 - 3. Motor-control center.
 - 4. Distribution panelboard.
 - 5. Branch circuit panelboard

- B. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Include studies of system-switching configurations and alternate operations that could result in maximum fault conditions.
- C. Calculate momentary and interrupting duties on the basis of maximum available fault current.
- D. Calculations to verify interrupting ratings of overcurrent protective devices shall comply with IEEE 141 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. Medium-Voltage Circuit Breakers: IEEE C37.010.
 - 3. Low-Voltage Circuit Breakers: IEEE 1015 and IEEE C37.20.1.
 - 4. 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.
- 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. Motors served by voltages more than 600 V shall be protected according to IEEE 620.
- E. 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.
- F. 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 selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:
 - 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.
- G. Completed data sheets for setting of overcurrent protective devices.

END OF SECTION 260573

This Page Intentionally Left Blank

SECTION 260620

WIRING DEVICES

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Provide all labor, materials, tools, and equipment required for the complete installation of work called for in the Contract Documents

1.2 DESCRIPTION OF WORK

- A. This section includes minimum requirements for the following:

1. Receptacles
2. Switches
3. Plugmold
4. Extension Cord Reels
5. Coverplates

1.3 QUALITY ASSURANCE

- A. All wiring devices shall be installed neatly, and parallel with building lines. Recessed devices shall be flush with the face of the wall. Provide extension rings on outlet boxes as required. 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's Representative. Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based upon the acceptable manufacturers listed. Where "approved equal" is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to approval.

1.4 SUBMITTALS

- A. Provide product data for all wiring devices and cover plates.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Wiring devices shall be specification grade as a minimum.
- B. Wiring device color shall be ivory.
- C. Suitable for installation in a 2-1/2" deep outlet box.

D. All receptacles and switches shall be from the same manufacturer.

E. Acceptable Manufacturers:

1. Hubbell
2. Pass & Seymour/Legrand
3. Arrow Hart
4. Eaton
5. Bryant

2.2 CONVENIENCE DUPLEX RECEPTACLES

- A. 125 volt, 20 ampere, two pole, three wire, grounding, straight blade, NEMA 5-20R.
- B. Side and back wiring.
- C. 0.32" thick brass three prong power contacts and #8 brass screws
- D. Brass center rivet
- E. All brass grounding system
- F. Nylon face with glass reinforced nylon back
- G. Dielectric Voltage withstands 2,000V minimum
- H. Terminals Identified in accordance with UL 498
- I. Tamper-Resistant
- J. UL 94V-2 Flame rating
- K. Design Make: Hubbell 5362TR Series

2.3 USB CHARGING RECEPTACLES

- A. Décor Style
- B. Commercial Grade USB Charger Outlet: (2) Type-C port configurations, high power 5 Amp, 5 Volt USB output, Tamper-Resistant duplex receptacle, USB ports rated 10,000 cycles.
- C. Duplex 125 volt, 20 ampere, two pole, three wire, grounding, straight blade, NEMA 5-20R.
- D. LED indicator lamp to show USB power is available.

- E. Tamper Resistant
- F. Meets UL94 and complies with USB BC1.2
- G. Design Make: Hubbell USB20C Series

2.4 GFI RECEPTACLES

- A. 125 volt, 20 ampere, two pole, three wire, grounding, straight blade, NEMA 5-20R.
- B. LED trip/test indication
- C. Tamper Resistant
- D. Side and back wiring.
- E. Nylon face and back.
- F. 2006 UL 943 revisions including “no power to the face when miswired” and “end of life indication” when unit is no longer capable of providing GFCI protection
- G. Designed to trip at maximum 6mA leakage current to ground.
- H. Suitable for feed through protection.
- I. Design Make:
 - 1. Hubbell GFR5362TR Series (Specification Grade)

2.5 SPECIAL RECEPTACLES

- A. Terminals identified in accordance with UL 498 (X, Y, Z, white, green)
- B. H and cord clamp housing material: Black nylon
- C. Terminal material: clear polycarbonate
- D. Contact spring material: brass
- E. Dielectric Voltage withstands 2,000V minimum
- F. Include NEMA type as called for on drawings to match equipment. At a minimum the manufacturer shall have special purpose receptacles available to meet the following NEMA connection types:
 - 1. 125 volt, 20 ampere, 2 pole, 3 wire, grounding, Twist lock, NEMA L5-20R
 - 2. 125 volt, 30 ampere, 2 pole, 3 wire, grounding, Twist lock, NEMA L5-30R
 - 3. 250 volt, 20 ampere, 2 pole, 3 wire, grounding, Twist lock, NEMA L6-20R.

4. 250 volt, 50 ampere, 2 pole, 3 wire, grounding, Twist lock, NEMA L6-30R.
5. 250 volt, 20 ampere, 2 pole, 3 wire, grounding, NEMA 6-20R
6. 250 volt, 30 ampere, 2 pole, 3 wire, grounding, NEMA 6-30R
7. 125/250 volt, 50 ampere, 3 pole, 3 wire, grounding, NEMA 10-50R
8. 125/250 volt, 30 ampere, 4 pole, 4 wire, grounding, NEMA L14-30R (Dryer Receptacle). Plug configuration to match equipment furnished by equipment supplier.
9. 125/250 volt, 50 ampere, 4 pole, 4 wire, grounding, NEMA L14-50R (Range Receptacle). Plug configuration to match equipment furnished by equipment supplier

G. Design Make: Hubbell

H. Acceptable Manufacturers: Pass & Seymour, Leviton

2.6 SURGE SUPPRESSION RECEPTACLES

- A. 125 volt, 20 ampere, two pole, three wire, grounding, straight blade, NEMA 5-20R.
- B. Side and back wiring.
- C. Nylon face and back.
- D. 3 mode protection (L-L, L-G, L-N) 13000 A. per mode, each protected by three 80 joule, 150 volt metal oxide varistors.
- E. LED indicates receptacle is operational
- F. 420 volt clamping voltage.
- G. Suitable for feed through protection.
- H. Blue in color.
- I. Design Make:
 1. Hubbell 5360S Series (Specification Grade)
 2. Hubbell 8360S Series (Hospital Grade)

2.7 ISOLATED GROUND RECEPTACLES

- A. 125 volt, 20 ampere, two pole, three wire, grounding, straight blade, NEMA 5-20R.
- B. Side and back wiring.

- C. Nylon face with glass reinforced nylon back.
- D. Isolated ground stud for direct connection to the service entrance grounding system.
- E. Orange in color
- F. Design Make:
 - 1. Hubbell IG5362 SERIES (Specification Grade)
 - 2. Hubbell IG8300 Series (Hospital Grade)

2.8 CORROSION RESISTANT RECEPTACLES

- A. 125 volt, 20 ampere, two pole, three wire, grounding, straight blade, NEMA 5-20R.
- B. Side and back wiring.
- C. High impact, arc and moisture resistant melamine construction.
- D. Yellow in color.
- E. Design Make: Hubbell catalog No. 53CM61.

2.9 SWITCHES

- A. 120-277 VAC, 20 ampere rated.
- B. Side or back wired.
- C. Quiet operation.
- D. Single pole, three way, and four way as called for on the plans.
- E. Design Make:
 - 1. Single pole: Hubbell catalog no. 1221
 - 2. Three way: Hubbell catalog no. 1223
 - 3. Four way: Hubbell catalog no. 1224

2.10 KEY SWITCHES

- A. 120-277 VAC, 20 ampere rated.
- B. Locking type. Provide (1) key per switch, all keyed alike.
- C. Side or back wired.

- D. Quiet operation.
- E. Single pole, three way, and four way as called for on the plans.
- F. Design Make:
 - 1. Single pole: Hubbell catalog no. 1221L
 - 2. Three way: Hubbell catalog no. 1223L
 - 3. Four way: Hubbell catalog no. 1224L

2.11 MOMENTARY SWITCHES

- A. 120-277 VAC, 20 ampere rated.
- B. Momentary contact.
- C. 2 circuit, 3 position, “center off”.
- D. Side wired.
- E. Quiet operation.
- F. Design Make: Hubbell catalog no. 1557

2.12 PLUGMOLD

- A. Ivory finished 2-piece steel housing.
- B. 6’ strip with duplex receptacles spaced 24” O.C.
- C. Pre-wired with 2-hots, 1-neutral, 1-insulated ground.
- D. Include with required power feed connector fittings, end caps, and elbows.
- E. Include with connector clips or custom single section plugmold where required for longer length installations.
- F. Design Make: Wiremold 24S7224GBA99IV Series or Approved Equal

2.13 COVERPLATES

- A. Provide type 302 stainless steel cover plates with satin finish for general purpose flush devices.
- B. Provide utility cover plates for surface mounted devices in mechanical rooms.
- C. Provide gasketed cover plates with a hinged cover on a cast aluminum outlet box for all devices in wet areas designated “WP”.

2.14 WEATHERPROOF COVERS

- A. Impact resistant polycarbonate, NEMA 3R construction.
- B. Clear cover to view the connection of the device.
- C. UL listed as a weatherproof enclosure with the receptacle in use.
- D. Hinged, latching cover with an opening at the bottom for a cord to exit the device.
- E. Padlockable
- F. Suitable for installation of a GFI protected duplex receptacle.
- G. Design Make: Hubbell Catalog No. WP26MGP
- H. Acceptable Manufacturers:
 - 1. Hubbell
 - 2. Leviton
 - 3. Arrow Hart
 - 4. Pass & Seymour
 - 5. Bryant

PART 3 - EXECUTION

3.1 GENERAL

- A. Install devices generally where called for.
- B. Coordinate exact locations of all devices with equipment, millwork, counters, fin radiation, windows, etc. and adjust locations as required as part of this contract.
- C. Provide steel box for all devices.
- D. Install receptacles and switches vertical, with the grounding pin down, and the toggle up in the on position.
- E. Install all switches on the strike side of the door, with the edge of the outlet box approximately 3" from the door frame.
- F. Do not install devices "back to back" in the same stud cavity without prior approval of the Owner. Offset devices as required to maintain code required fire rated assemblies or provide fire-stopping assembly around adjacent devices.
- G. Provide plaster rings on all outlet boxes to permit flush installation of devices.

- H. In all wet or damp areas, provide a surface mounted cast aluminum outlet box with threaded connections, gasketed cover, and non-ferrous screws.
- I. Prior to installation and as part of the contract, relocate any device a distance of 5 feet in any direction at the request of the Owner.
- J. Size outlet boxes in accordance with the NEC, based on the number and size of wires in the box.
- K. Provide a coverplate on all devices.

3.2 EQUIPMENT MOUNTING HEIGHTS:

- A. Refer to Specification Section 260100 – Basic Materials and Methods for mounting heights.

3.3 LABELING

- A. Provide tape labels indicating panelboard and circuit on the outside of all device coverplates.

3.4 SPARE WIRING DEVICES

- A. Furnish stock of 10% but not less than (4) of the following devices
 - 1. List Devices Here.

3.5 TESTING

- A. Test all receptacles for proper voltage, polarity, and grounding.
- B. Test all GFI receptacles for proper voltage, polarity, grounding, and verify the receptacle trips at 6 milliamperes or less.
- C. Rewire receptacles as required until receptacles test properly.

END OF SECTION 260620

SECTION 260800

ELECTRICAL SYSTEMS COMMISSIONING

PART 1 - GENERAL

1.1 DESCRIPTION

- A. The purpose of this section is to specify Division 26 responsibilities in the commissioning process.
- B. The Lighting Control systems (Occupancy and Daylight Controls) is to be commissioned in association with Section 019113 and 260810.
- C. Commissioning requires the participation of Divisions 26 (Electrical) Contractor to ensure that all systems are operating in a manner consistent with the Contract Documents. The general commissioning requirements and coordination are detailed in Section 019113. Division 26 shall be familiar with all parts of Section 019113 and shall execute all commissioning responsibilities assigned to them in the Contract Documents.
- D. Division 23 commissioning will require assistance of the Division 26 (Electrical) contractor relative to components and equipment provided under this Division, such as Variable Speed Drives. This contractor shall be familiar with the Division 23 testing requirements and provide assistance to the Division 23 contractor.

1.2 RESPONSIBILITIES

- A. Electrical Contractor. The commissioning responsibilities applicable to the Electrical Contractor (EC) are described in section 019113 and 260810 of these Specifications.

PART 2 - PRODUCTS

2.1 TEST EQUIPMENT

- A. Division 26 shall provide all test equipment necessary to fulfill the testing requirements of this Division.

PART 3 - EXECUTION

3.1 SUBMITTALS

- A. Division 26 shall provide submittal documentation relative to commissioning as required in Part 1 of this Section and Section 019113.

3.2 STARTUP

- A. The Electrical Contractor shall follow the Start-up and Initial Checkout Plan. Division 26 has start-up responsibility and is required to complete systems and sub-systems so they are fully functional, meeting the design objectives of the Contract Documents. The

commissioning procedures and functional testing do not relieve or lessen this responsibility or shift that responsibility partially to the CA or Owner.

- B. Functional testing is intended to begin upon completion of the entire system. Functional testing may proceed prior to the completion of systems or sub-systems at the discretion of the CA and CM. Beginning system testing before full completion does not relieve the Contractor from fully completing the system, including all Prefunctional Checklists as soon as possible.

3.3 FUNCTIONAL PERFORMANCE TESTS

- A. Refer to section 260810 for functional testing.

3.4 TESTING DOCUMENTATION, NON-CONFORMANCE AND APPROVALS

- A. Refer to Section 019113 and 260810 for specific details on non-conformance issues relating to Pre-functional and Functional Checklists and tests.

3.5 OPERATION AND MAINTENANCE (O&M) MANUALS

- A. The following O&M Manual requirements do not replace O&M Manual documentation requirements elsewhere in these specifications.
- B. Division 26 shall compile and prepare documentation for all equipment and systems covered in Division 26 and deliver this documentation to the GC for inclusion in the O&M Manuals prior to the training of owner personnel.
- C. The CA shall receive a copy of the O&M Manuals for review.
- D. Review and Approvals. Review of the commissioning related sections of the O&M Manuals shall be made by the A/E and by the CA.

3.6 WRITTEN WORK PRODUCTS

- A. Written work products of Contractors will consist of the filled out start-up, initial checkout, and Prefunctional Checklists. The CA shall be responsible for documenting functional test results.

END OF SECTION 260800

SECTION 262116

LOW-VOLTAGE UNDERGROUND ELECTRICAL SERVICE ENTRANCE

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Provide all labor, materials, tools, and equipment required for the complete installation of work called for in the Contract Documents. The utility company is Orange and Rockland Utilities Inc.
- B. Pay all utility company fees as part of the Contract.
- C. Electrical Contractor shall include a utility allowance to pay the electrical utility in the amount of \$50,000 in their contract for the new electrical service installation. This amount shall be identified separately on the awarded contractors schedule of values. Any remaining dollars not used in this allowance to pay the electrical utility shall be credited back to the contract. Provide copy of final utility installation invoice as a shop drawing submittal for this specification section.

1.2 DESCRIPTION OF WORK

- A. This section includes minimum requirements for the following:
 - 1. New 3-phase pad mount utility transformer and meter channel and transformer concrete pad. Provide new utility metering cabinet and reinstallation of PT/CT wiring.

1.3 QUALITY ASSURANCE

- A. The Service Entrance 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's Representative and the utility company. Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based upon the acceptable manufacturers listed. Where "approved equal" is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to approval.
- B. Materials specified herein shall comply with the applicable requirements the indicated utility company and the following articles of the National Electric Code (NFPA 70):
 - 1. 250 – Grounding and Bonding
 - 2. 230 - Services
 - 3. 340 - Overcurrent Protection
 - 4. 310 - Conductors for General Wiring

1.4 SUBMITTALS

- A. Provide product data for the following:
 - 1. Utility Metering Cabinet
 - 2. Meter Channel
 - 3. Copy of final utility installation invoice
- B. Send three copies of shop drawings to the utility company for review. Include one utility company approved copy with submittals for review.

PART 2 - PRODUCTS

2.1 SECONDARY SERVICE FROM UTILITY PAD MOUNTED TRANSFORMER

- A. Electric Service Characteristics:
 - 1. 480Y/277 volts, three phase, four wire, grounded wye connected, 60 Hz.
- B. Primary Raceway Requirements:
 - 1. Provide (2) two 4" PVC Schedule 80 , direct buried conduits from utility company riser pole to pad mounted utility transformer. Coordinate exact termination requirements of conduit with the utility.
 - 2. Install primary conduit to a minimum depth of 30". Slope conduit at least 1/16" per foot towards the manhole.
 - 3. All sweeps shall be rigid steel minimum of 42" radius for 4" conduit, and 48" for 5" conduit.
 - 4. Maximum cable pulling length shall be as follows:

Pad to pole, with one 90° bend at each end	200'
Handhole to handhole	425'
Handhole to handhole with one 90° bend at the feed-in end	400'
Handhole to handhole with one 90° bend a the pulling end	225'

Provide handholes or manholes where pulling lengths are in excess of the above distances.

C. Transformer Pad:

1. Provide concrete transformer pad with curb and crushed stone as detailed on the drawings and required by the utility.
2. Locate transformer pad as shown on the site plan, a minimum of 10' from any building or overhang, and 10' from the property line.
3. Where the transformer is installed near vehicular traffic, provide schedule 40, 4" steel diameter bollards on 4' centers around the transformer perimeter. Bury post 4' in the ground, and extend minimum 42" above ground. Fill post with concrete and provide a rounded cap.
4. Install conduits in the pad such that the transformer doors will be facing the street.

D. Secondary Service Entrance Feeder:

1. Provide type and quantity of conduits from the transformer pad to the service entrance equipment as called for on the drawings.
2. Provide conductors from the utility transformer to the service entrance equipment as called for on the drawings.
3. Terminate conduit and conductors at the transformer and service entrance as required by the utility.

E. Metering:

1. All meters and metering transformers shall be furnished by the utility company and installed by the electrical contractor.
2. Install metering current transformers in the utility transformer. Provide separate meter housing cabinet adjacent to pad mounted transformer, provided structural support frame for meter housing and conduit from transformer to meter as required by local utility.

PART 3 - EXECUTION

3.1 GENERAL

- A. Coordinate new service installation with the utility prior to the bid. Make adjustments to plans as required to meet all utility requirements. Include all associated utility costs as part of the bid.

- B. Provide Burndy type YA (compression-type lugs for all secondary cable terminations at

utility transformer.

END OF SECTION 262116

SECTION 262213

LOW VOLTAGE DISTRIBUTION TRANSFORMERS

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Provide all labor, materials, tools, and equipment required for the complete installation of work called for in the Contract Documents.

1.2 DESCRIPTION OF WORK

- A. This section includes minimum requirements for the following:
 - 1. Dry Type Transformers.

1.3 QUALITY ASSURANCE

- A. All low voltage power distribution 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's Representative. Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based upon the acceptable manufacturers listed. Where "approved equal" is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to approval.
- B. Materials and installation practices specified herein shall comply with the applicable requirements of:
 - 1. The following Articles of the National Electric Code (NFPA 70)
 - a. 240 - Overcurrent Protection
 - b. 450 - Transformers
 - 2. The following National Electrical Manufacturers Association (NEMA) Standards:
 - a. NEMA ST 20-2014 – Dry Type Transformers
 - 3. The Code of Federal Regulations 10:
 - a. CFR 431 – Distribution Transformer Efficiency
 - 4. The following U.L. Standards:
 - a. UL1561 – Dry Type Transformers

1.4 SUBMITTALS

- A. Provide product data including voltage, current, interrupting rating, and enclosure type for the following:

1. Dry Type Transformers

PART 2 - PRODUCTS

2.1 DRY TYPE TRANSFORMERS

- A. Electrical specifications:

1. All insulating materials are to be rated for 220°C.
2. Transformers 15 kVA and larger shall be rated for 150°C temperature rise above 40°C ambient. Transformers under 15 kVA shall be rated for 115°C temperature rise above 40°C ambient.
3. Transformers 25 kVA and larger shall have (2) 2 ½% full capacity above normal taps and (2) 2 ½% full capacity below normal taps.
4. The maximum temperature of the top of the enclosure shall not exceed 50°C rise above a 40°C ambient.

- B. Construction:

1. Transformer coils shall be of the continuous aluminum wound construction and shall be impregnated with non-hygroscopic, thermosetting varnish.
2. All cores to be constructed with low hysteresis and eddy current losses. Magnetic flux densities are to be kept well below the saturation point to prevent core overheating. Cores for transformers greater than 500 kVA shall be clamped utilizing insulated bolts through the core laminations to provide proper pressure throughout the length of the core. The completed core and coil shall be bolted to the base of the enclosure but isolated by means of rubber vibration-absorbing mounts. There shall be no metal-to-metal contact between the core and coil and the enclosure except for a flexible safety ground strap. Sound isolation systems requiring the complete removal of all fastening devices will not be acceptable.
3. The core of the transformer shall be visibly grounded to the enclosure by means of a flexible grounding conductor sized in accordance with applicable UL and NEC standards.
4. The transformer enclosures shall be ventilated and be fabricated of heavy gauge, sheet steel construction. The enclosure shall have a baked polyester powder coat suitable for use in damp locations. Color shall be ANSI 49 gray.
5. Transformers under 30 kVA shall be wall mounted. Transformers 30 kVA and larger shall be floor mounted.

C. Minimum Efficiency:

1. Transformers shall meet the requirements for minimum efficiency as outlined in the Code of Federal Regulations 10 CFR 431.

Single-phase		Three-phase	
kVA	Min. Efficiency	kVA	Min. Efficiency
15	97.7	15	97.0
25	98.0	30	97.5
37.5	98.2	45	97.7
50	98.3	75	98.0
75	98.5	112.5	98.2
100	98.6	150	98.3
167	98.7	225	98.5
250	98.8	300	98.6
333	98.9	500	98.7
		750	98.8
		1000	98.9

D. Sound Levels:

1. Sound levels shall be warranted by the manufacturer not to exceed NEMA ST 20-2014 standards.

E. Design Make: Square D

F. Acceptable manufacturers:

1. General Electric
2. Eaton
3. Siemens

PART 3 - EXECUTION

3.1 GENERAL

- A. Provide identification for all equipment and devices as indicated in section 260100.
- B. Provide miscellaneous bolts, washers, nuts, clips, lockwashers, hardware, etc. as required to install equipment.
- C. Unload, move, handle, set in place, install, erect, assemble, connect, test etc. all items as required.
- D. Provide minimum NEC working clearance for all equipment.

- E. Verify cable/lug sizes for terminations. Where a feeder is sized larger the lug provide replacement lug or in line splice as directed by Owner's Representative.

3.2 DRY TYPE TRANSFORMERS

- A. For floor mounted transformers over 45 kVA, provide a 4" housekeeping pad.
- B. Bolt transformers to floor or pad utilizing vibration isolators.
- C. Install transformers with sufficient Code required clearances.
- D. Do not install transformers under or over panelboards per N.E.C.
- E. All conduit connections to transformers shall be made with liquidtight flexible conduit. Provide green insulated grounding conductor.
- F. Meggar transformer prior to energizing.

END OF SECTION 262213

SECTION 262400

SWITCHBOARDS AND PANELBOARDS

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Provide all labor, materials, tools, and equipment required for the complete installation of work called for in the Contract Documents.

1.2 DESCRIPTION OF WORK

- A. This section includes minimum requirements for the following:

1. Circuit Breakers
2. Branch Circuit Panelboards
3. Distribution Panelboards
4. Group Mounted Switchboard
5. Service Entrance Rated Surge Protective Device (SPD)
6. Service Entrance Power Monitor
7. Branch Panelboard Surge Protective Device (SPD)
8. Bus Ducts
9. Enclosed Circuit Breakers

1.3 QUALITY ASSURANCE

- A. All low voltage power distribution 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's Representative. Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based upon the acceptable manufacturers listed. Where "approved equal" is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to approval.
- B. Materials and installation practices specified herein shall comply with the applicable requirements of:
 1. The following Articles of the National Electric Code (NFPA 70)
 - a. 240 - Overcurrent Protection
 - b. 368 - Busways
 - c. 404 - Switches
 - d. 408 - Switchboards and Panelboards
 2. The following National Electrical Manufacturers Association (NEMA) Standards:

- a. NEMA AB 1 1993 - Molded Case Circuit Breakers and Molded Case Switches
 - b. NEMA BU 1 - Busways
 - c. NEMA PB 1 - Panelboards
 - d. NEMA PB 1.1 - Instructions for Safe Installation, Operation, and Maintenance of Panelboards Rated 600 Volts or less.
 - e. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum)
 - f. NEMA 250 - Enclosures for Electrical Equipment
3. The following American National Standards Institute (ANSI) standards:
- a. ANSI/NETA-2013 ATS for Electrical Power Equipment and Systems
 - b. ANSI/IEEE C12.1 Code for Electric Metering
4. The following U.L. Standards:
- a. UL 50 - Enclosures for Electrical Equipment
 - b. UL 67 - Panelboards
 - c. UL 98 - Enclosed and Dead-Front Switches
 - d. UL 489 - Molded Case Circuit Breakers and Circuit Breaker Enclosures
 - e. UL 857 - Underwriters Busway Standard
 - f. UL 891 - Standard for Switchboards
 - g. UL 943 - Standard for Ground Fault Circuit Interrupters

1.4 SUBMITTALS

- A. Provide product data including voltage, current, interrupting rating, and enclosure type for the following:
- 1. Thermal Magnetic Molded Case Circuit Breakers
 - 2. Electronic Trip Molded Case Circuit Breakers
 - 3. Electronic Trip Insulated Case Circuit Breakers
 - 4. Load Centers
 - 5. Branch Circuit Panelboards
 - 6. Distribution Panelboards
 - 7. Switchboards, including the following:
 - a. Dimensioned plans and elevations.
 - b. Internal and External Connection Diagrams.
 - c. Power and control wiring diagrams.
 - d. Bill of Materials
 - e. Any modifications made to the switchboard or distribution system design to accommodate manufacturer's standard equipment.
 - f. Where utility equipment is required in the switchboard, show required modifications to the switchboard, and submit drawings reviewed and approved by the utility company.
 - 8. Surge Protective Devices
 - 9. Service Entrance Power Monitor

- 10. Bus Ducts
- 11. Enclosed Circuit Breakers

1.5 MINOR MODIFICATIONS

- A. Provide modifications to circuit breaker trip rating within the frame size at no additional cost, until shop drawings are reviewed and submitted.

1.6 FIELD SUPERVISION

- A. Provide field supervision and start-up by a qualified representative of the equipment manufacturer. Provide certification that the equipment has been installed in accordance with the manufacturer's requirements.

PART 2 - PRODUCTS

2.1 CIRCUIT BREAKERS

A. General

- 1. UL 489 listed.
- 2. Molded case circuit breakers shall be constructed of a glass reinforced insulating material. All current carrying components shall be completely insulated and isolated from the outside of the circuit breaker.
- 3. Provide an over-center, trip-free handle to provide quick-make, quick-break contact action.
- 4. Provide multi-pole breakers with common trip.
- 5. When the circuit breaker has tripped, the handle shall move to a position between the "on" and "off" positions. Provide a visual indication that the circuit breaker has tripped.
- 6. The ampere rating shall be clearly marked on the face of the circuit breaker.
- 7. Series rated fuse/circuit breaker installations are not acceptable.
- 8. Make provisions to add circuit breaker handle locks.
- 9. Circuit breakers shall have voltage, ampere, and interrupting ratings as called for on the Panelboard Schedule.
- 10. New circuit breakers installed in existing panelboards shall be UL listed for use in panelboard.

B. Thermal Magnetic Molded Case Branch Circuit Breakers

- 1. Below 200Amps – Unless otherwise noted operation shall from a be fixed thermal magnetic trip unit. Permanent trip unit containing individual thermal and magnetic trip elements.
- 2. 200Amps and above - Include field adjustable electronic Long Time, Short Time, and Instantaneous trip unit.

3. 400Amps and above - Include field installed interchangeable rating plugs.
4. 60°C terminal temperature rating for circuit breakers rated 125 amperes or below.
5. 75°C terminal temperature rating for circuit breakers rated above 125 amperes.
6. All 20 and 30 ampere, single pole circuit breakers shall be UL listed for switching duty.
7. Circuit breakers shall be bolt-on. Plug-on acceptable in load centers on residential applications only.
8. Circuit breakers rated 250 amperes and below shall be UL listed HACR type.
9. Where ground fault circuit breakers are required, provide a shunt trip circuit breaker with a zero sequence sensing ground fault module.
10. Design Make: Square D QOB (250 volt), EH, EHB (480 volt), I-Line style (600 volt).
11. Acceptable Manufacturers:
 - a. Square D
 - b. Eaton
 - c. General Electric
 - d. Siemens

C. Full Function Electronic Trip Molded Case Circuit Breakers

1. Microprocessor based true RMS sensing current sensing device with accuracy to the thirteenth harmonic.
2. Sensor frame and rating plug size shall be as indicated on the Panelboard Schedule.
3. UL listed to carry 100% of the ampere rating continuously.
4. Provide the following time/current response adjustments:
 - a. Long Time Pickup
 - b. Long Time Delay
 - c. Short Time Pickup
 - d. Short Time Delay (I²t IN and I²t OUT)
 - e. Instantaneous Pickup
 - f. Ground Fault Alarm only Pickup
 - g. Ground Fault Pickup
 - h. Ground Fault Delay (I²t IN and I²t OUT)
5. Provide a means to cover the trip unit adjustments in accordance with NEC Article 240-6(b).
6. Provide trip indication for overload, short circuit, and ground fault trips.
7. Capable of being monitored remotely for circuit breaker status, phase and ground fault currents, switch settings, and trip history.
8. Tripping system shall be equipped with an externally accessible test port for use with a Universal Test Set. Disassembly of the circuit breaker shall not be required for testing.
9. Design Make: Square D LE, ME, NE, PE
10. Acceptable Manufacturers:
 - a. Square D

- b. Eaton
- c. General Electric
- d. Siemens

D. Full Function Electronic Trip Insulated Case Circuit Breakers

1. Microprocessor based true RMS sensing current sensing device with accuracy to the thirteenth harmonic.
2. Sensor frame and rating plug size shall be as indicated on the Panelboard Schedule.
3. UL listed to carry 100% of the ampere rating continuously.
4. Provide the following time/current response adjustments:
 - a. Long Time Pickup
 - b. Long Time Delay
 - c. Short Time Pickup
 - d. Short Time Delay (I_{2t} IN and I_{2t} OUT)
 - e. Instantaneous Pickup
 - f. Ground Fault Pickup
 - g. Ground Fault Delay (I_{2t} IN and I_{2t} OUT)
5. Provide a means to cover the trip unit adjustments in accordance with NEC Article 240-6(b).
6. Provide trip indication for overload, short circuit, and ground fault trips.
7. Capable of being monitored remotely for circuit breaker status, phase and ground fault currents, switch settings, and trip history.
8. Tripping system shall be equipped with an externally accessible test port for use with a Universal Test Set. Disassembly of the circuit breaker shall not be required for testing.
9. Stored energy mechanism with 5 cycle closing time to open and close the circuit breaker.
10. Local pushbutton operation to open and close the circuit breaker.
11. Visual indication of the stored energy mechanism being "charged" or "discharged".
12. Electrical operation to open, close, or charge the circuit breaker.
13. Design Make: Square D SE
14. Acceptable Manufacturers:
 - a. Square D
 - b. Eaton
 - c. General Electric
 - d. Siemens

E. Arc Mitigation and Safety Options

1. Shall be provided on all circuit breakers 600 Amps or larger.
2. Alternate Maintenance Setting Switch (AMS)
3. Designed for the temporary arc-flash incident energy reduction during maintenance activities.

4. For each feeder circuit breaker, provide a manual switch on the compartment door to switch the circuit breaker short-time tripping characteristics to instantaneous with minimum pick-up setting, in order to reduce the danger from potential arc-flash at downstream equipment.
5. Provide a lock feature for the AMS switch so that it may be locked in either the Off or On maintenance mode position.
6. Provide a blue LED indicating light to indicate AMS switch is in the maintenance mode.
7. Wire contacts on all AMS switches to a common alarm input to plant control system.
8. Provide for remote AMS switches or indication, as needed.
9. If circuit breaker integral trip unit cannot be controlled as specified, provide discrete relay with shunt-trip or equivalent to provide specified performance.

2.2 BRANCH CIRCUIT PANELBOARDS

- A. 240 Volt rated, maximum 400 amperes.
- B. Copper bus bars with high dielectric thermoplastic insulators.
- C. Provide continuous current ratings, short circuit current ratings, branch circuit breakers, main circuit breaker or main lugs, and flush or surface trims as called for on the Panelboard schedule.
- D. Provide nameplate on each panelboard indicating voltage, current, phase, wire, and short circuit rating.
- E. 100% rated neutral of the same material as the main bus.
- F. Provide ground bus of the same material as the main bus.
- G. Interior trim shall be dead front construction, with pre-formed metal twist-outs covering unused mounting space.
- H. Enclosures shall be nominal 20" wide by 6" deep, galvanized steel construction with removable endwalls and knockouts.
- I. Fronts
 1. Surface or flush mounted as called for on the Panelboard Schedule.
 2. ANSI 49 gray electrodeposited enamel.
 3. Fronts shall be one piece with door, and continuous hinge to the enclosure.
 4. Provide cylindrical tumbler type lock with catch and spring loaded stainless steel door pull. All locks shall be keyed alike to match existing panelboards.
 5. Provide a clear plastic directory card holder on the inside of the door.
- J. Design Make: Square D NQ Series

K. Acceptable Equivalents:

1. Eaton Pow-R-Line Series
2. General Electric A-Series
3. Siemens P1 Panelboard Series

2.3 480 VOLT BRANCH CIRCUIT PANELBOARDS

- A. 480 Volt rated, maximum 400 ampere main circuit breaker or 600 ampere main lugs.
- B. Copper bus bars with high dielectric thermoplastic insulators.
- C. Provide continuous current ratings, short circuit current ratings, branch circuit breakers, main circuit breaker or main lugs, and flush or surface trims as called for on the Panelboard schedule.
- D. Service entrance rated.
- E. Provide nameplate on each panelboard indicating voltage, current, phase, wire, and short circuit rating.
- F. Provide ground bus of the same material as the main bus.
- G. Interior trim shall be dead front construction, with pre-formed metal twist-outs covering unused mounting space.
- H. Enclosures shall be nominal 20" wide by 6" deep, galvanized steel construction with removable endwalls and knockouts.
- I. Fronts
 1. Surface or flush mounted as called for on the Panelboard Schedule.
 2. ANSI 49 gray electrodeposited enamel.
 3. Fronts shall be one piece with door, and continuous hinge to the enclosure.
 4. Provide cylindrical tumbler type lock with catch and spring loaded stainless steel door pull. All locks shall be keyed alike
 5. Provide a clear plastic directory card holder on the inside of the door.
- J. Design Make: Square D "NF"
- K. Acceptable Equivalents:
 1. Eaton Pow-R-Line Series
 2. General Electric AE-Series
 3. Siemens P1 Panelboard Series

2.4 DISTRIBUTION PANELBOARDS

- A. 600 Volt rated, maximum 1200 amperes.
- B. 600 ampere and smaller: Copper bus bars with high dielectric polyester insulators.
- C. Over 600 amperes: Copper bus bars with high dielectric polyester insulators.
- D. Provide continuous current ratings, short circuit current ratings, branch circuit breakers, main circuit breaker or main lugs, and flush or surface trims as called for on the Panelboard schedule.
- E. Service entrance rated.
- F. Provide nameplate on each panelboard indicating voltage, current, phase, wire, and short circuit rating.
- G. 100% rated neutral of the same material as the main bus.
- H. Provide ground bus of the same material as the main bus.
- I. Interior trim shall be dead front construction.
- J. Enclosures shall be galvanized steel construction with removable endwalls and knockouts. If design make equipment is not used, verify enclosure will fit in space allotted.
- K. Fronts
 - 1. Surface mounted.
 - 2. ANSI 49 gray electrodeposited enamel.
 - 3. Fronts shall be one piece with door, and continuous hinge to the enclosure where possible.
 - 4. Provide cylindrical tumbler type lock with three point latch. All locks shall be keyed alike
 - 5. Provide a clear plastic directory card holder on the inside of the door.
- L. Design Make: Square D I-Line Series
- M. Acceptable Equivalents:
 - 1. Eaton Pow-R-Line Series
 - 2. Siemens P4/P5 Series

2.5 GROUP MOUNTED SWITCHBOARD

- A. General:
 - 1. Locate equipment as called for on the drawings. Refer to the Power One Line Diagram for system design.
 - 2. The Contractor shall verify that any equipment submitted that is not by the

Design Make Manufacturer shall fit into the space available. Any modifications required to fit non-design make equipment shall be made at no additional cost to the Owner.

3. Any modifications made to the switchboards layout or design shall be specifically shown on the shop drawings.
4. Provide full capacity bus throughout the entire switchboard. Construct busway to allow future expansion of switchboard in all directions with physical accessibility. Entire switchboards shall be fully equipped to accept future devices, including all appropriate connectors and mounting hardware.

B. Electrical Ratings:

1. 480Y/277 volts, three phase, four wire, 60 hz.
2. Ampere rating as called for on the drawings.
3. Main bus shall be plated copper.
4. Provide full capacity, isolated, plated copper neutral bus.
5. Provide plated copper ground bus, sized per the National Electric Code. Ground bus shall run the entire length of the switchboard.
6. Braced for 65,000 amperes available fault current, or as noted on the one line diagram.

C. Construction

1. UL 891 Construction.
2. Dead Front Construction suitable for mounting against the wall
3. Front and Single side/Front only switchboard accessibility to all internal connections and removable parts.
4. Front and Rear switchboard alignment.
5. Limiting dimensions shall be 90" high x 36" deep x width as required on Contract Documents wide.
6. NEMA 1 construction for indoor installation.
7. 1 1/2" steel channels under the entire perimeter of the switchboard.
8. Steel barriers between each section of the switchboard.
9. All switchboard sections shall be bussed together.
10. All busbar joints and connections shall be plated with silver, tin or nickel. The current density at contact surfaces in busbar joints shall not exceed 200 amperes per square inch for copper and 150 amperes per square inch for aluminum. A permanent label providing torque values or tightening instructions for all busbar joints shall be affixed to each section of a switchboard. Use bolts and conical spring washers for solid connection. Tighten to manufacturer's recommendations.
11. Incoming conductors shall be conduit and cable, and shall enter at the top and bottom of the switchboard.
12. Provide all necessary transition spaces as required to accommodate the bus work.
13. Provide engraved lamicoid plastic labels for each overcurrent protective device in the switchboard.
14. Provide manufacturer's standard paint finish.

D. Electrical Characteristics:

1. Service Entrance Rated. Provide removable neutral to ground link.
2. Provide long barrel, NEMA two hole compression terminal lugs for all cables terminated at the busway. Size lugs for cables terminated.
3. Provide main overcurrent protective devices as called for on the Switchboard Schedule.
4. Where no main overcurrent protective devices are called for, the switchboard shall be equipped with no more than six overcurrent protective devices that disconnect power to all loads in the building. Clearly label each device as a service entrance disconnecting means.

E. Non-Utility Metering

1. Provide circuit monitors and instrument transformers as called for in this specification section. Install circuit monitor semi-flush mounted in the front of the switchboard. Bring all circuit monitor and instrument transformer leads to a terminal strip mounted in the switchboard.

F. Distribution Section

1. Group mounted molded case circuit breakers.
2. All sections bus connected.
3. Steel barriers between all distribution sections.
4. All space for future overcurrent protective device shall be equipped with all necessary mounting hardware and connectors.

G. Design Make: Square D QED 2 Series

H. Acceptable Equivalents:

1. Eaton Pow-R-Line Switchboard
2. Siemens SB2 Switchboard

2.6 SERVICE ENTRANCE RATED SURGE PROTECTIVE DEVICE (SPD)

- A. This unitary surge suppressor unit shall UL listed for non-linear loads and shall be capable of the following:
1. Rated for use with non-linear loads.
 2. High-energy transient voltage surge suppression.
 3. Surge current diversion.
 4. High frequency electrical line noise attenuation and line control.
 5. Capable of mounting and protection both service entrance panels and branch panels or equipment.
- B. Operating voltage shall be as indicated on the drawings. The maximum continuous operating voltage shall not be less than 125% for 120 volt systems, and 115% for 208,

240, 277, and 480 volt systems.

C. 240,000 Amps of surge current per phase.

D. Protection modes:

Mode	Single Pulse Surge Current Ampacity Per Mode
Line – to – Neutral	160,000A
Line – to – Ground	160,000A
Neutral – to – Ground	160,000A
Line – to – Line	160,000A
Per Phase	240,000A

E. Noise Attenuation:

100 kHz	50 dB
1 MHz	51 dB
10 MHz	47 dB
100 MHz	39 dB

F. The performance ratings shall be UL 1449 fourth edition listed suppression ratings.

G. The suppression/filter system shall be provided in a NEMA 1 enclosure and surface mounted with a chase-nipple or integral connection to the Main Distribution Panel.

H. Include with a surge counting display on the cover.

I. The suppression/filter system shall have the following characteristics:

1. A solid-state high performance suppression system, utilizing arrays of fused non-linear voltage dependent metal oxide varistors. The suppressions system's components shall share surge currents in a seamless, low stress manner for maximum performance and reliability.
2. A UL 1283 approved high frequency extended range tracking filter for reduction of fast rise-time, high frequency transients and line noise.
3. Provide with audible alarm w/ silence switch and indicating lights for all three phases.
4. Mounted in parallel with the supply power system. Disconnect shall be integral to the device enclosure. Fuses or breaker for the surge protection enclosure shall be sized as recommended by the system manufacturer.
5. Design Make: Square D SurgeLogic

J. Acceptable Equivalents:

1. Eaton
2. Emerson

2.7 SERVICE ENTRANCE POWER MONITOR

- A. The service entrance power meter shall be used for basic power monitoring of the building electrical service.
- B. The monitor shall be installed ahead of any branch devices or main distribution panels. It shall be designed to mount in the same enclosure section as the main circuit breaker without requiring a separate switchgear section for CTs.
- C. Current Transformers
 - 1. Provide required quantity of split-core hinged current transformers for each 3-phase, 4-wire power monitoring and metering location called for on the drawings and in this section.
 - 2. The CTs turn ratio shall be calculated to provide a maximum current output that matches input limitations of the metering device.
 - 3. All CTs shall be approved by the system manufacturer and meet the readout accuracy requirements listed in this section.
- D. The monitor shall be capable of providing the following power measurements:
 - 1. THD & Frequency
 - 2. Voltage Phase to Phase and Phase to Neutral
 - 3. Amperage Phase to Phase and Phase to Neutral
 - 4. Minimum and Maximum:
 - a. Voltage and Current
 - b. Frequency
 - c. Power Factor
 - d. kW and kVAR
 - 5. Real and Reactive Energy (kW/kVAR)
- E. External RS-485 data acquisition port and 80kB internal memory
- F. 128 samples per. cycle with 31st harmonic and 12.16 ANSI class reading accuracy.
- G. High definition LCD display
- H. Control power voltage range: 90-457 VAC
- I. Design Make: Square D Powerlogic PM850
- J. Acceptable Equivalents:
 - 1. Electro Industries Shark 200
 - 2. Eaton
 - 3. Siemens

2.8 ENCLOSED CIRCUIT BREAKERS

- A. Circuit breakers shall be as specified above.
- B. Ratings as indicated on plans and as required by the installation.
- C. Short Circuit Withstand ratings of the assembly shall be equal to that of the circuit breaker.
- D. Provide NEMA rated enclosure as called for on the drawings, and as required by the environment.
- E. Externally operable handle, with provisions for padlocking in the OFF and On position.
- F. Gray baked enamel finish except for stainless steel, NEMA 4X enclosures.
- G. Knockouts at the top and bottom of NEMA 1 enclosures.
- H. Design Make: Square D
- I. Acceptable Manufacturers:
 - 1. Square D
 - 2. Eaton
 - 3. General Electric
 - 4. Siemens

PART 3 - EXECUTION

3.1 GENERAL

- A. Provide identification for all equipment and devices as indicated in section 260100.
- B. Provide miscellaneous bolts, washers, nuts, clips, lockwashers, hardware, etc. as required to install equipment.
- C. Unload, move, handle, set in place, install, erect, assemble, connect, test etc. all items as required.
- D. Provide minimum NEC working clearance for all equipment.
- E. Verify cable/lug sizes for terminations. Where a feeder is sized larger the lug provide replacement lug or in line splice as directed by Owner's Representative.
- F. Provide testing in accordance with ANSI/NETA-2013 ATS for Electrical Power Equipment and Systems.

3.2 CIRCUIT BREAKERS

- A. Install circuit breakers in panelboards and switchboards as called for on the plans and as recommended by the manufacturer.
- B. Adjust circuit breaker pick-up level and time delay settings to the values called for on the drawings indicated in the coordination study designated by the Engineer.
- C. Submit documentation that a qualified representative from the equipment manufacturer has inspected and approved the installation.

3.3 BRANCH CIRCUIT AND DISTRIBUTION PANELBOARDS

- A. Securely support all panelboard enclosures to walls. Install true and level.
- B. Install panelboards with top of the highest circuit breaker handle at 6'-6" to the centerline.
- C. Provide (5) five empty $\frac{3}{4}$ " conduits and (1) one empty 1 $\frac{1}{2}$ " conduit from each flush mounted panelboard backbox to the accessible ceiling space. Make 90° turn above the ceiling, arranged for further continuation of raceway, and cap.
- D. Make all branch circuit and feeder connections.
- E. Provide channel support between the wall and backbox for panelboards installed on outside walls.
- F. Tighten all bolt and lug connections using a torque wrench or screwdriver per the manufacturer's recommendations.
- G. Measure steady state load currents on each panelboard feeder. Rearrange branch circuits in the panelboard to balance the load within 20% of each other. Maintain proper phasing.
- H. Provide identification as required per section 260100.

3.4 SWITCHBOARDS

- A. Verify equipment location before ordering or installing switchboards.
- B. Provide a 4" high concrete pad as follows:
 - 1. Constructed of 3000 psi concrete.
 - 2. Pad shall extend 4" beyond all sides of the switchboard, except in the back for switchboards mounted tight against the wall.
 - 3. Provide 6" x 6" #4 welded wire mesh.
 - 4. Securely bond pad to floor by roughing the floor and coating with cement grout.
- C. Provide a drip pan above the switchboard wherever exposed piping is present. Provide a

1 ¼" copper pipe from the pan to the floor drain.

- D. Provide grounding bushings at all conduits terminating at the switchboard.
- E. Provide all power and control wiring as required.
- F. Provide copper color-coded control wire with crimp spade to screw terminals for all control wiring. Wire shall be UL listed for switchboard use.
- G. Paint all nicks, scratches, unpainted bolt heads, etc., with two coats of paint.
- H. Prior to energizing, thoroughly clean the switchboard, insulators and bus.
- I. Prior to energizing, obtain the services of a qualified manufacturer's representative to test the switchboard for correct installation.
- J. Provide identification as required per Section 260100.

3.5 SPD UNITS

- A. Provide circuit breaker over current protection or internal fused protection of unit per manufacturer requirements.
- B. Input leads for each phase, ground, and neutral may not exceed 3-feet in length from bus tap location to unit lug terminations.
- C. Provide minimum of #4awg wiring for all input leads.

3.6 SERVICE ENTRANCE POWER MONITOR

- A. Provide manufacturer startup and commissioning of the complete power monitoring system after installation of all components. The manufacturer representative for the system shall return to the site as many times as required until all systems and components are fully operational. The electrical contractor is responsible for coordinating all training and system commissioning of the system with the owners representative and the manufacturer representative.
- B. Provide potential transformers for monitoring and metering devices requiring a different control power voltage than the connected bus voltage.
- C. The electrical contractor shall be responsible for all PT and CT installation locations and over-current protection. Locations shown on the drawings reference the tenant load to be metered only. Provide separate enclosures to house the CTs if they do not fit in the indicated load panel or enclosed breaker.
- D. Tie wrap and neatly arrange all PT and CT wiring inside electrical enclosures. Provide one piece lengths of control wiring from the CTs its corresponding meter, splices in the CT wiring is not acceptable unless approved by the manufacturer.

- E. Provide all required wiring as recommended by the manufacturer. Wiring includes but is not limited to:
 - 1. RS-485 twisted shielded 2-pair 22 AWG network wiring to the DDC system panel for that building.
- F. Provide EMT conduit for all RS-485, Ethernet, and twisted control wiring from CTs and remote meters back to the main data recorder. Label all corresponding junction boxes with the following wording "Metering".
- G. Meet with owner's representative and provide original system configuration. Provide all required programming and software configuration for the owner to be read and record, the monthly kWh and peak kW.
- H. Where external circuit connections are required, terminal blocks shall be provided and the manufacturer's drawings shall clearly identify the interconnection requirements including wire type to be used.
- I. All wiring required to externally connect equipment lineups shall be installed by the Electrical Contractor.
- J. Provide (1) hours of training on the complete system operation and programming to the owner selected staff members. Training shall be done by manufacturer representative of the metering equipment.

3.7 ENCLOSED CIRCUIT BREAKERS

- A. Install enclosed circuit breakers in locations shown on plans. Install true and level.
- B. Tighten all bolt and lug connections using a torque wrench or screwdriver per the manufacturer's recommendations.
- C. Provide identification as required per section 260100.

END OF SECTION 262400

SECTION 262913

SWITCHES, CONTACTORS AND MOTOR CONTROLLERS

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Provide all labor, materials, tools, and equipment required for the complete installation of work called for in the Contract Documents.

1.2 DESCRIPTION OF WORK

- A. This section includes minimum requirements for the following:

1. Disconnect Switches
2. Lighting Contactors
3. Motor Control Equipment
4. Low Voltage Fuses

1.3 QUALITY ASSURANCE

- A. All low voltage power distribution 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's Representative. Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based upon the acceptable manufacturers listed. Where "approved equal" is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to approval.
- B. Materials and installation practices specified herein shall comply with the applicable requirements of:
 1. The following Articles of the National Electric Code (NFPA 70)
 - a. 240 - Overcurrent Protection
 - b. 404 – Switches
 - c. 430 – Motors, Motor Circuits, and Motor Controllers
 2. The following National Electrical Manufacturers Association (NEMA) Standards:
 - a. NEMA AB 1 1993 - Molded Case Circuit Breakers and Molded Case Switches

- b. NEMA PB 1.1 - Instructions for Safe Installation, Operation, and Maintenance of Panelboards Rated 600 Volts or less.
 - c. NEMA KS 1 - Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum)
 - d. NEMA 250 - Enclosures for Electrical Equipment
- 3. The following American National Standards Institute (ANSI) standards:
 - a. ANSI/IEEE C12.1 Code for Electric Metering
- 4. The following U.L. Standards:
 - a. UL 50 - Enclosures for Electrical Equipment
 - b. UL 98 - Enclosed and Dead-Front Switches

1.4 SUBMITTALS

- A. Provide product data including voltage, current, interrupting rating, and enclosure type for the following:
 - 1. Disconnect Switches
 - 2. Lighting Contactors
 - 3. Motor Control Equipment
 - 4. Low Voltage Fuses

1.5 MINOR MODIFICATIONS

- A. Provide modifications to fuse sizes within the frame size at no additional cost, until shop drawings are reviewed and submitted.

1.6 FIELD SUPERVISION

- A. Provide field supervision and start-up by a qualified representative of the equipment manufacturer. Provide certification that the equipment has been installed in accordance with the manufacturer's requirements.

PART 2 - PRODUCTS

2.1 DISCONNECT SWITCHES

- A. Three pole, single throw, or as called for on the drawings.
- B. Quick-make, quick-break switch operating mechanism.

- C. Heavy-duty, current rating as called for on the drawings, voltage rating as required by the equipment served.
- D. All current carrying parts shall be plated to resist corrosion.
- E. Lugs shall be removable and rated for 75°C temperature rating.
- F. Switch blades shall be visible when the switch is in the open position and the door is open.
- G. Switch shall be padlockable in the OFF and ON positions.
- H. Provide fusible switches with rejection type fuse holders and fuses as indicated on the plans or as per fed equipment requirements.
- I. Provisions for a field installable electrical interlock contacts on disconnect handle. Provide with electrical interlock contacts on handle on elevator disconnects serving elevators with battery lower option.
- J. Provide external override mechanism to open the disconnect switch door without opening the disconnect switch.
- K. Enclosure shall be steel with gray baked enamel paint.
- L. Provide NEMA type enclosures as called for on the drawings.
- M. NEMA type 1 enclosures shall be equipped with knockouts.
- N. Design Make: Square D
- O. Acceptable Manufacturers:
 - 1. General Electric
 - 2. Cutler Hammer
 - 3. Siemens ITE

2.2 MOTOR CONTROL EQUIPMENT

- A. General
 - 1. Provide motor starters, disconnect switches, etc., as listed on the Electric Equipment and Control Schedule on the drawings.
 - 2. Starters, contactors and controllers shall comply with NEMA standards having general purpose NEMA 1 or 1B enclosure unless otherwise called for. Provide explosion proof, weather resistant or watertight construction as required. Starters shall be minimum NEMA size 0 with overloads in each phase sized per NEC,

nameplate motor full load amperage, service factor, and motor operating conditions.

3. Pad lock arrangements shall be provided to lock the disconnect device in the "off" position. Magnetic starters shall be provided with a control power transformer with 120V secondary and primary and secondary fusing and be sized to accept the loads imposed there on. Starters shall have transformer type pilot lights and 6 volt long life bulbs. Each starter subject to electrical interlock and/or automatic control shall have necessary auxiliary contacts.
4. Auxiliary devices: Provide pushbutton stations, pilot lights, devices, relays, transformers, selector switches, electric thermostats, auxiliary starter contacts as required for functions called for. Provide separate relay for each speed to operate electric dampers or other devices as required for multispeed motor circuit.
5. Manual Motor Starter: Provide all starters with thermal overload(s); and pilot light(s), and handle lock-out provisions. Gang starter with selector switch for multispeed applications. Provide single or 2-pole as required:
 - a. 120 volt, single-pole, surface mounted: Square-D FG-1P.
 - b. 120 volt, single-pole, flush mounted: Square-D FS-1P.
 - c. 240 volt, two-pole, surface mounted: Square-D FG-2P.
 - d. 240 volt, two-pole, flush mounted: Square-D FS-2P.
 - e. 120 volt, single-pole, two speed, surface mounted: Square-D FG-11P.
 - f. 120 volt, single-pole, two speed, flush mounted: Square-D FS-101P.
 - g. 240 volt, two-pole, two-speed, surface mounted: Square-D FG-22P.
 - h. 240 volt, two-pole, two-speed, flush mounted: Square-D FS-202P.
 - i. 120 volt, single-pole, H-O-A selector, surface mounted: Square-D FG-72P.
 - j. 120 volt, single-pole, H-O-A selector, flush mounted: Square-D FS-72P.
 - k. 240 volt, two-pole, H-O-A selector, surface mounted: Square-D FG-72P.
 - l. 240 volt, two-pole, H-O-A selector, flush mounted: Square-D FS-72P.
 - m. 120 volt, single-pole, surface mounted, explosion proof: Square-D FR-1H.

- n. 240 volt, two-pole, surface mounted, explosion proof: Square-D FR-2H.
 - o. Manual Motor Starter - Speed Controller: Shall be similar to "Manual Motor Starter", above, except two-gang with motor speed control sized to handle motor indicated, with positive full on and full off bypass of speed control unit.
- 6. Manual Starter with Relay: Shall be similar to "Manual Motor Starter", above, except two-gang with relay sized for load indicated, and hand-off-automatic switch. Connect relay for 120V operation on load side of starter in "automatic" mode. Coordinate connection of Form C maintained contact for control with Mechanical Contractor.
- B. Magnetic Starters
 - 1. Shall be single-speed, across-the-line type rated in accordance with NEMA standards, sizes and horsepower ratings.
 - 2. Starters shall be mounted in NEMA 1 enclosures unless otherwise indicated.
 - 3. Magnetic starters shall be equipped with double break silver alloy contacts; all contacts shall be replaceable without removing starter or disconnecting power wiring.
 - 4. Starter shall have straight-through wiring. Coils shall be of molded construction and shall be replaceable from the front without removing starter.
 - 5. Overload relays shall be melting alloy type with replaceable control circuit module. Thermal units shall be of one-piece construction and interchangeable. Starter shall be inoperative if thermal unit is removed.
 - 6. Provide hand-off-auto selector switch, start-stop pushbuttons and "run" pilot light in cover. Wire for maintained contact unless otherwise noted.
- C. Combination Magnetic Starter: Shall be similar to "Magnetic Starter", above, except shall include fusible disconnect switch connected ahead of starter. The disconnect handle shall be in control of the disconnect device with the door open or closed. Disconnect handle shall be clearly marked as to whether the disconnect device is "on" or "off".
- D. Combination Two-Speed Magnetic Starter: Shall be similar to "Combination Magnetic Starter", above, except with two starters, and six thermal overload units coordinated to match torque and horsepower characteristics of the motor. Starter shall be designed for variable torque operation, and shall be provided with high-low-off-auto selector switch and high and low pilot lights mounted in the cover. Wire for maintained contact unless otherwise noted.
- E. Combination Reduced Voltage Magnetic Starter: Shall be similar to "Combination Magnetic Starter", above, except auto-transformer closed transition reduced voltage type

with auto-transformer protection by winding over-temperature device.

- F. Packaged Control Unit: Shall be furnished under Division 22 or 23, and connected by Electrical Contractor. Generally consists of one or more starters, disconnect switches and additional control devices prewired.
- G. Contactor: Shall be similar to "Magnetic Starter", above, except without thermal overload units.
- H. Acceptable manufacturers:
 - 1. Square D
 - 2. Siemens
 - 3. General Electric
 - 4. Eaton

2.3 LIGHTING CONTACTORS

- A. 480V rated contacts, minimum of 30A or larger rating as called for on the drawings.
- B. Electrically operated, electrically held
- C. Provide with 120V coil
- D. Provide with NEMA 1 enclosure or enclosure type if specified otherwise on drawings.
- E. Provide with number of poles as called for on the drawings
- F. Shall be field convertible for NO/NC operation
- G. Design Make: Square D Class 8903
- H. Acceptable manufacturers:
 - 1. Siemens
 - 2. General Electric
 - 3. Eaton

2.4 LOW VOLTAGE FUSES

- A. All fuses rated 600 volts and below shall be rejection type dual-element, time-delay type. Provide one complete sets of fuses for all fusible disconnect switches, plus 3 spare fuses of each size. Deliver spare fuses to the Owner and obtain receipt.

- B. Acceptable manufacturers: Fuses 600 amperes and below: Bussman Type FRN-R (300 volts), Type FRS-R (600 volts) or Approved Equal.

PART 3 - EXECUTION

3.1 GENERAL

- A. Provide identification for all equipment and devices as indicated in section 260100.
- B. Provide miscellaneous bolts, washers, nuts, clips, lockwashers, hardware, etc. as required to install equipment.
- C. Unload, move, handle, set in place, install, erect, assemble, connect, test etc. all items as required.
- D. Provide minimum NEC working clearance for all equipment.
- E. Verify cable/lug sizes for terminations. Where a feeder is sized larger the lug provide replacement lug or in line splice as directed by Owner's Representative.

3.2 DISCONNECT SWITCHES

- A. Install disconnect switches in locations shown on plans. Install true and level.
- B. Tighten all bolt and lug connections using a torque wrench or screwdriver per the manufacturer's recommendations.
- C. Provide identification as required per Section 260100.
- D. Provide fuses in all fusible switches.

3.3 LOW VOLTAGE FUSES

- A. Install low voltage fuses in disconnect switches as called for on the plans.
- B. Turn all spare fuses over to the Owner and obtain receipt.

3.4 MOTOR CONTROL EQUIPMENT

- A. Provide overload and fuses. Coordinate sizes with division 22 or 23 contractor.
- B. Terminate control wiring. Coordinate with division 22 or 23 contractor.
- C. Prior to releasing the starter and disconnect order the division 26 contractor shall obtain verification in writing from the division 22 and 23 contractors that all starter and disconnect sizes and types are correct. The division 26 contractor shall bear all cost if written approval is not obtained prior to releasing the order and size changes are required.

END OF SECTION 262913

SECTION 262923

VARIABLE FREQUENCY DRIVES

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Provide all labor, materials, tools, and equipment required for the complete installation of work called for in the Contract Documents.
- B. All Variable Frequency Drives will be furnished and installed by the Electrical contractor. The Electrical contractor shall provide all internal control wiring jumpers, communication card installation and network settings communicate with the temperature control system, overload settings, and factory startup.
- C. The division 22 and 23 contractors will furnish all adjustments and programming temperature controls system settings and sequences.

1.2 DESCRIPTION OF WORK

- A. This section includes minimum requirements for variable speed motor controls referred to as Variable Frequency Drives (VFD), also known as Variable Speed Drives (VSD).

1.3 QUALITY ASSURANCE

- A. All variable frequency AC drives 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's Representative. Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based upon the acceptable manufacturers listed. Where "approved equal" is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to approval.
- B. Each drive shall be subjected to the following test and quality control procedures.
 - 1. Each new product design shall undergo a 4000-hour pre-production burn-in test. A minimum of ten units shall be used to accumulate this entire time. Each unit shall be temperature cycled between 32 and 100 degrees Fahrenheit.
 - 2. Every VFD shall be functionally tested under motor load. During this load test the VFD shall be monitored for correct phase current, phase voltages, and motor speed. Correct Current Limit operation shall be verified by simulating a motor overload. Manufacturing test data on each drive shall be recorded and stored by the manufacturer.
 - 3. Verification of proper factory presets shall performed on 100% of all parameters to ensure proper microprocessor settings. Verification that the proper factory settings are loaded correctly in the drive shall be done via the drive serial interface port. Any parameter changes that are required after the addition of

options such as communication cards or bypass shall be verified in addition to the drive only defaults.

4. All options shall be functionally tested including operation of a motor in the bypass mode if supplied. Proper sizing and adjustment of the integral motor overload shall be set and verified.

1.4 CODES AND STANDARDS

- A. Materials and installation practices specified herein shall comply with the applicable requirements of:
 1. All applicable Articles of the National Electric Code (NFPA 70) including the following:
 - a. 430 – Motors, Motor Circuits, and Controllers
 2. All applicable Standards of the National Electrical Manufacturers Association (NEMA) including the following:
 - a. NEMA 250 - Enclosures for Electrical Equipment
 - b. NEMA ICS 7 - Adjustable Speed Drives
 - c. NEMA ICS 7.1 - Safety Standards for Construction and Guide for Selection, Installation, and Operation of Adjustable Speed Drive Systems
 3. All applicable Underwriters laboratories (U.L.) Standards including the following:
 - a. UL-50 - Enclosures for Electrical Equipment
 - b. UL-1995 – Approved for mounting in plenums and compartments handling conditioned air.
 - c. UL-508C – Industrial Control Equipment
 4. IEEE 519-2014
 5. FCC Part 15 Subpart J
 6. CE (EN/IEC 61800-3, Low voltage EN60204-1/EN50178). Drive shall meet product standard EN61800-3 for the First Environment restricted level (Category C2).
 7. IBC 2015 Seismic – Referencing ASC 7-05 and ICC AC-156
 8. Manufacturing facility shall be ISO certified and audited yearly to ensure product quality.

1.5 SUBMITTALS

A. Provide a summary list of all VFD's with the following information:

1. Bill of materials
2. Dimension drawings
3. Wiring diagrams
4. Product data sheets including:
 - a. Integrated Electrical Protection
 - b. Agency Certifications
 - c. Environmental tolerances
 - d. Electrical Characteristics
 - e. Enclosure material and rating
 - f. Control (Inputs, Outputs, Power Supplies)
 - g. Motor Lead length @ 8 KHz Carrier Frequency
5. List of all operator interface devices
6. List of any exceptions to this specification

1.6 START-UP SERVICE AND TRAINING

- A. VFD's shall not be powered up without authorization from the VFD manufacturer. The contractor shall notify the VFD manufacturer when the units have been installed and shall schedule startup by a factory trained and authorized technician. This technician shall complete a startup report that records all VFD data, settings and a checklist of tests and observations. A copy of this test report shall be forwarded to the project Commissioning Authority and included in the Operation and Maintenance Manual.
- B. The VFD factory trained and authorized technician shall make all final adjustments as required for proper operation. Coordinate with the mechanical contractor and equipment vendors as required.
- C. Provide one 2-hour training session on site by a VFD factory trained and authorized technician. This session shall review all operation and maintenance requirements plus the fundamentals of VFD's and their application to AC motors.

1.7 OPERATION AND MAINTENANCE MANUALS

- A. Provide one copy of complete documentation for each type of variable frequency drive installed. Documentation shall be bound and included in the Operation and Maintenance Manuals required in this Specification. Documentation shall include the following:

1. Wiring diagrams
2. Schematics
3. Operating and maintenance manuals
4. Local service representative
5. Emergency on sight technical support information
6. Recommended maintenance procedures
7. Recommended spare parts list

PART 2 - PRODUCTS

2.1 VARIABLE FREQUENCY DRIVE

A. General

1. The VFD shall convert three-phase utility power to adjustable frequency, three-phase, AC power for motor speed control on variable torque loads with NEMA design B motors. All general options and modifications shall be included with the standard variable frequency controller in a single UL listed assembly and supplied by a single manufacturer.
2. The variable frequency controller shall include metal oxide varistors for transient voltage suppression to allow reliable operation on a typical industrial or commercial power distribution system. The VFD shall operate satisfactorily when other VFD's are operated from the same bus. The base VFD shall be UL listed for 100 kA SCCR without the need for external input fuses. Optional power line fusing shall be rated 200,000 AIC.

B. Basic Description

1. The VFD shall produce an adjustable AC voltage / frequency output. It shall be of the pulse-Width Modulated (PWM) technology and shall consist of a full-wave diode bridge converter to convert incoming AC utility power to DC power, a capacitor filter/storage network and an inverter power transistor switching output section. The microprocessor controller generating inverter output shall include the internal base driver and specified protection and sensing circuits. The VFD waveform generator shall be IGBT based and capable of extended carrier frequency operation.
2. The VFD shall switch its output waveform with an adjustable carrier frequency from a minimum of 1.5 kHz for maximum efficiency, through at least 8 kHz for quiet operation without requiring derating of the VFD. The carrier frequency shall not be set lower than 8 kHz without prior approval.
3. The VFD shall include a carrier frequency control circuit that automatically reduces the carrier frequency based on actual VFD temperature to allow use of

higher carrier frequency settings without derating the VFD.

4. The VFD's nameplated horsepower shall be fully rated at 8kHz carrier frequency with a minimum motor lead length of 200 feet.
5. The VFD shall have a continuous output current rating of 100% motor nameplate current, with an overload rating of 110% VFD nameplate rating for 1 minute. The VFD PWM output shall not induce excessive power losses in the motor. The VFD shall continue to operate without faulting from a line of + 30% to -35% of nominal voltage.
6. The VFD shall include an AC transient surge protection system of MOV's (125 joule minimum rating), capacitor clamp, diode bridge and internal chokes. VFD's that do not include this level of transient surge protection shall include an external suppression system of equal function.
7. The VFD shall have an integral electronic overload circuit designed to protect an AC motor operated by the VFD output from extended overload operation on an inverse time basis. This Electronic overload shall be UL and NEC recognized as adequate motor protection. No additional hardware such as motor overload relays or motor thermostats shall be required.
8. VFD shall be capable of continuous full load operation under the following environmental conditions:
 - a. 5 to 104°F ambient temperature. Operation up to 122°F shall be allowed at a 10% reduction from VFD full load current
 - b. Altitude 0-3300 ft. Operation to 6600 ft shall be allowed with a 10% reduction in VFD full load current
 - c. Humidity less than 95% condensing.

C. Control Features

1. The operator interface keypad of each VFD shall include an alphanumeric readout for all drive functions on a 32-character, backlit, LCD display. The backlit LCD alphanumeric digital readout shall present all diagnostic messages and parameter values in English with standard engineering units. Codes are not acceptable. At a minimum, the operator interface keypad shall be able to display all of the following drive functions:
 - a. Frequency output
 - b. Voltage output
 - c. Current output
 - d. Motor RPM
 - e. Motor kW

- f. Elapsed Time
 - g. Time Stamped Fault Indication
 - h. DC Bus Volts
 - i. Faults
 - j. Parameter settings
2. The operator interface keypad shall be capable of controlling the VFD and setting drive parameters. The keypad shall include a “HAND-OFF-AUTO”, “SPEED SOURCE” selector and “PROGRAM-RUN” push buttons. The Hand-Off-Auto function shall be coordinated with any remote Hand-Off-Auto switch, such that stopping and restarting at the VFD remains possible, but only according to the remote setting. Available speed source selection shall include manual adjustment, automatic (4-20mA, 0-10 VDC, floating point, or Serial Communication), and preset speeds.
 3. The VFD shall be software programmable to provide automatic restart after a fault trip condition resulting from overcurrent, overvoltage, undervoltage, or automatic reset/restart function is not successful within the programmed number of restart attempts. During the automatic restart attempts the LCD display shall show the warning, “START PENDING”.
 4. An overcurrent speed reduction shall be activated to avoid tripping the drive during transient overloads. The drive shall return to set speed after the overload is removed. If the acceleration or deceleration rate is too rapid for the connected load, the drive shall automatically compensate to prevent a fault trip.
 5. The VFD’s shall utilize pre-programmed application macros specifically designed to facilitate start-up. The Application Macros shall provide one command to reprogram all parameters and customer interfaces for a particular application
 6. The VFD shall be capable of starting into a coasting load (forward or reverse) up to full speed and accelerate or decelerate to setpoint without tripping or component damage (flying start).
 7. VFD shall provide a programmable loss-of-load (broken belt / broken coupling) Form-C relay output. The drive shall be programmable to signal the loss-of-load condition via a keypad warning, Form-C relay output, and / or over the serial communications bus. The loss-of-load condition sensing algorithm shall include a programmable time delay that will allow for motor acceleration from zero speed without signaling a false loss-of-load condition.
 8. There shall be a run permissive circuit for damper or valve control. Regardless of the source of a run command (keypad, input contact closure, time-clock control, or serial communications), the VFD shall provide a dry contact closure that will signal the damper / valve to open (VFD motor does not operate). When

the damper / valve is fully open, a normally open dry contact (end-switch) shall close. The closed end-switch is wired to a VFD digital input and allows VFD motor operation. Two separate safety interlock inputs shall be provided. When either safety is opened, the motor shall be commanded to coast to stop and the damper shall be commanded to close. The keypad shall display “start enable 1 (or 2) missing”. The safety input status shall also be transmitted over the serial communications bus.

9. VFD control shall include a programmable time delay for VFD start and a keypad indication that this time delay is active. A Form C relay output provides a contact closure to signal a damper / VAV boxes (etc.) open. This will allow the equipment to be driven open before the motor operates. The time delay shall be field programmable from 0 – 120 seconds. Start delay shall be active regardless of the start command source (keypad command, input contact closure, time-clock control, or serial communications), and when switching from drive to bypass.
10. Two (2) PID Set point controllers shall be standard in the drive, allowing pressure or flow signals to be connected to the VFD, using the microprocessor in the VFD for the closed-loop control. The PID set point shall be adjustable from the VFD keypad, analog inputs, or over the communications bus.

D. Protective Circuits And Features

1. The VFD shall include the following protective circuits and features:
 - a. Inverse time electronic overload protection of 110% for 60 seconds, and 150% for 3 seconds.
 - b. Output phase-to-phase short circuit condition
 - c. Total ground fault under any operating condition.
 - d. Input line overvoltage
 - e. Input line undervoltage
 - f. Loss of input or output phase
 - g. External fault connection:
 - 1) Function Loss that will cause a drive fault and require control system to reset prior to returning to ready condition. This function will always be active even during a Purge (This protective circuit shall permit wiring of remote N.C. safety contacts to shut down the drive as required). User supplied end switches, thermal switches, fire-stats, freeze-stats inputs will be connected to this VFD supplied circuit.
 - h. Purge function (Smoke Control Mode):

- 1) The VFD bypass shall include a dedicated digital input that will transfer the motor from the VFD to bypass mode on receipt of a dry contact from the Fire / Smoke Control system. In this mode, the system will ignore low priority safeties and acknowledge high priority safeties. All keypad control, serial communications control and normal start / stop control inputs will be disregarded. This Smoke Control Mode shall be designed to meet the intent of UL864/UUKL.
 - 2) VFD shall include a fireman's override input. Upon receipt of a contact closure from the fire / smoke control station, the VFD shall operate in one of two modes: 1) Operate at a programmed predetermined fixed speed ranging from -500Hz (reverse) to 500Hz (forward). 2) Operate in a specific fireman's override PID algorithm that automatically adjusts motor speed based on override set point and feedback. The mode shall override all other inputs (analog/digital, serial communication, and all keypad commands), except customer defined safety run interlocks, and force the motor to run in one of the two modes above. "Override Mode" shall be displayed on the keypad. Upon removal of the override signal, the VFD shall resume normal operation, without the need to cycle the normal digital input run command
- E. DC link inductor or optional AC line reactor to reduce disturbances due to harmonic distortion.
- F. Diagnostic Fault Handling
1. The VFD shall include a comprehensive microprocessor based digital diagnostic system, which monitors its own control functions and displays faults and operating conditions
 2. A fault log shall record, store, and display upon demand, the most recent events and drive activity when the fault occurred. All fault records shall be retained in a nonvolatile RAM memory.
- G. Inputs And Outputs
1. Analog Outputs
 - a. 0 to 10 VDC and 2 to 10 VDC proportional to speed and load
 - b. 24 VDC @ 50 mADC for powering remote devices
 2. Digital Outputs
 - a. Programmable Form C relays rated 2 Amps at 28 VDC or 120 VAC for; Run, Fault, At Speed, Above Set Speed, Current Limit, Auto Mode, etc.

3. Analog Inputs
 - a. 4-20mA configurable to speed control
 - b. 0-10 VDC configurable to speed control
 - c. Potentiometer configurable to speed control
4. Digital Inputs
 - a. Two wire remote Start/Stop
 - b. Three wire remote Start/Stop
 - c. Local / Remote start and stop commands
 - d. Auto / Manual speed commands
 - e. A minimum of two preset speeds
 - f. Emergency / external fault stop from NO or NC contact
 - g. Increase / Decrease speed or setpoint
 - h. Fault reset.
 - i. Programmable relays for; Alarming, Run Permissive, Run Safety and status.

H. General Options And Modifications

1. The following options shall be included as specified in the document:
2. All options shall be factory mounted and wired and comply with same codes and standards as drive specified above.
3. Integral 3-pole manually operable fused circuit breaker disconnect switch as scheduled. Ampacity of switch as called for on the drawings or to match motor load size.
4. Provide RFI line side reactor filter on all drives connected to motors larger than or equal to 10 Horsepower regardless of voltage.
5. Three contactor Bypass
 - a. A three contactor bypass shall be provided to allow the motor to be safely transferred from VFD output to the AC line, or from the AC line to the VFD, while the motor is at zero speed. The bypass shall be accomplished manually by means of a BYPASS / OFF / DRIVE switch. The bypass configuration shall include the following:

- 1) Mechanically inter-locked VFD output contactor
 - 2) Full-voltage motor starting contactor
 - 3) VFD input contactor for drive isolation and test (Exceptions to the input contactor will not be accepted)
 - 4) IEC solid-state or thermal overload relay to provide motor protection
 - 5) Fused control transformer
6. The Bypass shall function as follows:
- a. Bypasses shall be furnished and mounted by the drive manufacturer. All VFD with bypass configurations shall be UL Listed by the drive manufacturer as a complete assembly and carry a UL508 label.
 - b. A complete factory wired and tested bypass system consisting of a door interlocked, padlockable circuit breaker, output contactor, bypass contactor, and fast acting VFD input fuses. UL Listed motor overload protection shall be provided in both drive and bypass modes.
 - c. The bypass enclosure door and VFD enclosure must be mechanically interlocked such that the disconnecting device must be in the “Off” position before either enclosure may be accessed.
 - d. The VFD and bypass package shall have a UL listed short circuit current rating (SCCR) of 100,000 Amps and this rating shall be indicated on the UL data label.
 - e. The drive and bypass package shall be seismic certified and labeled to the IBC:
 - f. Seismic importance factor of 1.5 rating is required, and shall be based upon actual shake table test data as defined by ICC AC-156.
 - g. Drive Isolation Fuses - Fast acting fuses, exclusive to the VFD, shall be provided to allow the VFD to disconnect from the line prior to clearing upstream branch circuit protection.
 - h. Motor protection from single phase power conditions - the bypass system must be able to detect a single phase input power condition while running in bypass, disengage the motor in a controlled fashion, and give a single phase input power indication
 - i. The bypass system shall be designed for stand-alone operation and shall be completely functional in both Hand and Automatic modes even if the VFD has been removed from the system for repair / replacement. Serial communications shall remain functional with the VFD removed.

- j. Serial communications – the bypass shall be capable of being monitored and / or controlled via on board serial communications Building Automation System Communications.
 - 1) Serial communication capabilities shall include, but not be limited to: bypass run-stop control, the ability to force the unit to bypass, and the ability to lock and unlock the keypad. The bypass shall have the capability of allowing the BAS to monitor feedback such as, current (Amps), kilowatt hours (resettable), operating hours (resettable), and bypass logic board temperature. The BAS shall also be capable of monitoring the bypass relay output status, and all digital input status. All bypass diagnostic warning and fault information shall be transmitted over the serial communications bus. Remote bypass fault reset shall be possible. The following additional status indications and settings shall be transmitted over the serial communications bus and / or via a Form-C relay output keypad “Hand” or “Auto” selected, bypass selected, and broken belt indication. The BAS system shall also be able to monitor if the motor is running in the VFD mode or bypass mode over serial communications
 - 2) The bypass serial communications shall allow control of the drive/bypass (system) digital outputs via the serial interface. This control shall be independent of any bypass function or operating state.
- k. There shall be an adjustable motor current sensing circuit for the bypass and VFD modes to provide proof of flow (broken belt) indication. The condition shall be indicated on the keypad display, transmitted over the BAS and / or via a Form-C relay output contact closure. The broken belt indication shall be programmable to be a system (drive and bypass) indication. The broken belt condition sensing algorithm shall be programmable to cause a warning or system shutdown.
- l. There shall be a coordinated run permissive circuit for damper or valve control. Regardless of the source of a run command (keypad command, time-clock control, digital input, or serial communications) the bypass shall provide a dry contact closure that will signal the damper to open before the motor can run. When the damper is fully open, a normally open dry contact (end-switch) shall close. The closed end-switch is wired to a bypass system input and allows motor operation. Up to four separate safety interlock inputs shall be provided. When any safety is opened, the motor shall be commanded to coast to stop, and the damper shall be commanded to close. This feature will also operate in Fireman’s override / smoke control mode.
- m. The bypass control shall monitor the status of the VFD and bypass contactors and indicate when there is a welded contactor contact or open contactor coil. This failed contactor condition shall be indicated on the bypass LCD display, programmed to activate a Form-C relay output, and

/ or over the serial communications protocol.

- n. The bypass control shall include a programmable time delay bypass start including keypad indication of the time delay. A Form C relay output commands the VAV boxes open. This will allow VAV boxes to be driven open before the motor operates at full speed in the bypass mode. The time delay shall be field programmable from 0 – 120 seconds.
- o. There shall be a keypad adjustment to select manual or automatic transfer to bypass. The user shall be able to select via keypad programming which drive faults will result in an automatic transfer to bypass mode and which faults require a manual transfer to bypass.
- p. The bypass shall include the ability to select the operating mode of the system (VFD/Bypass) from either the bypass keypad or digital input.
- q. The bypass shall include a two line, 20 character LCD display. At a minimum, the display shall allow the user to access and view:
 - 1) Bypass motor amps
 - 2) Bypass input voltage– average and individual phase voltage
 - 3) Bypass power (kW)
 - 4) Bypass faults and fault logs
 - 5) Bypass warnings
 - 6) I/O status
 - 7) Parameter settings / programming
 - 8) Printed circuit board temperature
- r. The following indicating lights (LED type) or keypad display indications shall be provided. A test mode or push to test feature shall be provided.
 - 1) Power-on (Ready)
 - 2) Run enable
 - 3) Drive mode selected
 - 4) Bypass mode selected
 - 5) Drive running
 - 6) Bypass running
 - 7) Drive fault

- 8) Bypass fault
 - 9) Bypass H-O-A mode
 - 10) Automatic transfer to bypass selected
 - 11) Safety open
 - 12) Damper opening
 - 13) Damper end-switch made
- s. The Bypass controller shall have a minimum of four programmable digital inputs, and four programmable Form-C relay outputs.
- t. The on-board Form-C relay outputs in the bypass shall be programmable for any of the following indications.
- 1) System started
 - 2) System running
 - 3) Bypass override enabled
 - 4) Drive fault
 - 5) Bypass fault
 - 6) Bypass H-O-A position
 - 7) Motor proof-of-flow (broken belt)
 - 8) Overload
 - 9) Bypass selected
 - 10) Bypass run
 - 11) System started (damper opening)
 - 12) Bypass alarm
 - 13) Over temperature
- u. The bypass shall provide a separate terminal strip for connection of freeze, fire, smoke contacts, and external start command. All external safety interlocks shall remain fully functional whether the system is in VFD or Bypass mode. The remote start/stop contact shall operate in VFD and bypass modes. The terminal strip shall allow for independent connection of up to four (4) unique safety inputs.

- v. The operator interface on the bypass option box shall have the following indicating LEDs:
 - 1) Ready (green)
 - 2) Interlock open (yellow)
 - 3) Bypass run (green)
 - 4) Bypass trip (red)
 - 5) PURGE (yellow)
 - 6) Drive output enable (green)

7. Building Automation System Communications:

- a. All configuration and control functions may be accessed through these cards. These option cards shall permit direct communication between the drive microprocessor and the host control system. Fault diagnostics, start/stop, speed commands, and all drive feedback variables shall be available over a single communication connection. Discrete signals such as Bypass Run or Interlock Open shall also be mapped through the drive terminal strip to the system for unitary control. The cards shall have the ability to be used in a "monitor only" mode where control shall be from an AHU or similar type controller directly wired to the drive.
- b. Serial communication in bypass shall include, but not be limited to; bypass run-stop control, the ability to force the unit to bypass, and the ability to lock and unlock the keypad. The bypass shall have the capability of allowing the BAS to monitor feedback such as, current (in amps), kilowatt hours (resettable), operating hours (resettable), and bypass logic board temperature. The BAS shall also be capable of monitoring the bypass relay output status, and all digital input status. All bypass diagnostic warning and fault information shall be transmitted over the serial communications bus. Remote bypass fault reset shall be possible
- c. A single RS-485 communication option card shall allow direct network protocol connection from the drive to the temperature control system. The serial communication protocol on the card shall be RS-485 based ModBus RTU

I. Design Make: Square D ATV S-flex

J. Acceptable Manufacturers:

- 1. Danfoss VLT 6000 Series
- 2. ABB ACS550 Series

3. Eaton H-Max Series

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install incoming 60Hz power conductors and frequency modulated conductors in separate conduits.
- B. Electrical contractor to provide fire alarm fan shut down relay connection between I/Os "12" and "18". Provide normally closed connection such that the connected air handler supply or return fan motor stops when the fan shut down relay is actuated. This relay shall be installed in series with the DDC system start/stop signal.
- C. Install VFD in an accessible location. Refer to contract documents for more information.
- D. Motor lead lengths shall not exceed manufactures recommendations as described in part 2 of this section.
- E. Provide all start up services and training as described in part 1 of this section.
- F. Completely assemble and provide connections to all terminal or terminal strips and any miscellaneous control devices.
- G. Input and motor leads for each VFD shall be in a separate dedicated steel conduit.
- H. Control wires shall be shielded and installed in a dedicated steel conduit. Ground shield as per manufactures recommendations.
- I. Adjust drive controls in accordance with manufacturer's requirements. Carrier frequency shall have an initial set point of 6 KHz.
- J. Coordinate entire installation, including communications interface with the temperature control contractor prior to ordering VFD.
- K. Provide factory trained representative and drive programming as required to meet temperature controls sequence of operation.
- L. Coordinate controls programming with division 22 or 23 contractor.
- M. When the VFD is located remotely from the motor and the associated disconnect switch, provide an interlock in the disconnect switch and provide 2-#12, in ½" C. from the VFD to the interlock. This shall be interfaced to disable the VFD prior to disconnection of power to the motor.

3.2 COORDINATION

- A. Provide overload and fuses. Coordinate sizes with division 22 or 23 contractor.
- B. Terminate control wiring. Provide all terminations of control wiring and coordinate with division 22 or 23 contractor.

- C. Prior to releasing the starter and disconnect order the division 26 contractor shall obtain verification in writing from the division 22 and 23 contractors that all starter and disconnect sizes and types are correct. The division 26 contractor shall bear all cost if written approval is not obtained prior to releasing the order and size changes are required

END OF SECTION 262923

SECTION 265100

LIGHTING

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Provide complete installation, including luminaires, standards, hangers, supports, fittings, lamps, wiring, connections and controls, as indicated in the Contract Documents. Types of luminaires in this project shall include LED only.
- B. Provide startup of all lighting control systems by a factory authorized manufacturer's representative. Provide initial system settings and owner training.
- C. Provide Lighting System Functional Testing as described in this section by a factory authorized manufacturer's representative hereby referred to as the Testing Agent.
- D. Refer to Specification Section 019113 for commissioning requirements related to this project.

1.2 DESCRIPTION OF WORK

- A. This section includes minimum requirements for the following:
 - 1. LED Luminaires
 - 2. LED Drivers
 - 3. Emergency Switching Module
 - 4. Room Controllers
 - 5. Low-Voltage Switches
 - 6. Occupancy Sensors
 - 7. Dimmer Switches
 - 8. Timer Switches
 - 9. Photo Sensors
 - 10. Light Poles and Standards
 - 11. Startup and Testing

1.3 SUBMITTALS

- A. Submit shop drawings as described in Section 260010. Shop drawings shall include

photometric data for each luminaire utilizing the specified lens/louver type, lamp(s) and ballast(s). All luminaire types and lighting control system components shall be submitted in a single complete brochure which shall be in the form of a soft cover binder with each luminaire separated by an identified index tab.

1. Information on each luminaire shall include:
 - a. Manufacturer and Catalog Number.
 - b. Dimensioned Construction Drawing(s).
 - c. Standard Catalog "Cut" Sheet.
 - d. Photometrics.
 - e. Lens/Louver Type.
 - f. Driver/Ballast Type and Rating.
 - g. Socket Type.
 - h. Lamp Type.
 - i. Maintenance Data
 2. Emergency Ballasts
 3. Emergency Switching Modules
 4. Room Controllers and Wiring Diagrams
 5. Occupancy Sensors
 6. Photo Sensors
 - a. Include data that indicated where the sensor shall be installed.
 7. Light Poles and Standards
- B. Submit for approval information detailing startup of the lighting control systems and the individual(s) who will be performing this service. Include documentation from the lighting control systems manufacturer indicating that they authorize said individual(s) to perform this work. Submittal will be rejected if this information is not included.

- C. Submit for approval a testing plan for all lighting control systems. Testing plan shall, at a minimum, observe and record all items described in the “Lighting System Functional Testing” part of this section and the individual(s) who will be performing this service. Include documentation from the lighting control systems manufacturer indicating that they authorize said individual(s) to perform this work. Submittal will be rejected if this information is not included.

1.4 QUALITY ASSURANCE

- A. Luminaires shall be standard products of manufacturers regularly engaged in the manufacture of the specific type luminaires specified and shall be the manufacturer's latest standard design that complies with specification requirements. Firms installing the luminaires shall have a minimum of five (5) years of successful installation experience on projects with interior lighting work similar to the requirements of this project.
- B. Codes and Standards
 - 1. NEC:
 - a. Shall comply with Articles 220, 410 and 510 as applicable to installation and construction.
 - 2. NEMA:
 - a. Shall comply with Standard Publication Nos. LE 1 and LE 2 as applicable to lighting equipment.
 - 3. UL:
 - a. All interior lighting luminaires and components shall be UL listed and labeled.
 - b. Comply with all applicable UL standards including UL 486A and B.
 - 4. CBM:
 - a. Fluorescent and HID ballasts shall comply with Certified Ballast Manufacturers Association standards and carry the CBM label.
 - 5. All work shall comply with applicable local code requirements of the authority having jurisdiction.
- C. Verify the availability of all luminaires proposed to be used in the execution of the work prior to submitting for approval. The discontinuance of production of any luminaire after such approval has been granted shall not relieve the Contractor from furnishing an approved luminaire of comparable quality and design at no additional cost.

- D. Luminaires shall be as specified in the "Luminaire Schedule." Luminaire types, characteristics, photometrics, finishes, etc., correspond to the first manufacturer, and associated catalog number, listed in the "Luminaire Schedule." Provide a sample luminaire from the factory for any products not listed as acceptable for approval. The Owner's Representative reserves the right to disapprove any luminaire type submitted which is not equal in quality, appearance or performance to the luminaire specified.
- E. All luminaires shall meet the Total Luminaire Efficiency (TLE) requirements of the New York State Energy Conservation Construction Code.

PART 2 - PRODUCTS

2.1 LED LUMINAIRES

- A. General:
 - 1. Manufacturers shall be a registered with the Department of Energy (DOE) as a Quality Advocate and taken the pledge to be listed on the LED lighting facts website.
 - 2. Luminaire measurements have been standardized and are in compliance with IESNA Standard LM-79 test procedure.
 - 3. LED's have been standardized and are in compliance with IESNA Standard LM-80 and demonstrate L70 life after 50,000 hours.
 - 4. Luminaires and/or replacement lamps shall be either Energy Star certified or Design Lights Consortium listed where noted on the luminaire schedule to qualify for NYSERDA or Utility provider rebate incentives. Submitted luminaires not currently on the DLC qualified products list (<http://www.designlights.org/>) will be rejected.
 - 5. Manufacturers shall prove color consistency across all LED's via 4 step MacAdam Ellipse.
 - 6. Luminaires shall be tested at an ambient temperature of +25 degrees for a minimum of 6000hrs.
 - 7. Maximum junction temperature of 80°C.
 - 8. Minimum drive current of 350mA. Maximum drive current of 700mA.
 - 9. Luminaires shall a minimum 5 year warranty.
 - 10. Refer to Luminaire Schedule on drawings for complete Luminaire makes and models.

2.2 LED DRIVERS

A. Driver:

1. Driver shall be of the constant current type, nonproprietary control type, open o-10v dimming.
 - a. Voltage: 120/277 as noted on drawing
 - b. Constant current
 - c. Driver Current: 350mA – 700mA.
 - d. Maximum THD: 10%
 - e. Minimum Power Factor: 0.9
2. Acceptable Manufacturers.
 - a. eldoLED
 - b. Philips Advance - Xitanium
 - c. Lutron Hi-Lume
 - d. Sylvania/Osram - Optotronic

B. Dimmable Driver (0-10v):

1. Driver shall be of the constant current type.
 - a. Voltage: 120/277 as noted on drawing
 - b. Driver Current: 350mA – 700mA.
 - c. 0-10v dimming capable down to 1%.
 - d. Maximum THD: 10%
 - e. Minimum Power Factor: 0.9
2. Acceptable Manufacturers.
 - a. eldoLED
 - b. Philips Advance – Xitanium
 - c. Lutron – Hi-Lume A series
 - d. Osram/Sylvania - Optotronic

2.3 EMERGENCY DRIVERS

- A. Emergency Drivers shall be installed in conjunction with AC ballast intended for normal luminaire operation. Contains internal battery that shall automatically switch over to power designated lamp(s) upon loss of normal power via internal voltage sensing device. Battery shall be maintenance free, nickel-cadmium type, and be an integral part of ballast assembly. Life expectancy of battery shall be minimum of seven years.
- B. Allows standard switching of Luminaire on normal power circuit.
- C. All emergency driver shall be inverter type with the following minimum requirements:
 - 1. LED performance – Shall operate up to (1) 23.1W LED lighting load for a minimum of 90 minutes on a output voltage of 28.0 to 33.0 VDC
- D. UL 924 listed for Emergency Lighting and Power Equipment
- E. Temperature Operation: 20°C to +55°C
- F. Shall include an emergency test switch with LED indicator remotely mounted in outlet box in ceiling above or adjacent to luminaire.
- G. Design Makes: Bodine B30ST; LED – Bodine BSL722

2.4 ROOM CONTROLLERS

- A. Modular, stand-alone one room lighting control system (0-10V dimming and switching) with control of multiple user presets and room occupancy and daylight sensing for daylight harvesting.
- B. Concealed mounting, self-contained, multi-channel lighting controller designed to communicate with occupancy and photo sensor inputs without the use of external power packs.
- C. Shall allow for on-site commissioning controls via an infrared handheld remote control.
- D. Lighting loads: Refer to floor plans for quantity of lighting channels per room. Where any room exceeds three channels, provide multiple room controllers networked together for proper system operation.
- E. Multiple room controllers connected together in a local network must automatically arbitrate with each other, without requiring any configuration or setup, so the individual load numbers are sequentially assigned using each controller's device ID's from highest to lowest.
- F. Each load shall at minimum be configurable to operate in the following sequences based on occupancy:
 - 1. Auto-on/Auto-off

- 2. Manual-on/Auto-off
- G. Manual override and LED indicated for each load.
- H. Compatible with 120/277 VAC systems.
- I. Maximum 20A combined 20A combined load per Room Controller.
- J. All digital parameter data programmed into each room controller shall be retained in non-volatile FLASH memory within the controller itself. Memory shall have an expected life of no less than 10 years.
- K. Room controller shall include:
 - 1. Real time current monitoring
 - 2. Efficient 250 mA switching power supply
 - 3. RJ-45 network ports with integral strain relief and dust covers
 - 4. One dimming output per relay
 - a. The 0-10 volt output shall automatically open upon loss of power to the Room Controller to assure full light output from the controlled lighting.
 - b. Each dimming output channel shall have an independently configurable minimum and maximum calibration trim level to set the dimming range to match the true dynamic range of the connected driver. The LED level indicators on connected dimmer switches shall utilize this new maximum and minimum trim.
 - c. Each dimming output channel shall have an independently configurable minimum and maximum trim level to set the dynamic range of the output within the new 0—100% dimming range defined by the minimum and maximum calibration trim.
 - d. Calibration and trim levels must be set per output channel.
 - e. All configuration shall be digital. Devices that set calibration or trim levels per output channel via trim pots or dip-switches are not acceptable.
 - 5. Fade rates for dimming loads shall be specific to connected switch buttons, and the load shall maintain a default value for any connected buttons that do not specify a unique value.
- L. Class 2 dimming control signal: 0-10VDC, sinks up to 100mA per channel for control of compatible drivers.
- M. UL 2043 Plenum rated.

- N. IR window built-in to room controller for commissioning with remote control.
- O. Provide (1) infrared remote control for startup, programming, and commissioning.
- P. Provide with digital input/output interface that includes an isolated relay with N/O and N/C outputs; rated for 1 Amp @ 30 VDC/VAC.
- Q. Five year warranty.
- R. Design Make: Wattstopper LMRC-210 Series with LMIO-101 Digital I/O Interface
- S. Acceptable Manufacturer's:
 - 1. Eaton Greengate RC3D-PL (Add E for UL 924 listing)

2.5 LOW-VOLTAGE SWITCHES:

- A. 0-10VDC Dimmers
- B. Provide 1-way or 3-way dimmers as shown on drawings, provide applicable model with matching wallplate.
- C. Provide accessory 120-277V input power pack to power accessory sensors as indicated and 10V control power for dimming switch.
- D. Vertical linear slider for dimming
- E. Controls 120-277V without a power pack, 8 Amp 120-277V rated. Internal power supply generates 0-10V output.
- F. Provides 3-way preset switching functionality
- G. Design Make: Steinel WLS-DIM or Approved Equal

2.6 LOW-VOLTAGE SWITCHES FOR ROOM CONTROLLERS:

- A. On/Raise & Off/Lower dimming control button with led status indicator
- B. Dimming switch with seven bi-level LED's to indicate load levels using 14 steps.
- C. Two-way infrared (IR) transceiver for use with personal and configuration remote controls.
- D. All digital parameter data programmed into each wall switch shall be retained in non-volatile FLASH memory within the controller itself. Memory shall have an expected life of no less than 10 years.
- E. Two RJ-45 ports for connection to the Room Controller network and other devices.
- F. Multiple digital wall switches may be installed in a room by simply connecting the to the

room controller network. No additional configuration shall be required to achieve multi-level switching.

- G. Ramp rate may be adjusted for each dimmer switch.
- H. Ivory color.
- I. Five year warranty.
- J. Shall be of the same manufacturer as the room controller.
- K. Design Make: Wattstopper LMDM-101 Series
- L. Acceptable Manufacturer's:
 - 1. Eaton Greengate RC-2-TLB

2.7 OCCUPANCY SENSORS

- A. General:
 - 1. All occupancy sensor layouts have been done using the “design make” sensors. Contractor shall be responsible for providing additional sensors and all associated equipment required to provide coverage for required areas.
- B. Wall mounted Sensors
 - 1. Switchbox type (single circuit):
 - a. 120-277 volt, 800/1200 watts
 - b. 600 sq. ft. of coverage, 180 degree viewing angle.
 - c. Passive infrared technology.
 - d. Adjustable time delay from 30 seconds to 30 minutes.
 - e. Adjustable sensitivity from 20% to 100%.
 - f. Manual on switch (Vacancy)
 - g. Internal photocell.
 - h. Decorator style, ivory color.
 - i. Install in single gang switch box.
 - j. Design Make: Wattstopper CS-50 series.
 - k. Acceptable Manufacturers:

- 1) Hubbell
- 2) Leviton ODS06
- 3) Eaton Greengate

2. Switchbox Dimming Type (single circuit):

- a. 120-277 volt, 800/1200 watts
- b. 900 sq. ft. of coverage, 180 degree viewing angle, passive infrared technology.
- c. Adjustable time delay from 30 seconds to 30 minutes.
- d. Adjustable sensitivity from 20% to 100%.
- e. Manual on switch allows occupancy/vacancy sensing
- f. Decorator style, white color.
- g. Install in single gang switch box.
- h. Internal photocell.
- i. Include with PowPak dimming module with 0–10V control
- j. Design Make: Lutron Maestro 0-10V dimming sensor
- k. Acceptable Manufacturers:
 - 1) Wattstopper PW311
 - 2) Leviton OSD10
 - 3) Hubbell

3. Switchbox type (two circuit):

- a. 120-277 volt, 800/1200 watts
- b. 600 sq. ft. of coverage, 180 degree viewing angle.
- c. Passive infrared technology.
- d. Adjustable time delay from 30 seconds to 30 minutes.
- e. Adjustable sensitivity from 20% to 100%.
- f. Two manual on switches for independent control of two separate circuits.

- g. Decorator style, ivory color.
- h. Install in single gang switch box.
- i. Design Make: Wattstopper CS-350 Series
- j. Acceptable Manufacturers:
 - 1) Hubbell

4. Type OS-A Ceiling Mounted Sensors

- a. Minimum 450 square feet of coverage, 360 degree viewing angle.
- b. Passive infrared technology. Adjustable sensitivity.
- c. Adjustable time delay from 5 to 30 minutes.
- d. Install semi-flush in single gang switch box above the ceiling.
- e. Standalone Sensors:
 - 1) Includes an isolated relay with N/O and N/C outputs; rated for 1 Amp @ 30 VDC/VAC
 - 2) Provide with relay power packs compatible with manual on operation and day-light operation and multi-level switching as shown on drawings.
 - 3) Compatible with optional low voltage switch for manual-on operation.
 - 4) Design Make: Wattstopper CI-300
 - 5) Approved Equivalents:
 - a) Hubbell OMNIIRRP
 - b) Sensor Switch CM Series
 - c) Eaton Greengate OAC-P-1500-R
- f. Sensors connected to Room Controllers:
 - 1) Two RJ-45 ports for connection to the Room Controller and other devices.
 - 2) Two-way infrared (IR) transceiver to allow remote programming through handheld commissioning tool and control by remote personal controls.

- 3) Load parameters including automatic/manual-on, blink warning, and daylight enable/disable when photo sensors are also connected to the Room Controller.
- 4) Shall be of the same manufacturer as the Room Controller
- 5) Design Make: Wattstopper LMPC-100 Series
- 6) Approved Equivalents:
 - a) Eaton Greengate OAC-P-1000-R

5. Type OS-B Ceiling Mounted Sensors

- a. Minimum 1,000 square feet of coverage, 360 degree viewing angle.
- b. Dual technology (Ultrasonic/PIR or Microphonic/PIR). Field selectable for either setting or both. Adjustable sensitivity.
- c. Adjustable time delay from 5 to 30 minutes.
- d. Installs surface mounted in 4" octagon J-box above the ceiling.
- e. Standalone Sensors:
 - 1) Includes an isolated relay with N/O and N/C outputs; rated for 1 Amp @ 30 VDC/VAC
 - 2) Provide with relay power packs compatible with manual on operation and day-light operation and multi-level switching as shown on drawings.
 - 3) Compatible with optional low voltage switch for manual-on operation.
 - 4) Design Make: Wattstopper DT-300
 - 5) Approved Equivalents:
 - a) Hubbell OMNIDT1000RP
 - b) Sensor Switch CM Series
 - c) Eaton Greengate OAC-DT-1000-R
- f. Sensors connected to Room Controllers:
 - 1) Two RJ-45 ports for connection to the Room Controller and other devices.

- 2) Two-way infrared (IR) transceiver to allow remote programming through handheld commissioning tool and control by remote personal controls.
- 3) Load parameters including automatic/manual-on, blink warning, and daylight enable/disable when photo sensors are also connected to the Room Controller.
- 4) Shall be of the same manufacturer as the Room Controller
- 5) Design Make: Wattstopper LMDC-100 Series
- 6) Approved Equivalents:
 - a) Eaton Greengate OAC-DT-1000-R

6. Type OS-C Ceiling Mounted Sensors [FOR USE IN CORRIDORS]

- a. Nominal 10' X 75' of coverage for corridors.
- b. Ultrasonic technology.
- c. Adjustable time delay from 30 seconds to 15 minutes.
- d. Adjustable sensitivity.
- e. Manual sensor bypass.
- f. Install surface mounted in single gang switch box above the ceiling.
- g. Provide with relay power pack.
- h. Design make: Wattstopper W-2000H
- i. Acceptable Manufacturers:
 - 1) Eaton Greengate OAC-U-1000-R

2.8 TIMER SWITCH

- A. Switch designed to fit decorator style switch plate covers.
- B. Ivory color.
- C. LCD countdown display
- D. Push button scroll adjustable solid state time setting up to 12 hour
- E. Integral on/off push button

- F. Amperage Capacity: 800W at 120VAC, 1,200W at 277VAC
- G. Power Specification: 120-277 Volt AC, 50/60 Hz
- H. Approvals: UL, CSA
- I. Design Make: Watt Stopper TS-400 Digital Time Switch or Approved Equal
- J. Acceptable Manufacturers:
 - 1. Hubbell TD300
 - 2. Philips OccuSwitch LTA24550C
 - 3. Leviton Vizia+

2.9 DIMMER SWITCHES

- A. 0-10VDC Dimmers:
 - 1. Provide 1-way or 3-way dimmers as shown on drawings, provide applicable model with matching wallplate.
 - 2. Provide accessory 120-277V input power pack to power accessory sensors as indicated and 10V control power for dimming switch
 - 3. Vertical linear slider for dimming
 - 4. Intended for 0–10V dimming for fluorescent and LED luminaires
 - 5. Controls 120–277V without a power pack, 8 Amp 120-277V rated. Internal power supply generates 0-10V output.
 - 6. Provides 3-way preset switching functionality
- B. Design Make: Steinel WLS-DIM or approved equal.

2.10 PHOTO SENSOR

- A. Digital daylighting sensor shall work with the Room Controllers describe in this section to provide automatic dimming daylight harvesting capabilities.
- B. Continuously monitors daylight entering window or skylight to enable daylight harvesting applications to provide control of room lighting based on presence of daylight.
- C. Shall provide the option, when daylight contribution is sufficient, of turning the lights off or dimming the lights to a field-selectable minimum level.
- D. Shall have a digital, independently configurable fade rate for both increasing and decreasing light level in units of percent per second.

- E. Shall provide adjustable cut-off time. Cut –off time is defined by the number of selected minutes the load is at the minimum output before the load turns off. Selectable range between 0-240 minutes including option to never cut-off.
- F. Wall switch override shall allow occupants to control lighting level with dimming wall switches.
- G. Automatically establishes application specific set points following manual calibration using a wireless configuration tool or PC with appropriate software. For switching operation, an adequate deadband between the ON and OFF set points for each zone shall prevent the lights from cycling; for dimming operation, a proportional control algorithm shall maintain the design lighting level in each zone.
- H. Install in location recommended by the manufacturer.
- I. Field of View: 60 Degree cone.
- J. Sensitivity: 1-6,553 foot-candles (10-70,536 lux).
- K. LED status and configuration indicators.
- L. Infrared (IR) transceiver for configuration and/or commissioning with a handheld configuration tool, to transmit detected light level to wireless configuration tool.
- M. One RJ-45 port.
- N. Connects to room controller via Cat.5e patch cable without the need for external power packs.
- O. Five year warranty.
- P. Shall be of the same manufacturer as the room controller.
- Q. Design Make: Wattstopper LMLS-500 Series
- R. Acceptable Manufacturers:
 - 1. Eaton Greengate DSRC-FMOIR

2.11 DIFFUSERS

- A. Lenses:
 - 1. Extruded 100 percent virgin acrylic material with a minimum weight of ten ounces per square foot.
 - 2. Type 12 - Clear material with 0.125 inch overall thickness with .080 Inch penetration comprised of 3/16 inch square based female cones aligned 45 degrees to the length and width of the panel.

3. Type 19 - Clear material with 0.156 inch overall thickness with 0.080 inch penetration comprised of 3/16 inch square based male cones aligned parallel and perpendicular to the length and width of the panel.
4. White matte - White material with 0.125 inch overall thickness.
5. While overlay - White material with 0.040 inch overall thickness.
6. The maximum deflection at the center of a 2 foot x 4 foot lens shall be no greater than 0.250 inch. Arched or warped lenses will not be accepted.
7. Parabolic Louvers
 - a. Medium cell louver - One piece injection molded acrylic, with all parabolic surfaces prepared with a primary undercoat, highly specular vacuum metalized finish, and encapsulated in a protective acrylic lacquer coating. Cell dimensions shall be nominal 1-1 /2 inches x 1-1 /2 inches x 1 inch deep, and shall provide approximately 38 degree shielding with a louver efficiency of not less than 52 percent. This louver shall have a VCP index rating of 0.93 for semi-specular silver finish. Panel finish shall be specular silver.
8. Baffles and Louvers
 - a. Cross Baffle - Constructed of 0.050 inch aluminum with one-way blades to provide 45 degree shielding. Blades 1-1/2 inches high and spaced 1-1/2 inches apart. While enamel finish. Side shields for support of the blades. Width to extend the full width of the lighting unit and of lengths to form a continuous baffle with no visible joints. Where inside and outside comers are required, the blades shall be mitered.
 - b. Parabolic Baffle - Constructed of 0.050 inch aluminum with one-way blades to provide 45 degree shielding. Blades 1-1/2 inches high and spaced 1-1/2 Inches apart. Clear anodized finish. Side shields for support of the blades. Width to extend the full width of the lighting unit and lengths to form a continuous baffle with no visible joints. Where inside and outside comers are required, the blades shall be mitered.
 - c. Directional Louver - Constructed and fabricated of aluminum with a "cold bonding joint method for integral vibration free and precise alignment of cells. Louver finish shall be custom color as directed by the Architect.

2.12 LIGHT POLES AND STANDARDS

- A. Metal Pole Lighting Standards: Provide metal, raceway-type, lighting poles and standards, of sizes and types indicated, comprised of shafts and tenon joints. Equip with grounding connections readily accessible from handhole base access doors; and construct of the following materials and additional construction features:

1. Material: Aluminum
 2. Configuration: Anchor base type with hand hole and cover.
 3. Metal Lighting Standard Accessories: Provide accessories for metal lighting standards, including anchor bolts, as recommended by lighting standard manufacturer, of sizes and materials needed to meet erection and loading application requirements.
 4. Provide metal seamless square anchor bolt cover to match pole construction.
- B. Provide pole with adequately sized reinforced handhole complete with matching cover 18" above grade level. Weld 1/2" grounding nut on shaft with accessibility from handhole. Design poles to withstand loads developed by 100 MPH wind pressure, as adjusted for height above ground level, structural shapes and cable wire loading.

2.13 STAGE DMX LIGHTING CONTROLLER

- A. Touch screen user interface, fully customizable using the Pharos Designer 2 software. Create multiple pages of lighting controls including buttons, sliders, keypads and color pickers, and configure their appearance and visual feedback. Able to import custom graphics or picking from one of many standard attractive themes.
1. Certifications: CE compliant, ETL/cETL listed
 2. Power: PoE (IEEE802.3af, Class 2) 4W typical
 3. Data Storage: Removable SD Card (supplied)
 4. Temperature: 0°C to 50°C (32°F to 122°F)
 5. Humidity: 10-50% relative, non-condensing
 6. Ingress: IP40
 7. Physical: Wall mounted, partly recessed in 2.5" backbox
 8. Weight: 0.25 kg (0.55 lbs)
 9. Shipping: 20 x 15 x 12 cm (8" x 6" x 5") 0.6 kg (1.3 lbs)
 10. Recovery: Hardware watchdog and recessed reset button
 11. Warranty: 5 years
- B. Interfaces
1. Ethernet: RJ45 socket for 10/100Base-TX Ethernet with Link/Data LEDs; Fixed IP or DHCP; Dual IP address for eDMX

2. Touchscreen: 4.3" capacitive touch; 480×272 24bpp; 340 cd/m²; magnetic overlay
 3. IR Sensor: Learning IR sensor for remote control
 4. Temperature: Built-in ambient temperature sensor
- C. Pharos Engine:
1. Certifications: CE compliant, ETL/cETL listed
 2. Power: Mains-powered; 100-240VAC / 50-60Hz / 0.1A (10W typical)
 3. Required: Pharos TPC
 4. Temperature: 0°C to 50°C (32°F to 122°F)
 5. Physical :8 unit wide DIN rail mounting enclosure (DIN43880 / EN60715 (35/7.5 rail))
 6. Weight: 0.5 kg (1.1 lbs)
 7. Shipping: 20 x 15 x 12 cm (8" x 6" x 5") 0.7 kg (1.6 lbs)
 8. Recovery: Hardware watchdog and recessed reset button
 9. Warranty: 5 years
 10. Interface
 - a. TPC PoE: RJ45 socket with Link/Data LEDs for direct connection to TPC only (100m max distance)
 - b. Ethernet: RJ45 socket for 10/100Base-TX Ethernet with Link/Data LEDs; Fixed IP or DHCP; Power-over-Ethernet (PoE)
 - c. DMX512 :Isolated DMX port, RDM compatible
 - d. DALI: Master (up to 64 devices) or Slave
 - e. Serial: RS232 Inputs: Individually selectable operating mode for contact closure, digital or analog input (24V maximum)
- D. Design Make: Pharos EXT, or approved equal

2.14 WIRING

- A. ANSiE1.11 (USITDMX512-A control cabling: comply with requirements specified in Section 260519 "Low Voltage Cables"

1. Plenum-Rated Cable, NFPA 70 Type CMP:
 - a. Paired, low-capacitance computer cable for ANSI E1.11 (USITT DMX512-A) applications. Two pairs, twisted, No. 22AWG, stranded, tinned copper conductors.
 - b. Inner Shield: 100 percent coverage, aluminum foil-polyester tape.
 - c. Outer Shield: 90 percent coverage, tinned-copper braid
 - d. Outer Shield Drain Wire: Stranded, tinned-copper
 - e. Listed and labeled in accordance with UL 444.
 - f. Investigate insulation and jacket materials in accordance with UL 2257.

2.15 LUMINAIRE SCHEDULE

- A. Luminaire schedule is found on the drawings.

PART 3 - EXECUTION

3.1 EXAMINATION:

- A. Examine areas and conditions, under which luminaires are to be installed, and substrate for supporting luminaires. Notify Architect in writing of conditions detrimental to proper completion of the work. Do not proceed with work until unsatisfactory conditions have been corrected.

3.2 PRE-INSTALLATION MEETING

- A. A factory authorized manufacturer's representative shall provide the electrical contractor a functional overview of the lighting control system prior to installation. The contractor shall schedule the pre-installation meeting after receipt of approved submittals to review the following:
 1. Confirm the location and mounting of all digital lighting control devices, with special attention to placement of occupancy and photo sensors.
 2. Review the requirements for low-voltage control wiring and termination.
 3. Discuss the functionality and configuration of all products, including sequences of operation, per design requirements.

3.3 COORDINATION

- A. Refer to respective reflected ceiling plan for each area. Reflected ceiling plans indicate proper luminaire location only. Locate occupancy sensors and photo sensors per the manufacturer's recommendations. Coordinate the proper arrangement with all other ceiling mounted items. Contract Documents indicate luminaire characteristics (type),

quality, quantity, etc. Verify with the ceiling supplier design of actual ceiling installed in each area and coordinate compatible luminaire flange/trim type.

B. General

1. Install interior luminaires at locations and heights as indicated, in accordance with luminaire manufacturer's written instructions, applicable requirements of NEC, NECA's 'Standard of Installation', NEMA standards, and with recognized industry practices.
2. Provide luminaires and/or luminaire outlet boxes with hangers to properly support luminaire weight. Submit design of hangers, method of fastening, other than indicated or specified herein, for review by Engineer.
3. Make installation such that the luminaire is free of finger marks, flaws, scratches, dents or other imperfections.
4. Arrangement
 - a. Align edges of luminaires with walls or other building elements. Where indicated by dimensions or indicated on Drawings, maintain indicated arrangement.
 - b. For wall to wall installed luminaires, field measure length required after completion of the wall construction and prior to ordering the luminaires. Fabricate in largest lengths allowable.
5. Recessed Mounting
 - a. Verify ceiling construction and material prior to ordering luminaires. Provide plaster frames for plaster ceilings and flanged frames for drywall ceiling. Provide necessary mounting hardware and accessories to adapt luminaire to ceiling construction. Provide gaskets, trims, flanges, etc. as required to prevent light leaks around trim. Where installing 'lay-in' type luminaires, each Luminaire shall be supported completely independent of the ceiling system by way of 12-AWG galvanized steel support wires. Support wires shall be attached from all four corners of the Luminaire housing to the building structure. Each support shall be capable of supporting 100 pounds. Provide saddle hangers or tie bars attached to runners or between crossbars of ceiling systems as a safety measure. Provide mounting splines or other positive means of maintaining alignment and rigidity.
6. Stem Mounting
 - a. Use self-aligning hangers in canopies for hanging luminaires true to vertical. Do not deface ceiling or walls. Locate hangers at intersections of joints or at centers of blocks in rooms with patterned type ceiling materials such as acoustic tile. Use hangers capable of supporting four

times luminaire weight. Align continuous rows of luminaires maintaining luminaires level without rotation about the longitudinal axis. Rigidly support outlet box independent of ceiling system from building structure. Where obstructions prevent direct support of outlet, provide offset or trapeze hangers of outlet box. Stem shall be supported directly from building structure on centers as called for by the manufacturer. There shall be a minimum of two stems per individual four foot luminaire, and three stems per individual eight foot luminaire for steel luminaires. Extruded aluminum luminaires shall have hangers as called for by the manufacturer.

- b. Provide brackets from the manufacturer of the same finish and material as the luminaires to present a seamless continuous row mounting appearance. Provide continuous row mounting brackets between all adjoining luminaires.

7. Surface Ceiling Mounting

- a. Mount surface luminaires tight to surface without distorting surface. Space luminaires in continuous rows to correspond to ceiling joint intersections. Continuous row luminaires may be fed by a single outlet where luminaires contain approved wireways and suitable wiring is used. Provide hangers for each luminaire, each rated to support four times the luminaire weight. Provide offset or trapeze hangers where required. Supports shall be provided on a maximum of 4 foot centers with a minimum of two hangers per individual four foot luminaire and three hangers per individual eight foot luminaire. Hangers shall be supported from the building structure and independently from ceiling system or other building services.
- b. Fasten luminaires securely to structural supports.

3.4 DELIVERY, STORAGE, AND HANDLING

- A. Luminaires and equipment shall be delivered with UL and manufacturer's labels intact and legible in factory fabricated containers.
- B. Luminaires and accessories shall be stored in protected dry locations in their original unbroken package or container. Luminaires shall be protected from dust and dampness both before and after installation. Luminaires shall be protected from paint and cleaning solvents during all phases of construction.
- C. Handle interior lighting luminaires carefully to prevent damage, breaking, and scoring of finishes. Do not install damaged luminaires or components; replace with new.

3.5 SEQUENCING AND SCHEDULING

- A. Coordinate with other work including ceiling type, wires/cables, electrical boxes, fittings, and raceways, to properly interface installation of interior luminaires with other trades.

- B. The contractor shall provide the lighting control systems manufacturer with three weeks written notice of the system startup and adjustment date.

3.6 REUSE AND REPAIR OF EXISTING LUMINAIRES

- A. Reuse existing luminaires only where called for. Perform the following work, as required, to upgrade existing luminaire. Replace faulty, leaking, or noisy ballast. Replace broken, damaged, worn, or faulted lamp sockets. Provide new luminaire wire. Provide new acrylic lens system to match existing, where existing is broken. Re-lamp luminaires. Completely damp clean lens and interior of luminaires.
- B. If ballasts have leaked, remove material deposited in luminaire. Assume material was PCB contamination, or a test samples to show material is not PCB and submit a report. Dispose of material as required by EPA, including clean-up materials used. Dispose of ballast which does not have non PCB label in PCB containers and have containers taken to EPA approved incinerators. Follow all EPA regulations for transporting material.
- C. New luminaires may be provided to replace existing luminaires scheduled to remain or be reused, subject to shop drawing approval.

3.7 REMOVAL OF BALLAST IN EXISTING LUMINAIRES

- A. Assume ballast contains PCB materials unless labeled otherwise or test samples to show materials are not PCB; submit test report. Remove all ballast from existing luminaires indicated on contract documents. Dispose of all ballast which do not have non-PCB labels in PCB containers and pay all costs to have containers taken to EPA approved incinerators and disposed of per all EPA regulations. Follow all EPA regulations for transporting containers and materials. If ballast has leaked in existing luminaire, remove material deposited in luminaire and dispose of those materials as listed above. Provide Certificate of Disposal and all associated paperwork to Owners representative.

3.8 REMOVAL OF LAMPS IN EXISTING LUMINAIRES

- A. Assume all fluorescent lamps contain Mercury materials unless labeled otherwise or test samples to show materials do not contain Mercury and submit test report. Remove all lamps from existing luminaires indicated on contract documents. Dispose of all lamps which do not have non-Mercury labels in compliance with the requirements of the New York State Department of Environmental Conservation and all applicable Federal Laws. Follow all regulations for transporting materials. Provide Certificate of Disposal and all associated paperwork to Owner's representative.

3.9 OCCUPANCY SENSORS

- A. Provide all necessary mounting brackets, wiring, low voltage transformers and control relays required to provide control of areas indicated.
- B. Provide initial time delay and sensitivity settings per owner's representative.
- C. Install in location as recommended by the manufacturer.

- D. Refer to “Lighting System Functional Testing” part of this section for additional information.

3.10 PHOTO SENSORS

- A. Provide hand held digital light meter measuring device in the 0-200 foot-candle range. Provide adjustments to threshold on sensor to meet user requirements. Initial foot-candle threshold setting to automatically turn off lights shall be 50 foot-candles. Provide adjustments to meet owner requirements and space constraints.
- B. Install in location as recommended by the manufacturer.
- C. Refer to “Lighting System Functional Testing” part of this section for additional information.

3.11 CONTROL WIRING

- A. Provide all required low-voltage control wiring for lighting control system components.
- B. Provide pre-terminated Cat.5e or better cable with RJ-45 connectors to connect devices in Room Controller network. Cables shall be of same manufacturer as the Room Controllers or listed as a manufacturer approved connectivity solution.

3.12 LIGHTING SYSTEM FUNCTIONAL TESTING

- A. Lighting system functional testing shall comply with the following requirements:
 - 1. Provide plan markup which indicates the exact location of each sensor, direction of aim, and certify on the plan that the direction of aim and placement are in compliance with manufacturer’s requirements. Include this plan with the Operation & Maintenance Manuals.
 - 2. Occupancy Sensor Controls:
 - a. Certify that the occupancy sensor has been located and aimed in accordance with the manufacturer’s recommendations.
 - b. All devices shall be tested. Verify the following:
 - 1) Where occupant sensor controls include status indicators, verify correct operation.
 - 2) The controlled lights turn off or down to the permitted level within the specified time.
 - 3) The lights turn on only when manually activated.
 - 4) The lights are not incorrectly turned on by movement in adjacent areas or by HVAC operation.

3. For Time – Switch Controls:

- a. Verify that timers are properly programmed with weekday, weekend and holiday schedules.
- b. Provide documentation to the Owner of time-switch controls programming including weekday, weekend, and holiday schedules and set-up and preference program settings. Include a copy in testing documentation package for approval by the Engineer.
- c. Verify time of day and day of week are properly set.
- d. Verify that any battery back-up is installed and energized.
- e. Verify that any override timer is set for less than 2 hours.
- f. Simulate occupied condition and verify the following:
 - 1) All lights can be turned on or off by respective area control switch.
 - 2) Light switches control only those lights in the enclosed area where the switch is located.
- g. Simulate unoccupied condition and verify the following:
 - 1) Non-exempt lights turn off.
 - 2) Manual override switches allows only the lights in the enclosed space where the override switch is located to turn on or remain on until the next scheduled shutoff occurs.
- h. For Daylight Responsive Controls:
 - 1) Verify that the control sensing devices have been properly located, field calibrated and set for accurate control set points and threshold lighting levels.
 - 2) Daylight controlled lighting loads adjust to light levels set points in response to available daylight.
 - 3) The location of calibration adjustment equipment is readily accessible only to authorized personnel.
 - 4) Record all set points and verify with calibrated light meter the actual field recorded lighting control levels.
 - 5) Upon request, repeat measurements in the presence of the Design Professional or their authorized representative to validate lighting level control response.

4. Create a log of deficiencies noted during testing. Correct all deficiencies and update log with corrective action records.
5. Complete and submit as part of the Operation and Maintenance Manuals the submitted and approved lighting testing plan.

B. Test Form:

1. Instruction: Contractor to complete either the following form or the form contained in the approved testing plan for each room in the project that receives lighting controls. Include completed forms in the Operation and Maintenance Manuals.

Room Name/Number:	Date:	
<i>Testing Agent's Name:</i>		
<i>Testing Agent's Signature:</i>		
<i>Testing Agent's Company & Position:</i>		
Occupancy Sensor Controls	<i>Initials</i>	<i>N/A</i>
I verify that the occupancy sensor has been located and aimed in accordance with the manufacturer's recommendations.		
I verify that the status indicators on the occupancy sensor are operating correctly.		
I verify that the controlled lights turn OFF or down to the permitted level within the specified time.		
I verify that the controlled lights turn ON only when manually activated.		
I verify that the lights are not incorrectly turned on by movement in adjacent areas or by HVAC operation.		
Time - Switch Controls	<i>Initials</i>	<i>N/A</i>
I verify that the timers are properly programmed with weekday, weekend, and holiday schedules.		
I verify that the time of day and day of week are properly set.		
I verify that battery back-up is installed and energized.		
I verify that the override timer is set for less than 2 hours.		
Simulate occupied condition: I verify that all lights can be turned on or off by respective area control switch.		
Simulate occupied condition: I verify that the lighting switches control only those lights in the enclosed area where the switch is located.		
Simulate unoccupied condition: I verify that all non-exempt lights turn off.		
Simulate unoccupied condition: I verify that the manual override switch allows only the lights in the enclosed space where the override switch is located to turn on or remain on until the next scheduled shutoff occurs.		
Daylight Responsive Controls	<i>Initials</i>	<i>N/A</i>
I verify that the control sensing devices have been properly located, field calibrated, and set for accurate control set points and threshold lighting levels.		

I verify that the daylight controlled lighting loads adjust to light levels set points in response to available daylight.		
I verify that the location of calibration adjustment equipment is readily accessible only to authorized personnel.		
Record set point (foot-candles):		
Record lighting control level with calibrated light meter (foot-candles):		
Record cut-off time (minutes):		
Record fade rate (units/second):		

3.13 TRAINING

- A. Upon completion of the system startup, the factory-authorized technician shall provide the proper training to the owner's personnel on the adjustment and maintenance of the lighting control system. Include sign in sheet with Operation & Maintenance Manuals.

3.14 SPARE PARTS

- A. Provide the following spare parts to the owner with sign-off receipt prior to job close-out:
 - 1. (10) Low-voltage switches

3.15 FINAL CLEANING

- A. Prior to acceptance, damp clean diffusers, glassware, trim, reflectors, lamps, louvers, lens and similar objects of all luminaires. Remove all dirt, corrosion, foreign material, finger marks, and blemishes. Replace all burned out lamps and failed components.

END OF SECTION 265100

SECTION 271000

HORIZONTAL AND BACKBONE COMMUNICATION CABLING

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Provide all labor, materials, tools, and equipment required for the complete installation of work called for in the Contract Documents.
- B. Provide (25) installed spare cat. 6A cables. Each installed cable shall include up to 300-feet of specified cat. 6A cable with termination, testing, and labeling at each end. Provide up to 20-feet of V2400 surface metal raceway, surface metal backbox, outlet, and RJ-45 cat. 6A jack at station end for each cable. Provide required supports and sleeves for distribution.

1.2 SCOPE

- A. Horizontal cabling includes STP between public address system peripherals, access control system, and security system equipment and devices as required by the manufacturer and called for on the drawings.
- B. Horizontal cabling includes Category 6A UTP from the Communications Equipment Room (CER) to the outlets as called for on the drawings. The horizontal cabling includes all horizontal cables, patch panels, patch cables, termination, testing, and mechanically terminated jacks/inserts and faceplates in the work area and the mechanical termination in the CER.
- C. UTP Backbone cabling includes new interior and exterior multipair-pair UTP cable between CERs, IDFs, and buildings. Additional required components include 110-blocks, termination, testing, direct buried splice cases, lightning protection, and required grounding. Telephone handsets and PBX programming by others.
- D. Backbone cabling includes interior and exterior multi-mode and single-mode optical fiber run between CERs (Communication Equipment Rooms) and between buildings. Additional required components include patch panels, direct buried splice cases, termination, and testing.
- E. Horizontal cabling includes audio and video cabling as indicated on the drawings.
- F. This section includes minimum requirements for the following:
 - 1. Cat. 6A Cabling
 - 2. Cat. 6A Patch Cables
 - 3. Connecting Hardware

4. 100 Ohm UTP Cable Testing
5. Optical Fiber Cabling
6. Fiber Connectors
7. Fusion Splicing
8. Optical Fiber Testing
9. Interior UTP Telephone Cable
10. Bonding Harness and Connectors
11. Lighting Protection
12. Audio/Video (A/V) Cabling and Accessories
13. STP Cabling

1.3 QUALITY ASSURANCE

- A. All cable 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's Representative. Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based upon the acceptable manufacturers listed. Where "approved equal" is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to approval.
- B. Provide with the submittals, documentation from an independent testing agency indicating that the complete assembly including cable and termination hardware has been tested and meets the performance criteria called for.
- C. Provide contractor or sub-contractor experienced in all telephone and fiber splicing and trained and experience with the fusion splicing equipment to be used on this project.
- D. Materials and work specified herein shall comply with the applicable requirements of:
 1. ANSI/TIA/EIA – 568-A
 2. ANSI/TIA/EIA – 568-C
 3. ANSI/TIA/EIA – 569-B
 4. NFPA 70 - 2014
 5. BICSI Telecommunications Distribution Methods Manual
 6. FCC 47 CFR 68

7. NEMA - 250
8. NEC - Articles 770 and 800

1.4 SUBMITTALS

- A. Manufacturers catalog sheets, specifications and installation instructions for all products in this section.
- B. Fusion splicing kits, pigtails, and splice trays.
- C. Test results for all telephone and data UTP cable, and fiber splicing, new fiber cable installations performed in this project. Submit immediately upon completion of cable installation for review and include second copy in final O&M manuals.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Provide an end-to-end connectivity solution in which all horizontal cabling and connecting hardware are made by the same manufacturer. At a minimum, all connecting hardware and UTP patch panels shall be from the same manufacturer. Refer to specification section 271100 for additional information regarding patch panels.

2.2 CAT. 6A PATCH CABLES

- A. Category 6A - TIA 568.C.2 compliant.
- B. Ultra-small diameter patch cord.
- C. Max. 28 AWG conductors.
- D. Factory terminated RJ-45 male at both ends with strain relief boot at each end of cable. T568A/B-T568A/B.
- E. 6-foot in length minimum.
- F. Blue in color.
- G. Design Make: Belden UTP CMP Patch Cords
- H. Acceptable Manufacturers:
 1. Legrand Quicktron Snagless Slim Patch Cable
 2. Panduit UTP2SP1 Series

2.3 CAT. 6A CABLING (100 OHM UNSHIELDED TWISTED PAIR)

- A. Shall be Category 6A type cable compliant with the requirements of the most current

edition of the TIA/EIA-568-B.2-10-2008 standard.

B. Physical Characteristics:

1. Shall be CMP, plenum rated.
2. Conductor shall be 23 AWG solid bare annealed copper.
3. Outer jacket color shall be blue.
4. Category marking shall be printed every one foot. Footage indicators shall also be provided on jacket.
5. The diameter of the insulated conductor shall be .023 in. maximum.
6. Shall consist of (4) twisted pairs.
7. Shall be suitable for the environment in which they are to be installed.
8. The color coding of pairs shall be:

Pair 1	W-BL; BL
Pair 2	W-O; 0
Pair 3	W-G; G
Pair 4	W-BR; BR

9. The overall diameter of the cable shall be no greater than 0.295 inches.
10. The ultimate breaking strength measured in accordance with ASTM D 4565 shall be 400 N minimum.
11. Cable shall withstand a bend radius of 1 inch at -20 degrees Celsius without jacket or insulation cracking.

C. Transmission Characteristics:

1. Cable shall be tested & characterized to 625 MHz.
 - a. Cable shall exhibit a PSNEXT loss of at least the following:

Frequency MHz	NEXT dB
1.0	73.3
4.0	64.3
10.0	58.3
16.0	55.2
20.0	53.8
31.25	50.9
62.5	46.4
100.0	43.3

200	38.8
250	37.3
300	36.1
400	34.3
500	32.8
625	31.4

- b. Cable shall exhibit an Attenuation loss of less than the following:

Frequency MHz	Attenuation dB
1.0	2.1
4.0	3.8
10.0	5.9
16.0	7.5
20.0	8.4
31.25	10.5
62.5	15.0
100.0	19.1
200	27.6
250	31.1
300	34.3
400	40.1
500	45.3
625	51.2

- c. Cable shall exhibit a Return loss according to the following:

Frequency MHz	Return Loss (dB)
1	20.0
4	23.0
10	25.0
16	25.0
20	25.0
31.25	23.6
62.5	21.5
100	20.1
200	18.0
250	17.3
300	16.8
400	15.9
500	15.2
625	14.5

D. Design Make: Belden 10GX13 Series

E. Acceptable Manufacturers:

1. OCC
2. Bertek
3. Commscope

2.4 CAT. 6A PATCH CABLES

- A. Meets all above requirements for 100 OHM unshielded twisted pair cable (Cat. 6A cable), except stranded conductors.
- B. Factory terminated RJ-45 male at both ends with strain relief at ends of the cable.
- C. 6' or 2-meter in length minimum.
- D. Yellow in color.
- E. Design Make: Belden AX3600XX Series
- F. Acceptable Manufacturers:
 1. OCC
 2. Bertek
 3. Commscope

2.5 CONNECTING HARDWARE

- A. Color shall be electric white or ivory unless otherwise noted below.
- B. Physical Characteristics
 1. Faceplates shall be provided with labels and plastic label protector strip.
 2. Faceplates shall be modular keystone jack type, 4-port minimum or 1-gang opening with mounting bezels to accept combination keystone jacks and multimedia jacks.
 3. Each jack shall be an individually constructed unit and shall snap mount into the faceplate keystone opening.
 4. Jack housings shall be high impact 94 V-0 rated thermoplastic.
 5. Jacks shall have a temperature rating of -10 °C (14°F) to 60°C (140 °F) in conformance with ANSI/TIA/EIA-568-A.
 6. Jack housings shall fully encase and protect printed circuit boards and IDC fields.

7. Housing shall be ultrasonically welded for tamper resistance.
8. Modular jack contacts shall accept a minimum of 2500 mating cycles without degradation of electrical or mechanical performance.
9. UTP jack IDCs shall accept a minimum of 20 re-terminations without degradation of electrical or mechanical performance.
10. Contacts will maintain a minimum vertical deflection force of 100 grams over deflection window.
11. Modular jack contact wires shall be formed flat for increased surface contact with mated plugs.
12. Modular jack contacts shall be constructed of Beryllium copper for maximum spring force and resilience.
13. Jack termination shall follow the industry standard 110 IDC. Includes insulated barrier between IDC contacts.
14. Jacks shall have a designation indicating the cable type on the nose which can be plainly seen from the front of the faceplate.
15. Jacks shall utilize a paired punch down sequence. Cable pair twists shall be maintained up to the IDC, terminating all conductors adjacent to its pair mate to better maintain pair characteristics designed by the cable manufacturer.
16. Jacks shall terminate 22-26 AWG stranded or solid conductors.
17. Jacks shall include wire retention stuffer cap that hold terminated wires in place and allow the conductors to be visually inspected in the IDC housing.
18. Jacks shall be color code marked with both T-568A and T-568B wiring.

C. RJ-45 Jack Design Makes:

1. Cat. 6A Data Jacks +18" AFF (Orange Colored)
2. Voice Jacks at +18" AFF (Blue Colored)
3. Voice Jacks +48" AFF in Plastic Wall Mount Phone Bracket w/ Metal Ears – Belden AX102902 w/ Blue Cat. 6 Jack
4. Design Make: Belden AX10XXXX Series

D. Multimedia & Accessory Jack Design Makes:

1. Blank Jack Snap-In –Belden AX102262
2. Type F Jack – Belden AX102904

3. S-Video Jack – Belden AX101883
 4. RCA Three Color Stereo Audio/Video Jack – Belden AX101879
 5. VGA HD-15 pin barrel connector – Belden AX102336
 6. Other components and mounting bezels/inserts as required for special mounting conditions and for floor boxes, surface raceways and modular furniture.
- E. Faceplate Design Makes:
1. Single Gang 4-Port Faceplate w/ ID Windows – Belden AX102249
 2. Single Gang Faceplate for Combination Multimedia & Data Jacks – Belden AX101747. Provide w/ required bezels/inserts
- F. Acceptable Manufacturers:
1. Panduit (NetKey not Acceptable)
 2. Hubbell
 3. OCC

2.6 100 OHM UTP TESTER

- A. User Interface
1. 240 x 320 backlit LCD display
 2. Date stamp of all tests
 3. Tone generation audio warning
- B. Physical interface shall be modular RJ-45 connector and a serial port with DB-9 connector.
- C. Shall test cable for compliance with the following standards:
- TIA Category 3, 5E, 6 and 6A: 100 Ohm
 - ISO/IEC 11801 and EN 50173 Class C and D: Link
 - ISO/IEC 11801 and EN 50173 Class C and D (new): Permanent Link or Channel
 - Aus/NZ Class C and D: Basic Link or Channel
 - STP cabling, (IBM Type 1, 150 □)
 - ANSI TP-PMD IEEE 802.3 10BASE5, 10BASE2: Ethernet with coaxial cabling
 - IEEE 802.3 10BASE-T, 100BASE-TX, 1000BASE-T: Ethernet with twisted pair cabling
 - IEEE 802.5: Token Ring, 4 Mbps or 16 Mbps
- D. Shall perform the following tests as a minimum:

- NEXT, NEXT @ Remote
 - Wire Map
 - Characteristic Impedance
 - Length
 - DC Loop Resistance
 - Propagation Delay Return Loss (RL), RL @ Remote
 - Delay Skew
 - Attenuation
 - Attenuation-to-Crosstalk Ratio (ACR), ACR @ Remote
 - Power Sum ACR, PSACR @ Remote
 - ELFEXT, ELFEXT @ Remote
 - Power Sum ELFEXT, PSELFEXT @ Remote
 - Power Sum NEXT, PSNEXT @ Remote
- E. Shall use injector for complete wire mapping and TDR for determining cable length.
- F. Shall measure NEXT for all six pair combinations and Attenuation on all four pairs from 1.0 to 500 MHz.
- G. Design Make: Fluke “DSX-5000” or Approved Equal
- H. Acceptable Manufacturers:
1. WaveTek
 2. Lantek

2.7 INTERIOR GRADE OPTICAL FIBER CABLE

- A. Cable shall be plenum rated and meet the requirements Flame Test: UL 910.
- B. Fiber Characteristics
1. All fibers in the cable must be usable fibers and meet required specifications.
 2. All optical fibers shall be sufficiently free of surface imperfections and inclusions to meet the optical, mechanical, and environmental requirements of this specification.
 3. Each optical fiber shall consist of a doped silica core surrounded by a concentric glass cladding. The fiber shall be a matched clad design.
 4. All optical fibers shall be proof tested by the fiber manufacturer at a minimum of 100 kpsi.
 5. The fiber shall be coated with a dual layer acrylate protective coating. The coating shall be in physical contact with the cladding surface.

6. The coated fiber shall have a layer of Teflon® placed between the dual layer acrylate coating of the optical fiber and the thermoplastic buffer. The diameter of the thermoplastic buffer coating shall be $900 \pm 50 \mu\text{m}$.
 7. The fiber coating and buffer shall be removable with commercially available stripping tools in a single pass.
- C. The multimode fiber utilized in the cable specified herein shall meet EIA/TIA-492AAAC-B, Detail Specification for type OM4 50 μm Core Diameter/125 μm Cladding Diameter Multimode Optical Fibers.
1. Optimized Data Rates: 1 Gb/s over 1000 m & 10 Gb/s over 300 m.
 2. Core diameter: $50 \pm 2.5 \mu\text{m}$.
 3. Cladding diameter: $125.0 \pm 1.0 \mu\text{m}$.
 4. Core-to-Cladding Offset: $\leq 2.0 \mu\text{m}$.
 5. Cladding non-circularity: $\leq 1.0 \%$.
 6. Core non-circularity: $\leq 5.0 \%$.
 7. Coating Diameter: $245 \pm 5 \mu\text{m}$
 8. Attenuation Uniformity: There shall be no point discontinuities greater than 0.2 dB at either 850 nm or 1300 nm.
- D. The non-dispersion shifted single-mode fiber utilized in the cable specified herein shall conform to the following specifications:
1. Typical Core Diameter: 8.3 μm .
 2. Cladding Diameter: $125.0 \pm 1.0 \mu\text{m}$.
 3. Core-to-Cladding Offset: $\leq 0.6 \mu\text{m}$.
 4. Cladding Non-Circularity: $\leq 1.0\%$.
 5. Coating Diameter: $245 \pm 10 \mu\text{m}$.
 6. Attenuation Uniformity- No point discontinuity greater than 0.1 dB at either 1310 nm or 1550 nm.
 7. Attenuation at the Water Peak- The attenuation at $1383 \pm 3 \text{ nm}$ shall not exceed 2.1 dB/km.
 8. Cutoff Wavelength- The cabled fiber cutoff wavelength shall be $< 1260 \text{ nm}$.

9. Mode Field Diameter: $9.30 \pm 0.50 \mu\text{m}$ at 1310 nm
 $10.50 \pm 1.00 \mu\text{m}$ at 1550 nm
10. Zero Dispersion Wavelength (λ_0)- $1301.5 \text{ nm} \leq \lambda_0 \leq 1321.5 \text{ nm}$.
11. Zero Dispersion Slope (S_0)- $\leq 0.092 \text{ ps}/(\text{nm}^2 \bullet \text{km})$.
12. Fiber Curl: $> 4.0 \text{ m}$ radius of curvature.

E. Fiber Parameters

1. All fibers in the cable shall meet the requirements of this specification.
2. The attenuation specification shall be a maximum attenuation for each fiber at $23 \pm 5^\circ\text{C}$.
3. The attenuation of the cabled fiber shall be uniformly distributed throughout its length such that there are no discontinuities greater than 0.1 dB at 1310 nm/1550 nm (single-mode) or 0.2 dB at 850 nm/1300 nm (multimode) in any one kilometer length of fiber.

F. Physical Characteristics

1. Plenum Cables up to 24 Fibers:
 - a. The fibers may be stranded around a dielectric central member and surrounded by layered aramid yarns. The aramid yarns shall serve as the tensile strength member of the cable.
 - b. A ripcord shall be applied between the aramid yarns and the outer jacket to facilitate jacket removal.
 - c. The outer jacket shall be extruded over the aramid yarns for physical and environmental protection.
2. Strength Members:
 - a. The strength member shall be a high modulus aramid yarn.
 - b. The aramid yarns shall be helically stranded around the buffered fibers.
 - c. A non-toxic, non-irritant talc shall be applied to the yarn to allow the yarns to be easily separated from the fibers and the jacket.
3. Cable Jacket:
 - a. The jacket shall be continuous, free from pinholes, splits, blisters, or other imperfections.

- b. The jacket shall have a consistent uniform thickness; jackets extruded under high pressure are not acceptable.
 - c. The jacket shall be smooth, as is consistent with the best commercial practice.
 - d. The jacket shall provide the cable with a tough, flexible, protective coating, able to withstand the stresses expected in normal installation and service.
- 4. The cable and subunit jacket color shall be teal for cables containing multimode fibers. The cable and subunit jacket color shall be yellow for cables containing single-mode fibers. The cable and subunit jacket color shall be black for hybrid or indoor/outdoor cables.
 - 5. For cables with more than two fibers, the cable jacket shall be designed for easy removal without damage to the optical fibers by incorporating a ripcord under each cable jacket. A non-toxic, non-irritant talc shall be applied to the aramid yarns to allow the yarns to be easily separated from the fibers and the jacket.
 - 6. The nominal thickness of the cable outer jacket shall be sufficient to provide adequate cable protection while meeting the mechanical, flammability, and environmental test requirements of this document over the life of the cable. The cable shall be all-dielectric.

G. Identification

- 1. The individual fibers shall be color coded for identification. The optical fiber color coding shall be in accordance with EIA/TIA-598, "Color Coding of Fiber Optic Cables." The coloring material shall be stable over the temperature range of the cable, shall not be susceptible to migration, and shall not affect the transmission characteristics of the optical fibers. Color coded buffered fibers shall not adhere to one another. When fibers are grouped into individual units, each unit shall be numbered on the unit jacket for identification. The number shall be repeated at regular intervals.
- 2. The outer cable jacket shall be marked with the manufacturer's name or file number, date of manufacture, fiber type, flame rating, listing mark, and sequential length markings every two feet. The marking shall be in contrasting color to the cable jacket.

H. Additional Requirements

- 1. The storage temperature range for the cable on the original shipping reel shall be -40°C to +70°C. The installation/operating temperature range for plenum cables shall be 0°C to +70°C. Testing shall be in accordance with FOTP-3.
- 2. Crush Resistance - The cable shall withstand a minimum compressive load of 890 N/cm (500 lbf/in) applied uniformly over the length of the compression

plate. The cable shall have an aluminum or steel interlock armor that increases the crush resistance at least ten times that of standard fiber cable, typically 89 N/cm (50 lbf/in). The cable shall be tested in accordance with FOTP-41, "Compressive Loading Resistance of Fiber Optic Cables." While under compressive load, the fibers shall not experience an attenuation change greater than 0.4 dB at 1550 nm (single-mode) or greater than 0.6 dB at 1300 nm (multimode). After the compressive load is removed, the fibers shall not experience an attenuation change greater than 0.2 dB at 1550 nm (single-mode) or greater than 0.4 dB at 1300 nm (multimode).

3. Impact Resistance - The cable shall withstand a minimum of 20 impact cycles. The cable shall be tested in accordance with FOTP-25, "Repeated Impact Testing of Fiber Optic Cables and Cable Assemblies." The fibers shall not experience an attenuation change greater than 0.2 dB at 1550 nm (single-mode) or greater than 0.4 dB at 1300 nm (multimode).
4. Cyclic Flexing - The cable shall withstand 25 mechanical flexing cycles at a rate of 30 ± 1 cycles per minute. The cable shall be tested in accordance with FOTP-104, "Fiber Optic Cable Cyclic Flexing Test." The fibers shall not experience an attenuation change greater than 0.2 dB at 1550 nm (single-mode) or greater than 0.4 dB at 1300 nm (multimode).
5. Flammability - All cables shall comply with the requirements of the National Electrical Code® (NEC®), Article 770. Plenum cables (OFNP and OFCP) shall pass UL-910.

I. Design Make: Corning ClearCurve Multimode (OM4) part number - 024T88-33190-29 and Singlemode (OS2) part number - 024E88-33131-29.

J. Acceptable Manufacturers:

1. OCC
2. General Cable
3. Belden

2.8 EXTERIOR GRADE OPTICAL FIBER

- A. Shall be a multi-mode/single-mode cable with the quantity of fibers as called for on the cable riser diagram and/or drawings.
- B. Outdoor cable for outdoor lashed aerial, ducts and Indoor when installed according to National Electric Code (NEC) Article 770. Cable shall meet or exceeds requirements for Inter-building fiber optic cables as outlined in GR-409-CORE.Design and Test Criteria ANSI/ICEA S-87-640.
- C. Indoor/Outdoor cable shall be UL-listed type OFNP in accordance with NEC sections 770-179 (A) and 770-154 (A) for use in ducts, plenums, and air-handling spaces. Meets

or exceeds requirements for intra-building fiber optic cables as outlined in GR-409-CORE.Design and Test Criteria ANSI/ICEA S-104-696; NFPA 262

D. General Fiber Characteristics

1. All fibers in the cable must be usable fibers and meet required specifications list above for interior grade optical fiber.

E. Physical Construction

1. Optical fibers shall be placed inside a loose buffer tube. The nominal outer diameter of the buffer tube shall be 3.0mm.
2. Each buffer tube shall contain up to 12 fibers.
3. The fibers shall not adhere to the inside of the buffer tube.
4. Each fiber and each buffer tube shall be distinguishable by means of color coding in accordance with TIA/EIA-598-A, "Optical Fiber Cable Color Coding."
5. The fibers shall be colored with ultraviolet (UV) curable inks.
6. Buffer tube colored stripes shall be inlaid in the tube by means of co-extrusion when required. The nominal stripe width shall be 1 mm.
7. For dual layer buffer tube construction cables, standard colors shall be used for tubes 1 through 12 and stripes are used to denote tubes 13 through 24. The color sequence applies to tubes containing fibers only, and shall begin with the first tube. If fillers are required, they shall be placed in the inner layer of the cable. The tube color sequence shall start from the inside layer and progress outward.
8. The buffer tubes shall be resistant to external forces and shall meet the buffer tube cold bend and shrinkback requirements of 7 CFR 1755.900.
9. The central anti-buckling member shall consist of a dielectric, glass reinforced plastic (GRP) rod. The purpose of the central member is to prevent buckling of the cable. The GRP rod shall be overcoated with a black colored thermoplastic when required to achieve dimensional sizing to accommodate buffer tubes/fillers.
10. All interior buffer tubes shall be protected against water penetration by water blocking tapes and yarns that swell to absorb water.
11. Two polyester yarn binders shall be applied contrahelically with sufficient tension to secure each buffer tube layer to the dielectric central member without crushing the buffer tubes. The binders shall be non-hygroscopic, non-wicking and dielectric with low shrinkage.
12. For single layer cables, a water blocking tape shall be applied longitudinally around the outside of the stranded tubes/fillers. The tape shall be held in place by

a single polyester binder yarn. The water blocking tape shall be non-nutritive to fungus, electrically non-conductive and homogenous. It shall also be free from dirt and foreign matter.

13. For dual layer cables, a second (outer) layer of buffer tubes shall be stranded over the original core to form a two layer core. A water blocking tape shall be applied longitudinally over both the inner and outer layer with each being held in place with a single polyester binder yarn. The water blocking tape shall be non-nutritive to fungus, electrically non-conductive and homogenous. It shall also be free from dirt and foreign matter.
14. The cable shall contain at least one ripcord under the sheath for easy sheath removal of all-dielectric cable. The cable shall contain at least one ripcord under the inner sheath and under the steel armor for armored cable. The ripcord color shall be orange for non-armored sheaths and red for armored sheaths.
15. Tensile strength shall be provided by dielectric yarns. The high tensile strength dielectric yarns shall be helically stranded evenly around the cable core.
16. OFNP listed type jacket material. The jacket or sheath shall be free of holes, splits, and blisters. The cable jacket shall contain no metal elements and shall be of a consistent thickness. The jacket shall contain carbon black to provide ultraviolet light protection and shall not promote the growth of fungus.
17. Cable jackets shall be marked with manufacturer's name, sequential meter or foot markings, month and year, or quarter and year of manufacture, and a telecommunication handset symbol, as required by Section 350G of the National Electrical Safety Code (NESC). The actual length of the cable shall be within -0/+1% of the length markings. The print color shall be white, with the exception that cable jackets containing one or more coextruded white stripes shall be printed in light blue. The height of the marking shall be approximately 2.5 mm.

F. General Cable Performance Specifications

1. When tested in accordance with FOTP-3, "Procedure to Measure Temperature Cycling Effects on Optical Fibers, Optical Cable, and Other Passive Fiber Optic Components," the change in attenuation at extreme operational temperatures (-40 °C and +70°C) shall not exceed 0.2 dB/km at 1550 nm for single-mode fiber and 0.5 dB/km at 1300 nm for multimode fiber.
2. When tested in accordance with FOTP-82, "Fluid Penetration Test for Fluid-Blocked Fiber Optic Cable," a one meter length of unaged cable shall withstand a one meter static head or equivalent continuous pressure of water for one hour without leakage through the open cable end.
3. When tested in accordance with FOTP-81, "Compound Flow (Drip) Test for Filled Fiber Optic Cable", the cable shall exhibit no flow (drip or leak) of filling and/or flooding material at 80°C.

4. When tested in accordance with FOTP-41, "Compressive Loading Resistance of Fiber Optic Cables," the cable shall withstand a minimum compressive load of 440 N/cm (250 lbf/in) for armored cables and 220 N/cm (125 lbf/in) for non-armored cables applied uniformly over the length of the sample. The load shall be applied at the rate of 3 mm to 20 mm per minute and maintained for ten minutes. The change in attenuation shall not exceed 0.4 dB during loading at 1550 nm for single-mode fiber and 1.0 dB during loading at 1300 nm for multimode fiber. The repeatability of the measurement system is typically ± 0.05 dB or less. No fibers shall exhibit a measurable change in attenuation after load removal.
5. When tested in accordance with FOTP-104, "Fiber Optic Cable Cyclic Flexing Test," the cable shall withstand 25 mechanical flexing cycles around a sheave diameter not greater than 20 times the cable diameter. The change in attenuation shall not exceed 0.1 dB at 1550 nm for single-mode fiber and 0.3 dB at 1300 nm for multimode fiber.
6. When tested in accordance with FOTP-25, "Repeated Impact Testing of Fiber Optic Cables and Cable Assemblies," the cable shall withstand 25 impact cycles. The change in attenuation shall not exceed 0.2 dB at 1550 nm for single-mode fiber and 0.3 dB at 1300 nm for multimode fiber.
7. When tested in accordance with FOTP-33, "Fiber Optic Cable Tensile Loading and Bending Test," using a maximum mandrel and sheave diameter of 560 mm, the cable shall withstand a tensile load of 2700 N (608 lbf). The change in attenuation shall not exceed 0.2 dB during loading and 0.1 dB after loading at 1550 nm for single-mode fiber and 0.5 dB during loading and 0.2 dB after loading at 1300 nm for multimode fiber.
8. When tested in accordance with FOTP-85, "Fiber Optic Cable Twist Test," a length of cable no greater than 4 meters shall withstand 10 cycles of mechanical twisting. The change in attenuation shall not exceed 0.1 dB at 1550 nm for single-mode fiber and 0.2 dB at 1300 nm for multimode fiber.
9. When tested in accordance with FOTP-181, "Lightning Damage Susceptibility Test for Optic Cables with Metallic Components," the cable shall withstand a simulated lightning strike with a peak value of the current pulse equal to 105 kA without loss of fiber continuity. A damped oscillatory test current shall be used with a maximum time-to-peak value of 15 μ s (which corresponds to a minimum frequency of 16.7 kHz) and a maximum frequency of 30 kHz. The time to half-value of the waveform envelope shall be from 40 - 70 μ s.
10. When tested in accordance with FOTP-37, "Low or High Temperature Bend Test for Fiber Optic Cable", the cable shall withstand four full turns around a mandrel of ≤ 10 times the cable diameter for non-armored cables and ≤ 20 times the cable diameter for armored cables after conditioning for four hours at test temperatures of -30°C and +60°C. Neither the inner or outer surfaces of the jacket shall exhibit visible cracks, splits, tears or other openings. Optical continuity shall be maintained throughout the test."

11. All cabled optical fibers > 1000 meters in length shall be 100% attenuation tested. The attenuation of each fiber shall be provided with each cable reel.
- G. Design Make: Outdoor cables shall be Corning Altos-All dielectric Multimode (OM4) cable part number - xxxTU4-T4790D20 and Singlemode (OS2) part number xxxEU4-T4701D20 or equivalent. Indoor/outdoor plenum cable shall be Corning Freedom Loose tube multimode (OM4) part - xxxTWP-T4190D20 and Singlemode (OS2) part number - xxxEWP-T4101D20 or equivalent. Where xxx represents the cable fiber count.
- H. Acceptable Manufacturers:
 1. OCC
 2. General Cable
 3. Belden

2.9 OPTICAL FIBER CABLE CONNECTORS

- A. Backbone optical fiber connectors shall be LC small form factor type.
- B. The terminations shall comply with the following standards:
 1. EIA/TIA-4750000B Generic Specifications for Fiber Optic Connectors
 2. EIA/TIA-455-A Standard Test Procedures for Optical Fibers, Cables, Transducers, Sensors, Connecting and Terminating Devices, and Other Fiber Optic Components (FOTPs)
 3. TIA/EIA-604-10 Fiber Optic Connector Interchangeability Standard, (Type LC)
- C. Connector Characteristics.
 1. Strain relief: The connector shall provide a strain relief mechanism for installation on a single fiber cable that contains strength elements. The fiber within the body of the connector shall be isolated mechanically from cable tension, bending and twisting.
 2. Interchangeability: The connector shall be designed in compliance with the appropriate TIA FOCIS document.
 3. Installation rate: The connector shall be installable on 900 µm buffered fiber in 1 minute or less total time.
 4. Installation polishing: The connector shall not require polishing of the endface in the field. Connectors shall have a factory-polished fiber stub in the connector ferrule.

5. Installation type: The connector installation shall not require the use of epoxies.
6. Fiber protection: The connector crimp-on mechanism shall protect the bare fiber from the ingress of air or waterborne contaminants and shall secure the fiber in the ferrule micro-hole.

D. Performance Requirements

Multimode Testing		Max delta change	Final Measurement
FOTP-171 METHOD B1	METHOD B1 REQ.: <.75dB	N/A	0.11 dB TYP 0.19 dB MAX
FOTP 107	RETURN LOSS REQ.: <-20dB	N/A	-42.5 dB TYP -36.3 dB MIN
FOTP-2	IMPACT 8 DROPS/ 1.5 M	N/A	0.14 dB IL -41.3 dB RL
FOTP-1	FLEX 0.5 KG	N/A	0.18 dB IL -41.3 dB RL
FOTP-36	TWIST 15 N AT 0 °	N/A	0.20 dB IL -41.2 dB RL
FOTP-6	CABLE RETENTION 66 N AT 0 °	0.06 dB	0.20 dB IL -41.2 dB RL
FOTP-6	CABLE RETENTION 19.4 N AT 90 °	0.06 dB	0.19 dB IL -41.2 dB RL
FOTP-185	COUPLING MECH 33 N AT 0 °	N/A	0.13 dB IL -41.5 dB RL
FOTP-21	DURABILITY 500 CYCLES	N/A	dB IL -36.3 dB RL
FOTP-4	TEMP LIFE 60°C/ 14 DAYS	0.01 dB	0.08 dB IL -39.0 dB RL
FOTP-5	HUMIDITY 4 DAYS @ 95%	0.15 dB	.09 dB IL -38.9 dB RL
FOTP-188	LOW TEMP. -10 °C/4 DAYS	0.22 dB	0.13 dB IL -42.3 dB RL
Single Mode Testing		Max delta change	Final Measurement
FOTP-171 METHOD B1	INSERTION LOSS	N/A	dB TYP 0.52 dB MAX
FOTP 107	RETURN LOSS	N/A	-44.4 dB TYP -36.2 dB MIN
FOTP-2	IMPACT	N/A	dB IL

Multimode Testing		Max delta change	Final Measurement
	8 DROPS/ 1.5 M		-40.6 dB RL
FOTP-1	FLEX 0.5 KG	N/A	0.40 dB IL -40.1 dB RL
FOTP-36	TWIST 15 N AT 0 °	N/A	0.37 dB IL -40.2 dB RL
FOTP-6	CABLE RETENTION 66 N AT 90 °	0.20 dB	0.39 dB IL -42.3 dB RL
FOTP-6	CABLE RETENTION 19.4 N AT 90 °	0.11 dB	0.34 dB IL -43.2 dB RL
FOTP-185	COUPLING MECH 33 N AT 0 °	N/A	0.37 dB IL -45.0 dB RL
FOTP-21	DURA- BILITY 500 CYCLES	N/A	0.35 dB IL -40.5 dB RL
FOTP-4	TEMP LIFE 60°C/ 14 DAYS	0.24 dB	0.29 dB IL -44.2 dB RL
FOTP-5	HUMIDITY 4 DAYS @95%	0.10 dB	0.30 dB IL -43.9 dB RL
FOTP-188	LOW TEMP. -10 °C	0.18 dB	0.29 dB IL -44.1 dB RL

E. Design Make: The fiber optic connector shall be Corning Unicam connector with LC multimode (OM4) part number - 95-050-99-X and single mode (OS2) part number - 95-200-99; SC multimode (OM4) part number - 95-050-41-X and singlemode (OS2) part number - 95-200-41 or equivalent. Termination of Loose tube cable fiber shall require the use of Corning indoor Fanout kit part number - FAN-BT25-12 and outdoor fanout kit part number - FAN-OD25-12 or equivalent.

F. Acceptable Manufacturers:

1. Belden
2. Hubbell
3. Leviton
4. Panduit

2.10 OPTICAL FIBER TESTING EQUIPMENT

A. Multimode optical fiber light source

1. Provide 850nm and 1300nm +/- 20 nm wavelength LED light sources.
2. Spectral width of sources shall be $\leq 50\text{nm}$ for 850nm wavelengths and $\leq 140\text{nm}$ for 1300nm wavelengths.
3. The output of the light source shall be 8 MW for 50um core optical fiber.
4. Output Stability +/- 0.40 dB from 0 to 50 degrees C.
5. Long Term output stability +/- 0.10dB at 25 degrees C.
6. Power shall be from rechargeable Ni-Cad batteries.
7. Connector types shall include: LC, ST and SC.
8. Design make: Siecor Light source.
9. Acceptable Manufacturers:
 - a. Fluke
 - b. Wavetek
 - c. Lantek

B. Singlemode optical fiber light source

1. Provide 1300nm and 1500nm +/- 20 nm wavelength Laser light sources.
2. Output Stability +/- 0.40 dB from 0 to 50 degrees C.
3. Long Term output stability +/- 0.10dB at 25 degrees C.
4. Power shall be from rechargeable Ni-Cad batteries.
5. Connector types shall include: SMA, FC, ST and SC.
6. Design make: Siecor OS-200D.
7. Acceptable Manufacturers:
 - a. Fluke
 - b. Meson
 - c. Amp

C. Power Meter

1. Provide 850nm, 1300nm and 1500nm +/- 20 nm wavelength test capability.
2. Measurement range shall be from 10 to -60 dBm.
3. Accuracy shall be +/- 5% at 0 to -50dBm and +/- 10% 10 to 0dBm and -50 to -60 dBm.
4. Resolution shall be 0.1 dB.
5. Connector types shall include: LC, ST and SC.
6. Design make: Siecor OM-100F.
7. Acceptable Manufacturers:
 - a. Fluke
 - b. Meson
 - c. Amp

2.11 FUSION SPLICING

- A. Fiber splicing techniques shall be conducted in such a manner that the cores of the fibers to be spliced will be aligned as perfectly as possible to allow maximum light transmission from one fiber to the next. Without proper alignment or nonidentical core diameters, light will leave the fiber core and travel through the fiber cladding. Light outside the fiber core is not a usable light signal and is not acceptable.
- B. The cable manufacturer's recommendations concerning pulling tensions and bending radius shall be followed.
- C. Fiber optic splices shall be made in areas where temperature, humidity, and cleanliness can be controlled. Fusion splicing techniques shall require a splicing vehicle equipped with a work station that will allow environmental control.
- D. Clean all cable coatings and fibers to fusion splicing equipment manufacturer's recommendations.
- E. Cleaving tools shall be clean and have sharp cutting edges to minimize fiber scratches and improper cleave angles. Cleaving tools that are recommended by the manufacturer of the splicing system shall be used. Design Make: Siecor # FBC-005, Alcoa Fujikura C012 or equal.
- F. The average fusion splice loss shall not exceed 0.2 dB for both single and multi-mode fibers. The average splice loss is defined as the summation of the loss as measured in both directions using an optical time domain reflectometer (OTDR) through the fusion splice divided by two.

- G. Protective pig-tail splicing kits inside fiber optic patch panels with integrate adapters.

2.12 BONDING HARNESS

- A. Shall be used to ground the shields of the spliced cables.
- B. Bonding harness shall be 14 AWG and sized according to closure.
- C. Adhere to all manufacturer installation guidelines.
- D. Design Make: 3M or Approved

2.13 BONDING CONNECTORS

- A. Shall consist of a base and upper member, two securing nuts and a plastic shoe to aid connector installation and protect the conductors.
- B. Base and upper members shall be made of tin plated tempered brass, slightly curved so as to exert a continuous spring form on sheath and shield after clamping.
- C. Design Make: 3M Telecommunication Access Division Products or equal
 - 1. 3M Part # 4460 – S Shield Bond Connector for cables of greater than 100 pair.
 - 2. #M Part # 4460 – D Shield Bond Connector for cables of less than 100 pair.

2.14 GROUNDING BRAID

- A. Provide #6 AWG insulated green 600-volt THHN conductor from telecom equipment grounding point back to equipment ground bus in nearest 120V panelboard.
- B. All taps shall be made with UL listed lugs.
- C. Provide ½” EMT conduit to protect ground conductor from the equipment grounding point back to the 120V panelboard.

2.15 BUILDING ENTRANCE TERMINALS

- A. Shall be installed at the termination point at each end of exterior backbone UTP cable installations between buildings.
- B. Shall be wall mountable and protect up to 25 lines.
- C. BIX-style input connector and BIX-style output connector.
- D. External ground lug.
- E. Accommodates industry standard 5-pin lightning protection modules.
- F. Design Make: Porta-Systems or Approved Equal.

2.16 LIGHTNING PROTECTION MODULES

- A. Shall be 5-pin, 3-element gas type surge-protection modules.
- B. Over voltage on either side of termination shall ionize gas and ground both sides of the circuit.
- C. UL 497 listed.
- D. Black plastic housing for surge modules, green plastic housing on spare modules.
- E. Nominal breakdown voltage – 230VDC @ 100V/msec.
- F. Design Make: Comm-Omni SRA-200EP or Approved Equal.
- G. Design Make: AT&T #3B2D Green dummy modules or Approved Equal.

2.17 AUDIO/VIDEO (A/V) CABLING AND ACCESSORIES

- A. All interconnect audio and video cabling and patch cabling shall be high-resolution shielded type coaxial cable.
- B. Audio and video cabling lengths are to be field measured unless otherwise listed.
- C. Category 6 cable may be used for unbalanced RCA audio cabling where the distance does not exceed 30 feet.
- D. All balanced audio cabling shall be STP type.
- E. All S-Video (Y&C) signals transmitted over 6' shall be split onto (2) separate coaxial cables. (1) Cable for the Y signal and (1) cable for the C signal. These individual cables shall have BNC or RCA connectors.
- F. All full-length cables between active components shall have factory pre-terminated connectors. Field verify cable terminations requirements i.e. (male/male) or (male/female).
- G. All analog S-Video, Composite Video cabling shall be 75Ω.
- H. Video cabling shall meet the following requirements:
 - 1. VGA Video Cabling
 - a. HD15-pin type connectors
 - b. Bandwidth - 135 MHz @ 50', -3dB, w/.7 Vp-p signal
 - c. .35" diameter
 - d. Design Make: Extron IN8000 series or Approved Equal

2. 3.5 mm Stereo Audio Cables

- a. mini stereo jack male connectors on both ends of cable
- b. same length as VGA cable
- c. Design Make: Extron 26-571-05 or Approved Equal
- d. Bandwidth - 120 MHz @ 50', -3dB, w/.7 Vp-p signal
- e. .24" diameter
- f. Design Make: Extron IN8600P series or Approved Equal

3. HD-SDI Cabling

- a. Up to 100-foot factory terminated cable available.
- b. Superior performance cable for critical analog AV systems and SDI/HDSOI applications
- c. Double-shielded foil and copper braid to reduce crosstalk, maintaining integrity of the video signal. Highest resolution, low loss cable.
- d. One 18 AWG, 75 ohm coaxial conductor
- e. Terminated with high quality 75 ohm BNC connectors
- f. Design Make: Extron RG6 BNC Series or Approved Equal

4. HDMI Cabling

- a. 4K verified up to 50 feet (15.2 m)
- b. 1080p/60 verified up to 200 feet (60 m)
- c. Cables up to 50-feet: Supports 4K @ 30 Hz (4096 x 2160), UHD @ 30 Hz (3840 x 2160), and 1080p @ 60 Hz signals, Data rates to 10.2 Gbps, Color depth up to 48 bits - 16 bits per color.
- d. Cables up over 75-feet: Exceeds HDMI Standard Speed Cable Specifications, Supports signals up to 1080p @ 60 Hz, 8-bit color depth, Data rates to 4.95 Gbps, Color depth to 24 bits - 8 bits per color.
- e. Include required HDMI active equalizer for all cable lengths over 75-feet. Equalizer shall Extend HDMI signals over HDMI cable up to 200 feet, self powered for cables 125-feet or less. Prove with 120V:12VDC power adapter. HDMI input and output ports.
- f. Design Make: Extron HDMI Pro Series w/ HDMI 101 Plus equalizer or

Approved Equal

5. Speaker Wire
 - a. 2 conductor twisted, No. 14 AWG stranded copper
 - b. Design Make: West Penn Wire Corporation, No. 226
- I. Provide the following cable adapters as required:
 1. HD-SDI to HDMI: Design Make: Extron or Approved Equal
 2. HDMI to mini-HDMI: Design Make: Extron or Approved Equal
 3. 3.5mm mini stereo male to (2) RCA female: Design Make: Extron or Approved Equal
- J. Provide Multimedia A/V outlet for all locations shown on the drawings.
 1. Provide barrel type jacks for connecting all pre-terminated cable.
 2. Provide solder type jacks for audio cable or where bulk cable is required.
 3. Wall plates shall be designed for standard 1-gang backbox mounting.
 4. The wall plates shall accept the following A/V modules and jacks.
 - a. S-Video
 - b. Type F coaxial
 - c. RCA stereo audio
 - d. 3.5mm mini stereo jack
 - e. BNC
 - f. 3-pin and 4-pin XLR
 - g. RCA audio and video with separate colors
 - h. HDMI
 - i. DVI-D
 - j. HD15-pin VGA

2.18 PUBLIC ADDRESS STP CABLING

- A. Cable shall be ASTM tinned copper, 18 AWG (7x26 stranded), shielded and unshielded

twisted pairs. Pair counts as required by manufacturer.

- B. 300 Volt insulation.
- C. Aluminum foil shield with tinned copper drain wire.
- D. Cable shall be UL listed NEC type CMP, constructed in accordance with UL 444.
- E. Cable shall be fully functional from -10°C to 60°C.
- F. Design Make: West Penn or Approved Equal

2.19 ACCESS CONTROL STP CABLING

- A. Aluminum foil shield with tinned copper drain wire.
- B. Cable shall be UL listed NEC type CMP, constructed in accordance with UL 444.
- C. RS485 Network Wiring: RS-485 standard compliant, up to 4000 feet (1200 m), 22-24 AWG Tinned Copper, FEP (Teflon) insulation, Impedance: 100-120 Ohms Capacitance: 12-16pf/f.
- D. Reader Wiring: 3-Pair 22 AWG Shielded
- E. Design Make: West Penn or Approved Equal

2.20 LABELING

- A. All labels shall be typed on self-adhesive label strips where a plastic protector is not present on the termination equipment.
- B. All letters and numbers shall be capital and the same font, black colored text on white background, closest to size 12 ARIAL FONT as possible.
- C. Label maker Design Make: DYMO or Approved Equal.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Labeling
 - 1. Label horizontal all cable outlets to mirror the labeling on the demarc end or wiring closet end. All labels shall be typed indicating CER, Patch Panel, and Port Number.
- B. Horizontal Cable Runs:
 - 1. All interior cabling shall be installed concealed inside the wall cavities and ceiling space. Provide a continuous ENT or innerduct raceway system in

accordance with NEC Article 800 for horizontal cable runs through all inaccessible ceiling (drywall) and wall cavity spaces. All flexible raceway system runs shall be securely attached to ceiling joists and wall studs. The flexible raceway system shall be adequately supported and routed to allow the addition and removal of cables in the future.

2. Provide open top “J-Hook” cable hangers located 3-feet on center for all wiring installed above recessed drop ceilings. Securely attach cable hangers to building structure.
3. Refer to specification section 260533 – Raceways for maximum cable fill in raceway systems.
4. Where larger cable quantities are required to share a single raceway refer to EIA/TIA-569 Conduit Sizing Table 4.4-1.
5. All new device outlets in finished areas shall be flush mounted in the walls.
6. Provide surface raceway for all wiring installations in unfinished areas and conduit for all areas with no ceiling open to the structure.
7. All exterior cabling shall be run in direct buried conduit.
8. Provide separate pathways for all control, video, and signal wiring from 120V branch circuiting.
9. Provide all sleeves as required for routing of cables.
10. Provide firestopping at all firewall and floor penetrations.
11. Do not untwist Cat. 6 cable pairs more than 0.5 in. when terminating.
12. Provided inner duct as required to route A/V signal cabling in plenum ceiling spaces. Inner duct shall be 1 ½” diameter, plenum rated, and have pull tape. Design Make: Carlon CH4X1C-350.
13. Cable shall have no physical defects such as cuts, tears or bulges in the outer jacket. Cables with defects shall be replaced.
14. Install cable in neat and workmanlike manner. Neatly bundle and tie all cable in at terminations.
15. Maintain the following clearances from EMI sources.
 - a. Power cable - 6 in.
 - b. Fluorescent Lights - 12 in.
 - c. Transformers - 36 in.

16. Do not install with more than 110N pull force.

3.2 AUDIO/VIDEO CABLING AND ACCESSORIES

- A. Provide all required patch cables not shown on the drawings to interface equipment specified in this section.
- B. Provide 2'x2' projector plate with extension column above ceiling mount projector location. Prior to rough-in coordinate distance off projector screen or SmartBoard based on the selected projector throw. Independently support the projector plate with support wires to structure above drop ceiling.
- C. Cut 2'x4' acoustical ceiling tiles to fit the 2'x2' projector plate. General contractor shall furnish 2' t-bar ceiling accessible bracket to support the half tile and unsupported end of the projector plate.
- D. Hang projector from projector plate. Install 120V duplex receptacle flush in knockout in plate. A/V wiring may be run directly to projector and concealed inside 1 ½" pipe column from ceiling down to projector.
- E. Connect A/V wiring and power cord to projector.

3.3 UTP TELEPHONE CABLE

- A. Backbone copper cables shall be installed in metallic conduit inside building where the length is greater than 50-feet.
- B. Placement of underground cables shall conform to REA 644 Cable Standards.
- C. Label 110-Style backbone cable termination blocks, with typed or printed designation strips, matching color code and 606A standards or as called for. Stencil first and last pair tab with appropriate count. Stencil every fifth pair of each termination block with the appropriate cable count. For 25 pair and greater house or backbone cable, provide designation strips with 5 pair increments identified for quick reference.
- D. The contractor shall replace the cable if damaged during installation.
- E. Test all backbone copper cable pairs and record results on test sheets provided at end of this section. Multi-pair cables shall be replaced if they contain more than 1% bad pairs.
- F. Cross connect hardware and designation strips for BIX blocks shall be color-coded with industry standard 606A coded fields, as follows:

Description	Color
C.O. Circuits	Green
PBX Circuits	Purple
Auxiliary Circuits	Yellow
Wiring to Work Station	Blue
Back Bone Cable	White

Wiring from MUX Concentrators, etc. on a Fiber or UTP Backbone	Orange
Tie Lines	Grey

- G. Unless otherwise specified, noted backbone copper cables shall be sized based on two pairs/connected voice jack. Round up to the next audible pair sizing when doing calculations.
- H. Where backbone copper cable incorporates a campus system (i.e., multiple buildings connected to the backbone), all cable shall be installed with gas tube or solid state protection devices at both ends.
- I. Secure all backbone cables to wall within 12" of all splice enclosures. Support cable and splice enclosures at both ends and the center of all splice enclosures.
- J. Unless otherwise specified, noted backbone cables shall be sized based on two-pairs/connected voice jack. Round up to the next audible pair sizing when doing calculations.
- K. Where backbone cable incorporates a campus system (i.e., multiple buildings connected to the backbone), all cable shall be installed with gas tube or solid state protection devices at both ends.
- L. Test, label and document. Provide completed tests sheets for all backbone copper pairs, on copper test sheets provided.
- M. A pull cord (nylon; 1/8" minimum) shall be co-installed with all cable installed in any conduit.
- N. Where cables are housed in conduits, the backbone and horizontal cables shall be installed in separate conduits.
- O. All backbone cables shall be securely fastened to the side wall of the CER.

3.4 OPTICAL FIBER CABLE

- A. General
 - 1. Interior cable shall be installed completely inside UL listed innerduct or integral concentric metallic jacket.
 - 2. Innerduct and fiber cables shall be supported by top J-hook cable hanger's 3-foot on center or in cable tray.
 - 3. Install the cable and innerduct assembly as close to the ceiling deck as possible in a segregated pathway. Do not install with UTP or coax cables.
 - 4. Provide tie wraps to close top of cable hangers after installation is complete.

5. Exterior cable shall be installed in one of the following methods:
 - a. Underground ductbank
 - b. Metallic conduit for installations more than 50 feet inside building in accordance with NEC Article 770 and 800.
- B. Maintain polarization for entire system as described in ANSI/EIA/TIA-568-A section 12.7.1.
- C. Cable shall be continuous. Splices are not allowed except where fusion splicing is called for in the documents.
 1. Cable Pulling
 - a. Adhere to all manufacturer's requirements regarding pulling tension, allowable lubricants and bending radius.
 - b. Provide cable pullers designed to suit field conditions. (i.e. horizontal vault pulls, vertical pulls and 45 degree pulls).
 - c. Use cable guides with aluminum adapters sized for the 1 ¼" cells. Provide extensions, sheaves and adapters as required by the installation conditions.
 - d. Use directional pulling swivels as conditions require.
 - e. Use Line Tension meter during cable pull to provide accurate measurements of the force exerted on a cable as it is installed. The meter shall have a programmable overload set point with an audible and visual indication of an overload condition. The meter shall have controls to disengage the cable puller if an overload occurs. Provide chart recorded documentation of the cable pull for the Owner's records.
 - f. Provide cable rack supports in all manholes with 10-foot service loop.

3.5 UTP CABLE TESTING

- A. General
 1. All cables and termination hardware shall be 100% tested for defects in installation and to verify cabling system performance under installed conditions according to the requirements of each applicable ANSI/TIA/EIA section listed above for each cable type.
 2. All pairs of each installed cable shall be verified prior to system acceptance. Any defect in the cabling system installation including but not limited to cable, connectors, feed through couplers, patch panels, and connector blocks shall be repaired or replaced in order to ensure 100% useable conductors in all cables

installed.

3. The testing parameters called for in this section shall apply for up to 90 meters of horizontal cable, a work area equipment cord, an RJ45 outlet and 2 cross connect connections in the closet.
4. The test parameters shall include Wire Map, Length (report only), Attenuation and NEXT.
5. Wire Map - The wire map test shall verify pair to pin termination at each end and check for connectivity errors. The wire map shall indicate the following for each of the eight conductors:
 - a. Continuity to the remote end
 - b. Shorts between any two or more conductors
 - c. Crossed pairs
 - d. Reversed Pairs
 - e. Split Pairs
 - f. Any other miswiring
6. Attenuation - The link attenuation and NEXT of all cables shall be tested. The link is the sum of the attenuation of all connecting hardware, patch and equipment cords, and cable. The following tables indicate the acceptable values:

Attenuation			
Frequency (MHz)	Category 3 (dB)	Category 5e/6 (dB)	Category 6A (dB)
1.0	3.2	2.0	2.1
4.0	6.1	4.1	3.8
10.0	10.0	6.5	5.9
16.0	13.2	8.2	7.5
20.0	-	9.3	8.4
31.25	-	11.7	10.5
62.5	-	17.0	15.0
100.0	-	22.0	19.1
155	-	28.1	24.1
200	-	32.4	27.6
300	-	41.0	34.3
350	-	44.9	37.2
400	-	-	40.1
500	-	-	45.3
625	-	-	51.2

PS Next (worst pair to pair)			
Frequency (MHz)	Category 3 (dB)	Category 5e/6 (dB)	Category 6A (dB)
1.0	40.1	70.3	73.3
4.0	30.7	61.2	64.3
10.0	24.3	55.3	58.3
16.0	21.0	52.2	55.2
20.0	-	50.7	53.8
31.25	-	47.8	50.9
62.5	-	43.3	46.4
100.0	-	40.3	43.3
155	-	37.4	40.4
200	-	35.7	38.8
300	-	33.1	36.1
350	-	32.1	35.1
400	-	-	34.3
500	-	-	32.8
625	-	-	31.4

B. Data reporting and accuracy

- General: a Pass or Fail result for each parameter shall be determined by the allowable limits for each parameter. If the test result of a parameter is closer to the test limit than the accuracy of the tester it shall be marked with an asterisk. Data at all measured points shall be uploaded to a P.C. and printed on a laser printer.
- Wire Map: Wire map tests shall be marked “Pass” if wiring is determined correct.
- Length: Test results shall be reported in meters.
- Attenuation: Report the attenuation value and the frequency at point of failure or the highest frequency passed. Measured attenuation values lower than 3dB used for a pass/fail determination. Report the attenuation per unit length for links longer than 15 meters. Attenuation shall be measured from 1 MHz to 16 Mhz (Category 3) or 350 Mhz (Category 5e/6) or 500 MHz (Category 6A) in the steps listed in the tables above.
- NEXT: Report the NEXT value and “pass or fail” for samples based on the following:

Frequency Range (MHz)	Maximum Step Size (MHz)
1-31.35	0.15
>31.25-100	0.25

- C. Submit copies in binder format and 4 copies on compact disks containing all summary reports, full plot data test results, tester software tools required to view and inspect and**

print any selection of the test reports, spreadsheets, end to end reports and as built drawings called for at the completion of job.

3.6 OPTICAL FIBER CABLE TESTING

A. Backbone Cable

1. Test the cable on the reel for continuity before installing it, to insure no damage was done in shipment from the manufacturer to the job site.
2. After installation and termination, test each segment of the cable plant individually as it is installed, to insure each connector and cable is good.
3. Link attenuation is the only required field test except for the patched runs in the campus backbone system where an OTDR test will be required. Use launch cables at each end and provide print outs showing all connectors. OTDR will also be required to determine bad connections or damage when the link attenuation test fails.
4. Maximum localized attenuation allowed is 2dB.
5. Backbone multimode fiber shall be tested in one direction at both 850nm and 1300 nm in accordance with ANSI/EIA/TIA-526-14A method B.
6. Backbone single mode fiber shall be tested in one direction at both 1310nm and 1550 nm in accordance with ANSI/EIA/TIA-526-14A method A.1.
7. Multimode fiber shall conform to the following:

850 nm: Length (meters)	Attenuation (dB)
500	3.5
1000	5.5
1500	7.5
2000	9.0

1300 nm: Length (meters)	Attenuation (dB)
500	2.2
1000	3.0
1500	3.8
2000	4.5

8. Single Mode Fiber shall conform to the following (note: taken at 1550nm)

Inside:

Length (meters)	Attenuation (dB)
500	2.0

1000	2.5
1500	3.0
2000	3.5
2500	4.0
3000	4.5

Outside:

Length (meters)	Attenuation (dB)
500	1.8
1000	2.0
1500	2.2
2000	2.5
2500	2.8
3000	3.0

B. Documentation

1. Provide attenuation and cable length test results for all installed cable pairs. 1

3.7 SHIELD BOND CONNECTORS

- A. Install Bonding Connectors so as not to damage the conductors in the cable.
- B. Provide Bonding Connector and bonding conductor on all armored optical fiber cables and all optical fiber installed with metallic strength members, per manufacturer recommendations and as called for in the section.

3.8 GROUNDING BRAID

- A. Adhere to all manufacturer installation guidelines.
- B. Provide ground braid across all copper backbone cable sheath openings at splice enclosures. If an existing splice enclosure is reused, and is found to be missing proper grounding/bond per this section, provide labor and materials to bring it up to these standards.

3.9 LIGHTNING PROTECTION

- A. Install lightning protection modules to protect all pairs at each end of exterior UTP cable installations where terminated inside the building. Follow all manufacturer termination and installation requirements.

3.10 DIRECT BURIED SPLICE CASES:

- A. Install Splice cases inside handholes.
- B. Provide cable testing of all fiber and telephone splices per. same requirements as new cable installations.

- C. Repair and replace any splices failing tests.

END OF SECTION 271000

This Page Intentionally Left Blank

SECTION 271100

COMMUNICATION EQUIPMENT ROOMS AND SPACES

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Provide all labor, materials, tools, and equipment required for the complete installation of work called for in the Contract Documents.
- B. This section includes the minimum requirements for equipment and cable installations in Communication Equipment Rooms (CERs). The following equipment is described in this section:
 - 1. Floor Mounted Racks
 - 2. Cable Management
 - 3. Fiber Patch Panels
 - 4. UTP Patch Panels
 - 5. Telecom Ground Bar (TGB) - Grounding And Bonding
 - 6. Backboards
 - 7. Cable Hangers and Supports
 - 8. Hook and Loop Wraps
 - 9. Ladder Rack
 - 10. UPS Units
 - 11. Labeling

1.2 QUALITY ASSURANCE

- A. All equipment rooms 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 Owners representative. Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based on the acceptable manufacturers listed. Where "approved equal" is stated, equipment shall be equivalent in every way to that of the equipment specified, and subject to approval.
- B. Materials and work specified herein shall comply with the applicable requirements of:
 - 1. ANSI/TIA/EIA-568B.x

2. NECA/BICSI 568-2001
3. ANSI/TIA/EIA-569A –x
4. ANSI/TIA/EIA-606-A
5. TIA/EIA-607
6. Underwriters Laboratory
7. Federal Communications Commission
8. NFPA 70 – latest version of the National Electric Code

1.3 SUBMITTALS

A. Provide product data for the following:

1. Equipment Racks & Cabinets
2. Power Strips
3. Equipment Shelves
4. Cable Management
5. Fiber Patch Panels
6. UTP Patch Panels
7. Telecom Ground Bar (TGB) - Grounding And Bonding
8. Cable Hangers and Supports
9. Ladder Rack
10. UPS Units

PART 2 - PRODUCTS

2.1 GENERAL

- A. Provide an end-to-end connectivity solution in which all UTP Patch Panels and horizontal cabling connecting hardware are made by the same manufacturer. Refer to specification section 271000 for additional information regarding horizontal cable connectivity.

2.2 4 POST FLOOR MOUNTED RACKS

- A. Racks shall meet the following physical specifications:
 - 1. 19" rack mounting space.
 - 2. 7 foot high.
 - 3. Steel construction.
 - 4. Black polyurethane finish.
 - 5. Adjustable depth from 28" -36"
 - 6. 40" - 48" deep base with four (4) ¾" bolt down holes.
- B. Rack shall have double sided 12/24 tapped holes and 5/8", 5/8", ½" standard EIA hole pattern.
- C. Power strip with (6) surge protected outlets, meeting U.L. 1363 and 1449-second addition requirements, mounted on the rack.
- D. Design Make: Belden XDR8419
- E. Acceptable Manufacturers:
 - 1. Hoffman
 - 2. Hubbell
 - 3. Chatsworth
 - 4. Panduit

2.3 RACK MOUNT PDU (POWER DISTRIBUTION UNIT) – L5-20R

- A. Rack mountable 120volt 20amp power distribution unit. 10'-0" length cord, LCD screen, phase and selection metering.
- B. Physical size: 63.1"L x 2.56"W x 2.56"H
- C. Input connector: L5-20P
- D. Output connectors: (24) 5-20R
- E. Communications: Ethernet interface (RJ-45) and Serial (RS-232)
- F. Metered Outlet
- G. Design make: EM0114-10 or Approved Equal

2.4 CABLE MANAGEMENT

- A. Provide rack mounted horizontal and vertical cable management for all horizontal, backbone and patch cables as called for on the drawings.
- B. Panels shall have front and back channels with hinged or removable covers.
- C. Cable management panels shall be plastic with plastic or metal hinged covers and have integral wire retaining fingers. The wire retaining fingers shall be spaced and designed to accommodate Cat. 6A cabling.
- D. Vertical cable manager – 6"W x 84"H x 16"D w/ dual hinged door on front, none on rear. Include center divider with cable pass thru openings.
- E. Horizontal cable manager- 2U high, front and rear mounting to rails, 3.5"H x 19.0"W x 13.1"D
- F. Management panels shall mount to any standard 19" rack and include all required mounting brackets and screws.
- G. Design Make: Vertical Cable Manger – Panduit PRV6 w/ PRD6 Door
- H. Design Make: Horizontal Cable Manger – Panduit NM2
- I. Acceptable manufacturers:
 - 1. Belden
 - 2. Hubbell
 - 3. Leviton

2.5 FIBER PATCH PANELS

- A. Shall be wall or rack mounted as called for on drawings.
- B. Shall include factory installed rounded rubber fittings to protect fiber cable at all entry and exit points.
- C. The patch panel shall utilize a single mounting footprint and shall be interchangeable between the rack and wall mountable hardware used.
- D. The panel shall be attached with two push-pull latches to allow quick installation and removal.
- E. The adapter panel shall be available with industry standard single fiber and small form factor multi-fiber adapters, including the SC duplex and LC duplex.
- F. The adapter panel shall accommodate OM2 thru OM4, and OS2 optical fiber.

G. Panels shall be manufactured from injection molded polycarbonate for structural integrity.

H. General Specifications

1. Fiber Optic housings shall provide a means for securing, strain-relieving, protecting, and labeling of fiber optic cable terminations. Housings shall be available in both rack-mount and wall-mount configurations, and accept one standard adapter panel footprint for all housings.
2. All patch panels shall include integral modular removable plates to support optical fiber connector adapters.
3. Housings for rack-mounted or frame-mounted applications shall support conventional cross-connection and interconnection schemes as well as splicing applications.
4. Housings shall be available in 1U, 2U, 3U and 4U. One industry standard (EIA compliant) rack unit or panel height (denoted as 1U) is defined as being 44.45 mm (1.75") in height in compliance with EIA-310-D ("Cabinets, Racks, Panels, and Associated Equipment").
5. The housings shall have capacity specifications as listed below in Table.

Unit Size	Panel Capacity	Housing Fiber Capacity, using:		
		6f / panel	12f / panel	24f / panel
1U	2	12	24	48
2U	4	24	48	96
3U	6	36	72	144
4U	12	72	144	288

I. Provide duplex style single-mode and multi-mode fiber cassettes located inside housing. Provide blank cassettes in unused frame spaces.

J. Patch panels shall include integral removable splice tray drawer complete with coil rings for cable management and cable tie-down clips for support of main cable.

K. Accommodates integral pigtail splice tray kit with rounded cable coil managers.

L. Design Make: 12 fiber Adapters shall be Corning Closet Connector Housing (CCH) panel with part numbers – LC duplex multimode (OM4) - CCH-CP12-E4, LC Duplex single mode - CCH-CP12-A9 , SC duplex multimode (OM4) - CCH-CP12-E6, LC Duplex single mode - CCH-CP12-59 or equivalent

M. Acceptable Manufacturers:

1. Hubbell

2. Leviton
3. Panduit

2.6 UTP 48-PORT PATCH PANELS

- A. Shall meet or exceed all Category 6A UTP specifications outlined section 271000.
- B. Terminated in accordance with T568B Pin Configuration
- C. Provide only 48 port panels, in 2 RU height
- D. Cable managements clips in rear.
- E. Provide 5" deep cable strain relief supports in rear.
- F. Rack or wall mounted as called for.
- G. Unloaded type, provide (48) white 110-style termination keystone jacks with each patch panel. Each jack shall match horizontal cable category being terminated on that jack. Refer to section 271000 for 100-ohm UTP jack and termination requirements.
- H. UL listed File # E129878
- I. .09" thick rolled edge black anodized aluminum construction.
- J. Beryllium copper with minimum 50 micro-inch gold plating.
- K. Accepts keystone jacks 110 termination with tin lead plated IDC.
- L. Each patch panel shall be factory labeled 1-48.
- M. Design Make: Belden AX103115
- N. Acceptable Manufacturers:
 1. Hubbell
 2. Leviton
 3. Panduit

2.7 BACK BOARDS

- A. Shall be 4' x 8' x 3/4" CDX, fire rated plywood
- B. Shall be painted with gray, acrylic, interior, fire retardant paint. Manufacturer: Pratt & Lambert "Stormy Sea #2233.
- C. 2"D" Rings Part numbers: Senior Industries SI-4754 shall be used for cross connects

above blocks and SI-4755 for routing Category 5E cables vertical and horizontally.
Owner to review in field before installation.

2.8 SPIRAL WRAP

- A. Shall be constructed flame retardant polyethylene as required for organizing, protecting and identifying loose fibers in each fiber patch panel, especially where they house multiple cable sheaths.
- B. Shall be a size large enough to contain all fiber strands of a given cable sheath under one wrap.
- C. Shall be clear or opaque to allow visual observation through wrap without opening.
- D. Shall accept ink from permanent pen markers or adhesive labels, to identify fiber number and building designators.
- E. Design make: Panduit T50 series.
- F. Acceptable Manufacturers:
 - 1. Pepico
 - 2. Ark-Plas Products.

2.9 TELECOM GROUND BAR (TGB) - GROUNDING AND BONDING

- A. Each Communication Equipment Room (CER, IDF, MDF, NOC, Wiring Closet, or data Closet) shall be equipped with a telecommunications grounding bus bar (TGB). This TGB shall be used to ground all telecommunications cable shields, equipment, racks, cabinets, raceways, and other associated hardware that has the potential to act as a current carrying conductor. The TGB shall be installed and bonded to the building's electrical entrance grounding facility in accordance with the recommendations contained in the ANSI/TIA/EIA-607 Telecommunications Bonding and Grounding Standard.
- B. The intent of this system is to provide a grounding system that is equal in potential to the building electrical ground system. Therefore, ground loop current potential is minimized between telecommunications equipment and the electrical system to which it is attached.
- C. All racks, metallic backboards, cable sheaths, metallic strength members, splice cases, cable trays, etc. entering or residing in the CER shall be grounded to the respective TGB using a minimum #6 AWG stranded green jacket insulated copper bonding conductor and compression connectors at each end.
- D. All wires used for telecommunications grounding purposes shall be identified with a green insulation. Non-insulated wires shall be identified at each termination point with a wrap of green tape. All cables and busbars shall be identified and labeled in accordance with the Testing and Administration Section of this specification.
- E. Installation and termination of the main bonding conductor to the building service

entrance ground shall be performed by a licensed electrical contractor.

F. TGB (Telecom Ground Bar)

1. Dimensions: ¼” thick x 2” wide x 12” long
2. Includes two h wall mount brackets with insulators
3. (18) 3/8” Hole Sets
4. Design Make: Harger Erico EGBA14212GG or Approved Equal

2.10 HOOK AND LOOP WRAPS

- A. Provide hook and loop strip wraps, in a minimum of 1.5” wide for dressing out, bundling and support UTP, fiber, coaxial cables in CER’s, in cable trays, in J-hook, on ladder racks, in racks and cabinets and in horizontal pathways.
- B. Provide hook and loop wraps on 4’ centers in all CER’s.
- C. Do not use tie-wraps to bundle and secure UTP, coaxial or fiber cables.
- D. Provide UL Listed Hook & Loop Cable Ties for use in Air Handling Spaces
- E. Design Makes: Panduit HLSP1.5S Series for air handling spaces Panduit HLT, HLS and HLS-15R for other environments
- F. Acceptable Manufacturers:
 1. Leviton Soft Cinch

2.11 WALL MOUNTED CABLE SUPPORTS

- A. Provide wall mounted “D” rings for wall mounted vertical and horizontal cable management.
- B. Design Make: Senior Industries -SI-4754 - cross connect wiring, SI-4755 Vertical and Horizontal Category 6 cable.
- C. Acceptable manufacturers:
 1. Allen Tel
 2. Panduit

2.12 LADDER RACK

- A. Provide 9”, 12” and 15” wide cable rack as shown on CER plans and as required to suit field conditions.

- B. Include connecting and support hardware to suit the installation.
- C. Rack shall solid side bar nominally 3/8" thick by 1 1/2" high. Provide rungs 9" on center.
- D. Side bars shall be painted gray.
- E. Design Make: Belden
- F. Acceptable manufacturers:
 - 1. Newton
 - 2. Homaco

2.13 UPS UNITS

- A. 3000VA UPS UNIT
 - 1. Output power capacity 2,100 Watts / 3,000 VA
 - 2. Double conversion on-line power, pure sine wave output
 - 3. Maintenance-free sealed Lead-Acid battery
 - 4. 12-minute run time full load, 30-minute runtime on half load
 - 5. Input: NEMA L5-30P on 8-foot cord
 - 6. Output: (6) NEMA 5-15R receptacles + (2) 5-20R
 - 7. Monitoring and shut-down Interface Ports: RJ-45 10/100 Base-T & USB
 - 8. Includes rack mount rails
 - 9. 3U high
 - 10. Design Make: APC SURTA3000RMXL3U-NC
 - 11. Acceptable Manufacturers: Emerson or Tripp-lite

2.14 LABELING

- A. All labels shall be typed on self-adhesive label strips where a plastic protector is not present on the termination equipment.
- B. All letters and numbers shall be capital and the same font, black colored text on white background, closest to size 12 ARIAL FONT as possible.
- C. Label maker Design Make: DYMO or Approved Equal

PART 3 - EXECUTION

3.1 LABELING

- A. Label horizontal all cable outlets to mirror the labeling on the patch panel at the demarc end or wiring closet end. Label all telephone and/or data jack to the following example:

“BA11” = B – CER B A – Patch Panel A, 11 – Patch Panel Port 11

- B. Label all fiber patch panels such that each pair can be identified by fiber type (single mode or multimode), source building of fiber, and pair number per. the following example:

“SMF-MS-CERA-01” = Singlemode Fiber – To Middle School CER A - Pair 1

“MMF-HS-CERA-01” = Multimode Fiber – To High School CER A - Pair 1

3.2 FLOOR MOUNTED RACKS/CABINETS

- A. All racks shall be anchored to the floor.
- B. Provide vertical and horizontal cable management as called for in this section and the drawings.
- C. Mount rack a minimum of 36” from wall when orientated parallel to wall and tight to wall when perpendicular to wall.
- D. Ground the rack to the equipment ground bar with a #6 copper wire.
- E. Provide (1) rack mount shelf and power strip for each new rack or cabinet.
- F. Label racks and cabinets for each CER designation on plastic engraved label.

3.3 CABLE MANAGEMENT

- A. Provide (2) rack mounted vertical cable managers on both sides. If two or more racks are installed side by side, install vertical cable managers between the racks and cable managers on the outside or end of racks.
- B. Provide one horizontal cable manager for each 48 UTP port panel and fiber patch panel installed.

3.4 CABLE SUPPORTS

- A. Provide “D” rings 2 ft. on center for all exposed vertical cable runs.
- B. Provide cable hangers 3 ft. on center for all exposed horizontal and backbone cable runs.
- C. Keep Horizontal wall mounted cable runs to a minimum. In general horizontal runs shall be in wall mounted ladder rack.

- D. Provide cable brackets 4' on center supported to building structure for all cable runs above ceilings where cable tray is not called for.
- E. Refer to specification section 260533 for additional information.

3.5 LADDER RACK

- A. Provide ladder rack from sleeve entrance to CER to opposite wall, travel shall extend above rack/cabinets.
- B. Secure rack to walls and to the top of the equipment racks.
- C. Refer to specification section 260533 for additional information.

3.6 BACK BOARDS

- A. Linear wall space used for anchoring equipment shall be lined for the full closet width with fire treated BCX grade exterior plywood 3/4" and 8' high.
- B. Plywood for mounting termination equipment on shall be installed vertically side by side a minimum of 6" above finished floor. Mounting of said plywood shall be sufficient enough to support the equipment.
- C. Plywood for supporting riser cables shall be installed vertically resting directly on the finished floor. Anchoring and mounting techniques of plywood used to support backbone riser cables shall be sufficient to support a minimum of 1500 pounds of weight.
- D. In no cases shall the heads of mounting screws protrude past the face of the plywood.
- E. Contractor shall install distribution rings for the cross-connect fields above all wall mounted blocks. Two rings per vertical row. Scorings with copper tubing cutters to eliminate $\frac{3}{4}$ of one of the mounting legs, snap off and debur. Mount rings with two hex head screws per ring.

3.7 MISCELLANEOUS REQUIREMENTS

- A. Provide Ladder Rack from overhead sleeve locations in closets to equipment racks and punch down block locations.
- B. Provide nylon cable ties with Velcro fastening means for organizing all patch and loose cable.
- C. All cables shall be neatly "dressed out" in equipment rooms.
- D. Provide all required sleeves for routing of telecom cabling sized properly for no more than 40% wire fill capacity.
- E. Provide Ladder Rack from overhead sleeve locations in closets to equipment racks and punch down block locations.

- F. Provide hook and loop wrap strips as the primary means for organizing all voice, data and coaxial cables in CERs.
- G. All cables shall be neatly “dressed out” in equipment rooms.
- H. The division 26 contractor shall provide all required sleeves, penetrations and cores for communications raceways and cabling.
- I. Provide a minimum of (2) 4” EMT sleeves with nylon bushings on each end into each Communications Equipment Room.
- J. Fire Stop all sleeves and conduit openings at time of removal of existing abandoned cables and again at time of cable installation, as called for.

3.8 PUNCH DOWN BLOCKS

- A. Installed on plywood backboard so that top of block is 5’6” AFF
- B. Mount Blocks with steel, zinc plated 5/16" slotted hex head #10 x 3/4" drill screws. Part # Metalics DS181.
- C. Label per specifications or as directed by Engineer.

3.9 TELECOM GROUND BAR (TGB) - GROUNDING AND BONDING

- A. Provide pre-drilled tin plated copper bus bar, with standard NEMA bolt hole sizing and spacing for connectors being used, in all communication equipment rooms.
- B. All connectors and clamps shall be mechanical type made of silicon bronze.
- C. Terminals shall be solderless compression type, copper long-barrel NEMA two bolt.
- D. Provide #6 AWG conductor from the bus bar to the electrical system equipment ground.
- E. Bond the ground bar in the main communication equipment room to dedicated communications equipment panelboard where applicable.
- F. Bond metallic equipment racks and cabinets to the ground bar.
- G. Bond the shield of shielded cable to the ground bar in communications rooms and spaces.

3.10 CROSS CONNECT

- A. Shall be color-coded with industry standard coded field as follows:

Description	Color
Wiring to work Station	Blue
Backbone Cable	White
Tie Lines	Gray
Misc. Connections (Alarm & a Security)	Yellow

- B. Provide a description of color coding and labeling on the wall adjacent to the punch down blocks.

3.11 UTP PATCH PANELS

- A. Provide rear wire manager near the top of panel.
- B. Route cables from the back of patch panel through coupler openings and attach cable to the wire manager with cable ties.
- C. Do not untwist cable more than 0.5 in. when terminating.
- D. Locate so that combined length of cables and cords from panel to switch does not exceed 3m.
- E. Label patch panels per drawings and specifications.

3.12 CLEANING

- A. In all terminating spaces that have had floor or wall penetrations, hammer drilling, or core boring activities - a thorough brooming, vacuuming, and wet mopping/sponging shall be performed. Cleaning shall include floors, walls, ladder trays, tops of cabinets/racks, existing/new passive and active components, per manufacturer recommendations.
- B. All non-metallic cable managers and snap covers shall be wiped clean, both inside and outside of front, including rear channels. All clear covers and doors shall be cleaned, both front and rear per manufacturer recommendations.
- C. Inside of fiber optic enclosure and patch panels shall be blown clean of settled dust. Said cleaning shall be performed for all new construction projects or where gypsum sanding has been performed.
- D. All scraps, boxes, spools, pull line and trash shall be removed and properly disposed of.
- E. All residual cable lubricant shall be cleaned from floors and walls with an appropriate degreaser.
- F. In carpeted CER rooms, thoroughly vacuum room clean.

END OF SECTION 271100

This Page Intentionally Left Blank

SECTION 275116
AUDIO VIDEO SYSTEMS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. The Contractor shall be held to have read all the Bidding Requirements; all of the General Conditions and Supplementary General Conditions and all Divisions of the Technical Specifications before submitting a bid proposal for the project, and in the execution of the work, they will be bound by all of the conditions and requirements therein.

1.2 WORK INCLUDED

- A. Work in this section includes, but is not limited to the following items:
1. Speakers
 2. Rack mount Amplifiers, remote volume control.
 3. Digital processor
 4. Mixer
 5. Wireless Microphone System
 6. Microphone
 7. Power Conditioner
 8. FM Hearing Assistance System
 9. Antenna Distribution System
 10. Projector
 11. Electronic Screen
 12. Equipment Cabinet
 13. Remote System Control
 14. Wiring and connectors
- B. Provide all labor, materials, equipment, interconnecting cabling, etc. and services to perform operations required for the complete installation and fully functional sound system and related work as required in Contract Documents.

1.3 COORDINATION

- A. Coordinate all work indicated in this section with all work included and specified elsewhere in the project. This includes, but is not limited to the Specification Sections in Div. 260000, 270000, and 280000.
- B. Coordinate all work to be performed with actual field and project conditions. At a minimum, perform the following tasks prior to submitting bids or shop drawings for the project:

1. Perform field investigations to determine all necessary incidental items which will be required for complete and proper installation of all work. Verify all items affecting the bid price prior to bidding.
2. Perform all necessary field measurements to provide complete, accurate, and coordinated shop drawing submittals
3. Organize and attend all necessary coordination meetings required to assure proper coordination and installation of all related work included in the project.

1.4 SUBMITTALS

- A. Submit the manufacturers catalog Product Data Sheets for each and every product specified in this section.
 1. Reinforcing and bracing required to meet the design criteria specified herein.
 2. Details of conditions unique to the project. This includes details indicated on the contract drawings, details to address specific job conditions, or details which the contractor may propose to use which differ from those indicated on the contract drawings.
- B. Underwriters Laboratory Certification for all products and assemblies to be used on the project.

1.5 QUALITY ASSURANCE

- A. Warranties: All work is to be subject to the following warranties:
 1. Materials Warranties: The material manufacturer's standard warranties are to be provided for each product unless otherwise indicated.
 2. Labor and Workmanship Warranty: Provide a one year warranty against defects in workmanship which lead to failures within that period. Contractor's warranty is to include the correction of all other related work affected by any failure. Contractor will at their own expense without charge to the Owner make repair to the originally specified condition of all work required to be corrected as a result of all failures occurring within the warranty period.
- B. All methods of construction, details of workmanship that are not specifically described or indicated in the contract documents, shall be subject to the control and approval of the Owner's Representative. Equipment and materials shall be of the quality and manufacture indicated in their respective sections of the specifications. The equipment specified is based upon the acceptable manufacturers listed. Equipment types, device ratings, dimensions, etc. correspond to the nomenclature dictated by those manufacturers. All equipment shall be tested at the factory. Unless specified elsewhere, standard factory inspection and operational tests will be acceptable.
- C. Installation shall be accordance with NFPA-70 (National Electric Code), National Electric Safety Code (NESC), state codes, local codes, and requirements of authority having jurisdiction.
- D. Equipment shall be designed, manufactured, assembled, and tested in accordance with the latest revisions of applicable published ANSI, NEMA and IEEE Standards.

- E. Each item shall bear the UL Label.
- F. The system provider must:
 - 1. Provide equipment from manufacturers for which they maintain a contract, distributorship, are an agent, or other formal arrangement for which documentation can be produced showing authority to sell and service the equipment in this territory.
 - 2. Demonstrate that they have successfully installed these systems, utilizing their standard products, for a period of five (5) years.
 - 3. Vendor shall hold a CTS, CTS-1, and CTS-D from manufacturer to install and program their products.
 - 4. Maintain adequate spare parts inventory to provide both normal and emergency service.
 - 5. Employ service technicians who are trained in accordance with the systems manufacturer's recommendations.

1.6 GENERAL DESCRIPTION

- A. The work included in this section is shown on the drawings or described in the specifications, and consists of furnishing all labor, material, services, and skilled supervision necessary for the construction, erection, installation, and connection of all circuits, apparatus, and equipment specified herein or shown on the drawings in a first class, workmanlike manner, and its delivery to the Owner ready for use.
- B. Each part of work is to be complete in detail and operable in unison with all other sections, to constitute completely installed portable sound reinforcement system and connections of same, as shown on drawings and described in specifications.
- C. Work in this section includes, but is not limited to:
 - 1. It is the intent of this specification to outline the requirements for a complete and satisfactory operating portable sound system with permanently mounted outdoor type speakers.
 - 2. The Contractor shall do everything necessary to make a thoroughly satisfactory and working sound system, including furnishing and installing all items required to complete the work, whether specifically called for or not. The Contractor shall obtain all wiring requirements from the system manufacturer prior to bidding and include in his bid all wiring as recommended by the manufacturer.
 - 3. The sound system shall consist of all necessary equipment to perform the following functions:
 - a. Provide for adequate broadcasting of stage performance while simultaneously broadcasting alternate source into the gymnasium.
 - b. Have the ability to interconnect portable digital audio devices, in various inputs and mix signals for level output to audio system amplifiers.
 - c. Wireless microphone for remote broadcasting from cafeteria or gymnasium.
 - d. Provide the ability to supply reinforced pre-recorded music to the areas.
 - e. Provide for the selection of separate speaker zones.

4. System shall be provided as shown on the drawings and called out in the specifications.
5. Provide all equipment, speakers, jacks, mounting hardware and all interconnecting wiring as required and called out on contract documents.

PART 2 – PRODUCTS

2.1 GENERAL SYSTEM OPERATION

- A. The sound reinforcement system shall provide for the amplification of voice and music.
- B. Amplify recorded program from portable digital audion device, CD's, etc.

2.2 SPEAKERS

- A. Type "A" - Full range Mid/High modular line array
 1. Frequency Response (+/-3 dB): 155 Hz - 12 kHz
 2. Frequency Range (-10 dB): 100 Hz - 16 kHz
 3. Nominal Dispersion: 145° H x 20° V
 4. Recommended High-Pass Filter: 125 Hz
 5. Loudspeaker EQ: Required
 6. Overload Protection: PTC / Lamp
 7. Long-Term Power Handling: 300 W (1200 W peak)
 8. Sensitivity (SPL / 1 W @ 1 m): 88 dB SPL
 9. Maximum SPL @ 1m: 113 dB SPL (119 dB SPL peak)
 10. Nominal Impedance: 8 Ω
 11. CVT-MA12: transformer available
 12. Enclosure: Extruded-aluminum sidewalls with zinc-plated steel top and bottom endcaps, all powder coated
 13. Grille: Powder-coated aluminum grille Environmental Outdoor per IEC 529 IPX5
 14. Connectors: Two (2) parallel-wired NL4 Neutrik® Speakon® connectors, One (1) two-conductor barrier strips
 15. Suspension / Mounting: Four (4) x M6 threaded inserts (back)
 16. Dimensions 38.8" H x 4.2" W x 5.5" D (985 mm x 104 mm x 139 mm)
 17. Design make: Bose Panaray MA12
- C. Type "B" – Ceiling Mounted loud speaker
 1. 90x60 degree high frequency horn 70Hz – 18kKz
 2. 126 dB peak SPL
 3. Two (2) LF8 8-inch woofers
 4. Frequency Response (-3dB): 80Hz to 16kHz
 5. Frequency range (-10db): 70Hz to 18kHz

6. Nominal Coverage Pattern (H x V): 90 x 60 (rotatable high frequency horn)
7. Recommended high pass filter: 70Hz with minimum 12-db / octave filter
8. Crossover: passive: separate bandpass filters per transducer (200Hz and 1.2kHz)
9. Power handling: 300w (1200W peak)
10. Nominal impedance: 8Ω
11. Enclosure: Exterior Grade Plywood
12. Finish: Two-part spray polyurea coating, Black
13. Grille: 3-layer: perforated stainless steel, acoustic foam, stainless steel mesh, powder-coat finish.
14. Connectors: 1x barrier strip
15. Dimensions 9.3" x 27.0" x 11.0" with input cover
16. Design make: Bose Arena Match Utility AMU208

2.4 AUDIO AMPLIFIERS

- A. The amplifier shall employ Class-D amplification together with a digital signal processing architecture running at 48 kHz / 24 bit. The amplifier shall incorporate a switch-mode power supply allowing normal operation from AC outlets ranging from 100 – 264 V at 50/60 Hz. The amplifier shall have an IEC 320-C14 electrical power inlet and shall be equipped with a removable power supply cord. A power switch shall be located on the front panel. The product shall include protection from shorted loads and general overheating. The amplifier's physical size shall be 1 RU in height by 1 RU in width and be capable of rack mounting. The product shall have venting with two fans, variable front-to-back airflow. Each output channel shall have output attenuation controls. The amplifier shall have two 600 W output channels with a frequency response of 20 Hz to 20 kHz (+/- 1 dB) when driving low-impedance (4 - 8 Ω) systems, and a frequency response of 50 Hz to 20 kHz when driving 70/100 V distributed audio systems. The amplifier shall have THD+N at rated power less than 0.04%. Output connections shall be made via a 4-pin terminal block connector.
- B. The amplifier shall meet or exceed the following performance specifications: channel separation (crosstalk) greater than 80 dB below rated power at 1 kHz. The amplifier shall incorporate 2 line-level inputs. The nominal input sensitivity shall be 4 dBu for balanced line-level inputs (6-pin Euroblock connector). The amplifier can also accept up to two AmpLink audio inputs (Two RJ-45 connectors, Input and Thru). Five LEDs shall be visible on the front panel: one Power (white) for power indication, (blinking white) for standby indication, (red) for fault indication, and (blinking red) for thermal fault indication. Per-channel Signal (green) to indicate input signal presence, (amber) to indicate within 3 dB of input clipping, and (red) to indicate input clipping. Per-channel Limit (amber) when an output is limiting, (red) for fault indication, and (blinking red) when outputs are muted. The amplifier shall offer a master mute connection for use with external dry contacts, normally open or normally closed, to mute all outputs of the amplifier.
- C. The amplifier chassis shall be constructed of painted steel. The dimensions of the amplifier shall allow for 19-inch (483 mm) EIA standard rack mounting. The amplifier shall be 44 mm (1.7 in) in height, 483 mm (19 in) in width and 420 mm (16.5 in) in depth. The amplifier shall weigh 6.2 kg (13.7 lb).
- D. The amplifier is UL/cUL Listed according to UL60065 (8th edition), UL62368_1, CAN/CSA C22.2 No. 60065-16 and CAN/CSA C22.2 No 62368-1-14; The amplifier complies with CE requirements per EN62368-1:2014 and is CB Certified according to IEC60065:2014 and IEC62368-1:2014, including all group and national differences. This model also complies with FCC Part 15B Class A,

ICES-003 Class A, EN55032:2012, EN55035, CISPR 13: Ed. 5.0 (2009-06), requirements.

- E. Warranty shall be five years.
- F. Design Make: Bose PowerSpace P2600A versatile power amplifier.

2.5 CONFIGURABLE AUDIO AMPLIFIER

- A. The amplifier shall contain all solid-state circuitry, using MOSFET output devices employing Class-D topology and a current and voltage feedback loop circuit. The amplifier shall incorporate a switch-mode power supply with fast-tracking power factor correction (PFC) that will allow full-rated power from AC outlets ranging from 100 – 240 V, 50/60 Hz. The amplifier shall have an IEC 60320-C14 10/15-amp electrical power inlet and shall be equipped with a removable power supply cord. The amplifier shall include protection from shorted and open loads, general overheating, DC, high-frequency overloads, under/over voltage and internal faults. The amplifier shall contain eight independent amplifier channels, which can be configured to allocate the 2000 watts total rated output power between 2 and 8 channels. The amplifier shall contain variable speed fans, which are automatically controlled to minimize acoustic noise. Fan airflow direction will be from the front panel to the rear panel and should not require air filtering. Rack mounting of multiple amplifiers shall be possible without extra rack spacing for ventilation. The amplifier shall be capable of continuous operation at 1/3 of rated power into 4-ohm loads, in ambient temperatures up to 104° F (40° C). The typical current draw at 1/3-rated power shall be 8.1 amps with 120 VAC and 4.1 amps with 230 VAC.
- B. The power amplifier shall meet or exceed the following performance specifications:
 - 1. • Analog input sensitivity for rated output: 0, +4, +12 and +24 dBu, user selectable
 - 2. • Rated output power, per channel, with all channels driven at less than 0.1% THD, typical (1 kHz): Mono mode with up to 8 channels, 250 watts into 4 and 8 ohms. V Bridge mode with up to 4 channels, 500 watts into 4 ohms, 8 ohms, or with 100V lines (at 1% THD), 400 watts with 70V lines (at 1% THD). IShare mode with up to 4 channels, 500 watts into 2 ohms. Quad mode with up to 2 channels, 1000 watts into 4 ohms or with 100V lines (at 1% THD), 800 watts with 70V lines (at 1% THD)
 - 3. • Frequency Response (± 0.5 dB at 1 watt): 20 Hz to 20 kHz
 - 4. • Signal-to-Noise Ratio (below rated power, A-weighted with +24 dBu analog input sensitivity) >99 dB
 - 5. • Total Harmonic Distortion (1 watt from 20 Hz to 20 kHz): less than 0.4%
 - 6. • Intermodulation Distortion (SMPTE 60 Hz and 7 kHz): less than 0.4%
 - 7. • Channel Separation (adjacent channels at 1 kHz): greater than 65 dB
 - 8. • Damping Factor (10 – 1000 Hz, 4 ohms): greater than 1000
 - 9.
- C. The amplifier shall incorporate eight balanced analog inputs, with rear-panel mounting and utilizing 3-pin terminal block connectors. The analog inputs shall support up to +24 dBu input signals. The amplifier shall support a digital expansion slot capable of receiving 8 digital audio channels using optional digital expansion cards, available in proprietary and industry-standard protocols. The amplifier outputs shall terminate with 8-pin, high-current, terminal block connectors, which accept 10-22 AWG cables. The amplifier shall include digital signal processing (DSP) optimized for loudspeaker processing, with 24-bit, 48 kHz operation. The total latency (analog input to amplifier output) shall be less than 0.95 milliseconds. The fixed-block signal processing shall include the following elements for each of the eight channels: 5 band parametric input EQ, array EQ, bandpass

(crossover) filters, 9-band parametric output EQ, delay, output peak and RMS-average limiter. An 8x8 matrix mixer shall be included for routing and attenuation of any input/output combination. A signal generator supporting tone, noise and sweep functions shall be included, which shall also enable the amplifier to measure, record and store automated impedance sweeps on any output channel. The amplifier front panel shall contain a user interface with a 240 x 64 LCD primary display, with LED indicators for signal present, input clipping, output limiting and fault. Functions accessible from the front-panel interface shall include output configuration, fault logging, mute, input sensitivity selection, output attenuation, EQ on/off per channel and loudspeaker processing preset recall. The amplifier shall contain a PC interface with a front-panel USB connection, which will allow full amplifier setup, configuration and monitoring using Bose® ControlSpace® Designer™ software. The network amplifier shall also contain a rear-panel Ethernet interface available from an RJ-45 connector to allow serial over Ethernet communications and network control/monitoring of multiple network version amplifiers when using a PC running Bose ControlSpace Designer software. The amplifier chassis shall be constructed of steel with a durable black finish. The dimensions of the amplifier shall allow for 19- inch (483 mm) EIA standard rack mounting. The amplifier shall be 3.5 inches (2RU, 88 mm) in height, and 20.7 inches (525 mm) in depth. The amplifier shall weigh 28.3 pounds (12.8 kg).

- D. Design Make: Bose PowerMatch® PM8250N configurable professional power amplifier.

2.6 DIGITAL PRESENTATION SYSTEM

- A. Basis of Design Product: Crestron DMPS3-4K-350-C

1. Device Architecture: The Presentation Processor unit shall be a single unit composed of internally integrated components providing multiple functions. Included sub-components:
 - a. Front Panel Control Interface shall provide basic control of the Presentation Processor.
 - b. Audio Matrix/Mixer
 - c. Audio Amplifier
 - d. Video Matrix
 - e. Single Cable Transmission
 - f. Control Processor
2. Built-In Device Configuration Software, Configuration Software, Software shall support the following:
 - a. System configuration through web browser, specialized software shall not be required.
 - b. System Configuration shall include:
 - 1) Source setup
 - 2) Display setup
 - 3) User Interface setup
 - 4) Manufacturer shall provide multiple user interface options.
 - 5) occupancy sensor option
 - 6) Add network management integration
 - c. Security Requirements:
 - 1) Secure access through full user/group management or Active Directory integration
 - 2) Hardware level security using 802.1X authentication
 - 3) TLS, SSL, SSH, and SFTP network security protocols
 - d. Deployment, A single configuration file shall be network deployable to multiple rooms.

3. Video System:
 - a. Video Inputs
 - b. Video inputs include HDMI and HDBaseT type input. Provide (6) HDMI, (2) DM; OUTPUTS: (2) HDMI, (2) DM
 - c. HDBaseT type inputs shall be compatible with HDBaseT and manufacturers proprietary format supporting additional control functionality.
 - d. HDMI inputs are compatible with DVI and Dual-Mode DisplayPort sources
4. 4K Video Switcher
 - a. Built-in video matrix switching allows video sources to be routed simultaneously to output connectors.
 - b. Internal switcher shall support routing of HDMI and other AV sources to HDMI and HDBaseT outputs.
 - c. The HDMI outputs are compatible with DVI and the HDBaseT outputs are compatible with HDBaseT and manufacturer proprietary format supporting additional control functionality.
 - d. 4K/60 Video Scaling - Unit shall include an independent, 4K scaler on each HDMI output.
5. Audio System
 - a. Audio Inputs - Each HDMI and analog audio input includes adjustable input compensation to accommodate a range of signals and maintain consistent volume levels when switching between sources.
 - b. Audio Amplifier - Unit shall include a built-in power amplifier.
 - c. Amplifier shall support three mutually exclusive amplifier modes.
 - 1) 100V mode: mono, 40 Watts RMS per channel.
 - 2) 4 ohm, 8 ohm mode: Stereo, 20 Watts RMS per channel at 4 ohms or 8 ohms.
 - 3) 70V mode: mono, 40 Watts RMS per channel.
6. Audio Matrix Functions:
 - a. Any analog input, digital audio input, or HDBaseT audio input signal shall be routable to:
 - 1) Amplified Speaker Output
 - 2) Analog line level outputs
 - 3) HDBaseT type output
 - 4) HDMI output
7. Microphone Preamplifier
 - a. Microphone Inputs - Each internal microphone preamplifier input shall be connected to two mutually exclusive input connections:
 - 1) Detachable terminal block - Balanced microphone level analog audio with switchable 48 volt DC phantom power.
 - 2) Detachable terminal block - Balanced or unbalanced line level analog audio.
8. Audio Mixer:
 - a. All stereo audio outputs shall be capable of outputting independent microphone and program audio mixes.

- b. All stereo sources and microphone sources shall be available simultaneously.
 - c. All stereo sources and microphone sources shall have controllable levels in mixed output signal.
- 9. Audio DSP
 - a. Each analog audio output shall include DSP processing, allowing each output to be configured separately. DSP parameters include:
 - 1) real-time adjustable volume, bass, treble, and mute controls
 - 2) 10-band graphic equalization
 - 3) 4-band parametric equalization
 - 4) Adjustable limiting
 - 5) Up to 85 ms of speaker delay adjustment
- 10. Single Cable Transmission System
 - a. HDBaseT type inputs and outputs allow for connecting to remote sources and display devices, and integrating with larger systems via a single CAT5 type cable.
 - b. The one-wire interface supports transmission of ultra high-definition video, audio, control, power, and networking signals over CAT type cable at distances up to 330 feet (100 meters).
 - c. Unit shall be HDBaseT Certified
 - d. The processor shall be designed using HDBaseT Alliance specifications, and shall support interoperability with other HDBaseT certified products.
- 11. Control Processor
 - a. Unit shall include a built-in control processor with onboard control ports for control of external devices.
 - b. The Central Switching And Control Unit shall include an integrated microprocessor based control processor.
 - c. The built-in control processor shall support customizable control of integrated AV devices, room lighting hardware, window shades, and projection screens.
 - d. Controller shall include the following onboard control ports:
 - 1) Ethernet
 - 2) Four IR ports
 - 3) Two RS-232 COM ports
 - 4) Four relay ports
 - 5) Four digital input ports
 - 6) RS-422 type network control bus
 - e. Control Subnet Networking
 - 1) Unit shall include a built-in control subnet network port.
- 12. The controller shall support a network management system by the same manufacturer, supporting overall remote system controlling, monitoring, and managing through network computers and mobile devices.
- 13. The controller shall support touch screens, keypads, and wireless remotes and mobile device Apps from the same manufacturer.

14. Multimedia Presentation Gateway
 - a. General Functionality
 - b. Gateway shall support presentation of content from network connected devices.
 - c. Architecture, Gateway functionality shall be a built-in function.
 - d. Communication
 - 1) Dedicated LAN Connection, 10/100 Mbps, auto-switching, auto-negotiating, full/half duplex, DHCP, SSL, TLS, SSH, SNMP, IPv4, HTTPS web server
 - 2) User Device Support
15. Gateway shall support connection of up to 32 user devices for presentation.
16. Gateway shall support multiple user device types and Operating Systems:
 - a. Laptop and desktop computers:
 - 1) Windows XP, Windows Vista, Windows 7, Windows 8, Window 10, Mac OS X (versions 10.5 thru 10.11)
 - b. Mobile Devices:
 - 1) Apple iOS, Android
17. Audio
 - a. Audio Format: Stereo
18. Video
 - a. Video Frame Rate Supported: 15 fps (typical)
 - b. Supported Resolutions
 - 1) 800x600@60Hz, 1024x768@60Hz, 1280x720@60Hz (720p60), 1280x768@60Hz, 1280x800@60Hz, 1280x1024@60Hz, 1360x768@60Hz, 1400x1050@60Hz, 1440x900@60Hz, 1600x1200@60Hz, 1920x1080@60Hz (1080p60), 1920x1200@60Hz

2.7 DIGITAL MIXING CONSOLE

- A. The console shall operate at up to a 96kHz sampling frequency and provide versatile mixing capability. With 16 + 1 (Master) faders it shall provide a mixing capacity of up to 40 mono inputs, 8 groups, and 8 auxiliary buses. It shall provide 4 powerful effect processors that allow selection of VCM effects, REV-X reverb effects, and more. All mono input channels shall include gate, compressor, 4-band PEQ, delay, and other facilities. It shall also allow 16-in/16-out USB audio streaming and come supplied with “Cubase AI” DAW software that allows digital multitrack recording and playback. Local I/O shall include 12 microphone/line inputs, 4 line inputs, 12 inserts, 4 outputs (TRS phone), 2TR I/O (RCA), stereo output, monitor output, ADAT I/O, IEC-60957 I/O, a Mini-YGDAI slot, word clock I/O, MIDI I/O, and USB host connectors.
- B. Features:
 1. 16 in/16 out live audio streaming at 96kHz via USB2.0 for direct multitrack recording and playback.
 2. 24-bit/96-kHz performance with improved studio-quality head amps.
 3. A variety of Yamaha VCM effects and high-resolution REV-X reverbs.
 4. 96-kHz internal effects and top-quality compression, gating and delay.
 5. Powerful mixing capacity with up to 40 inputs and 20 buses at 96kHz.
 6. I/O expansion slot accepts Mini-YGDAI cards for up to 16 additional channels of I/O in a variety of analog or digital formats.

7. Cascade Link function allows two 01V96i consoles to be connected to provide up to 80 input channels.
8. Precision 100mm motor faders and scene memory with recall save and global paste functions.
9. Bundled with the latest version of Cubase AI.
10. Compatible with both Windows or Macintosh versions of 01V96i Editor for offline data management and online control.
11. Dimensions shall be 436 (W) x 148 (H) x 548 (D) mm. Weight shall be 14 kg

C. Design Make: Yamaha 01V96i Digital Mixing Console

2.8 MEDIA PLAYER RECEIVER WITH BLUETOOTH

- A. Front-loading media player with slots for CD, USB, SD/SDHC. With support for CD-DA, MP3, WAV, and AAC file formats, small 1U rack mounting height. Front panel Backlit display with the following features:
1. Super-fast loading, slot-in CD mechanism
 2. Supports removable USB thumb and HDDs, SD/SDHC cards
 3. Wireless audio playback from devices via Bluetooth™
 4. Plays CD, MP3, WAV, and AAC files
 5. 3.5mm Aux-in for audio playback of other devices
 6. AM/FM Tuner w/ dedicated audio out for multi-room use
 7. Unbalanced combi audio output
 8. 10-key direct track access
 9. Random, Repeat One, Repeat All, and continuous play modes
 10. Folder only and All play modes
 11. IR controllable with included, compact remote
 12. 1RU chassis with removable rack ears
 13. Detachable IEC-weighted AC inlet• 100-220v switching power supply

B. Design Make: Denon DN-300Z

2.9 PROJECTOR

- A. Features
1. Color system: Laser phosphor / 4 segment (RGBY) colour wheel / 2x120Hz
 2. 1920 x 1200 pixels native display
 3. Aspect ration 16x10
 4. Display type: 1x0.67" DarkChip DMD
 5. Fill Factor 87%
 6. 8,000 ANSI lumens bright and a 20,000:1 (dynamic) contrast ratio.
- B. Video & Graphics Processing
1. HDMI 2.0 for Side by Side, Frame Packing & Top Bottom 3D Formats.
 2. Dual Flash Processing can be used to multiply the displayed frame rate for 3D sources (example 144Hz display)
 3. Synchronisation of active glasses and compatible with polarised glasses
 4. 24p and 1080p native display.
 5. Sealed light engine
 6. DICOM Simulation Mode.
 7. HDR Support

8. Powerful 7 point colour correction for accurate colour matching
- C. Geometry Correction
 1. Cornerstone, Vertical & Horizontal Keystone.
 2. Selectable Aspect Ratios
 3. Digital Zoom
- D. HDBaseT® Interface
 1. Built in support for transmission of uncompressed High Definition Video over standard CAT5e/6 LAN cable.
 2. Allows projector to be placed up to 100m from source with low cost cabling.
 3. Projector Control via HDBaseT.
- E. Design Make: Digital Projection E-Vision Laser 9000WU

2.10 16:10 MOTORIZED TAB TENSIONED PROJECTION SCREEN

- A. Screen Operation: Electrically operated, UL and ULC listed, retractable, heavy duty, with rigid metal roller and motor housed within the roller. Tab guide cable tensioning system to maintain even, lateral tension and hold viewing surface flat. Bottom end of fabric to be inserted into a custom aluminum slat bar with added weight to provide vertical tension on the screen surface.
- B. Motor: Single motor, UL and ULC certified, 3-wire permanently lubricated reversal-type, attached to header, with preset adjustable limit switches to automatically stop viewing surface in UP or DOWN position. Includes automatic thermal overload protection, integral gears, capacitor and electric brake to prevent coasting.
 - a. Voltage, Frequency: 115 V, 60 Hz.
 - b. Amperage: 2.4 amps.
 - c. Limit Switches: Preset and adjustable to automatically stop viewing surface in UP or DOWN position.
 - d. Housing: Inside metal roller.
2. Screen Mounting: overhead ceiling mount to be provided
3. Screen Case: steel case with backed-on black plastisol finish.
4. Viewing surface: TecVision Optiflex.
5. 133" HDTV surface
- C. Design Make Electric Premier Tab-Tensioned
 1. Accessories
 - a. Screen Drop: Extra drop of 18 in black fabric.
 - b. Single Motor Low Voltage Control (LVC): External.

2.11 WIRELESS MICROPHONE SYSTEM

- A. With transparent 24-bit digital audio quality and incredibly efficient RF spectrum usage, the SLXD4 Digital Wireless Receiver combines professional features with streamlined setup and operation.
- B. Automatic scanning quickly finds open frequencies, and one-touch IR sync quickly deploys them to transmitters.

- C. Ethernet networking enables networked channel scanning across multiple receivers and Wireless Workbench® software integration for remote control of receiver settings from a PC or Mac. Remote monitoring and control from iOS devices also is available via the ShurePlus™ Channels Mobile App.
- D. Features
 - 1. 44MHz tuning bandwidth (region dependent)
 - 2. More than 32 preset compatible channels per frequency band (region dependent)
 - 3. Up to 10 compatible systems per 6 MHz TV channel; 22 systems per 8 MHz channel
 - 4. Digital predictive switching diversity ensures solid RF connection
 - 5. AES 256-bit encryption for secure wireless transmission
 - 6. Up to 42 dB of adjustable audio gain
 - 7. High-contrast LCD menu and controls with lockout feature
 - 8. Audio and RF LED meters with peak indicator
 - 9. Detachable ½ wave antennas
 - 10. Mic / line switchable XLR output
 - 11. ¼" Instrument output
 - 12. Durable aluminum construction with brushed finish
- E. Rack mounting hardware
- F. Provide remote hi-gain antennas.
- G. Provide power distribution with AC filtering.
- H. SLXD1 Bodypack transmitter one per wireless microphone, SLXD2 wireless microphone (2 total)
- I. Design Make: Shure SLX-D system or approved equal

2.12 HARD WIRE MICROPHONE

- A. dynamic microphone
- B. Frequency response 50 to 15,000 Hz
- C. Impedance: 150Ω
- D. Standard press-to-talk with “lock” feature, lift to talk with enabled/disable switch, slideswitch to select impedance.
- E. Durable molded cycolac in black with zinc dies cast matching base
- F. 25’ heavy duty cable 4 conductor (two shielded)

- G. Provide power distribution with AC filtering
- H. Provide a minimum of Two (2) microphones or number noted and or shown on contract documents.
- I. Design make: Shure SM85

2.13 LOCAL CONTROLLER

- A. Wall Mounted LCD Display controller, password protected with the following features:
 1. 5in. Wide screen active-matrix color display and 1280 x 720 HD 720 display resolution
 2. Capacitive touch screen display
 3. Custom-programmable virtual control buttons
 4. Supports Crestron HTML5 and Smart Graphics® software custom user projects
 5. H.265 H.264, or MJPEG streaming video display
 6. Native Crestron room scheduling app
 7. Native app for Sonos® home sound control
 8. Built-in web browsing
 9. Single wire Ethernet connection with PoE or PoE+ power
 10. Dual USB 2.0 ports for room availability accessories
 11. Enterprise grade security and authentication
 12. Web, cloud, or device-based configuration
 13. Wall mount provided
 14. 40 hours on site programming and training for owner.
- B. Design Make: Crestron TSW-570

2.14 FM HEARING ASSISTANCE SYSTEM

- A. Provide one complete system at the auditorium.
- B. FM Hearing Assistance System shall consist of one transmitter with antenna, audio cable and power supply, eighteen (18) receivers with batteries and mini "earbud" earphones, and a wall plaque. With a minimum of seven (11) receivers being hearing aid compatible.
- C. Transmitter Specifications
 1. Microphone inputs: two low-impedance, unbalanced, 1/4" phone jack.
 2. Input Level: Dynamic Mics: 250uV to 25mV. Electret Mics: 1mV to 100mV, phantom powered.
 3. Line Inputs: One balanced bridging, 10K impedance, Female XLR. One unbalanced, 100K impedance, RCA jack.
 4. Input Level: 0.03 to 1V RMS, nominal.

5. Automatic Gain Control: 40dB range, 30mV threshold.
6. Input attenuator: 3 positions, 0dB, -20dB, -40dB.
7. Low frequency attenuator: 6dB/octave, 3 positions: "O"=-3dB at 20Hz, "1"=-10dB at 80 Hz, "2"=-10dB at 240 Hz.
8. Tape output: 1K impedance, 1/4" phone jack.
9. Tape out level: 1V into 5K ohms, at threshold of AGC.
10. Monitor jack: 8-32 ohm load, 3.5mm jack.
11. Max. RF power supplied to final RF stage: 250 mW.
12. Max. transmitted field strength: 800uV/m at 30m.
13. Transmitter range: 300 ft. typical.
14. Operating Frequency: Channel (E) 72.9 Mhz standard; Alternates: Channel (A) 72.1, (F) 75.5, (H) 75.9 Mhz.
15. Frequency Tolerance: $\pm 0.005\%$.
16. Maximum deviation: $\pm 75\text{kHz}$.
17. Pre-emphasis: 75 mS.
18. S/N ratio: 55dB.
19. Power requirements: 100-130 VAC, 1 watt; 6-foot 3-wire grounded cord/plug. 12V DC at 75mA.
20. Antenna: 80" half-wave coaxial, integral with 50 ft. RG 59 coax cable, "F" connector.

D. Receiver Specifications

1. Battery type: 9 volt.
2. Battery Drain: 12mA idle, 20mA average.
3. Battery Life: 10 hours, typical.
4. FCC approval: Accepted by Notification, FCC Part 15.
5. Frequency: 72-76 mHz.
6. 1F: 70 kHz.
7. De-emphasis: 75mS to match transmitter.
8. FM Deviation: $\pm 75\text{kHz}$, max.
9. AFC range: $\pm 300\text{kHz}$.
10. Sensitivity: 2uV for 12dB Sinad with squelch defeated.
11. Input overload: 20mV.
12. Squelch threshold: 8-10uV.
13. S/N ratio: 10uV produces 50dB quieting.
14. Antenna: Integral with earphone cord.
15. Controls: Combination volume with on/off control.
16. Indicators: Red "on" indicator.
17. Audio Frequency Response: 40Hz to 15kHz $\pm 3\text{dB}$.
18. Audio Output: 250mW max into 16 ohms.
19. Output load: 8-16 ohms.
20. Output connector: 3.5mm phone jack, mono.
21. Distortion: 1.5% THD at rated output.
22. Acoustic output: 130d

E. Design Make: Listen Technology LT-800-072, (18) eighteen, LR-3200-072 receivers, (5)

five LA-430 neck loop lanyards, (18) eighteen, LA401 Universal Ear Speakers, LA-423 4 port USB Charger, LA-326 Universal Rack mount kit, (2) two LA-304 assistive listening Notification signage kits, LA-122 Universal Antenna Kit.

2.15 A/V SOUND SYSTEM RACK

- A. Breakthrough design provides high strength without extra weight
- B. Fixed solid sides for security and to control airflow
- C. Accepts Lever Lock™ system tool free cable management accessories
- D. Accepts extender bay to add 3” of useable depth to the front or rear at any time
- E. Accepts brush grommet rear door kit for a large cable passage without fishing
- F. Wide open top and bottom offer many cabling and cooling options
- G. Standard front and rear adjustable 10-32 threaded rack rail with numbered spaces
- H. Includes standard vented rear door that accepts optional fans
- I. General Info
 - 1. Finish Type: Black Powder Coat
 - 2. UL Standards Tested: UL1678
- J. Listing Agencies/Third Party Information
 - 1. ASCE: 7-10
 - 2. RoHS: Yes
 - 3. Greenguard: Yes
 - 4. UL Listing No: E173107
- K. Technical Information
 - 1. Rackrail Type: 10-32
 - 2. Seismic Load Capacity: 1175
 - 3. UL Load Capacity: 3000
 - 4. Material: Steel
 - 5. Mounting: Horizontal
 - 6. Seismic Certified: Yes
- L. Design Make: Middle Atlantic Products DWR Series

2.16 A/V EQUIPMENT NETWORK SWITCH

- A. Features:
 - 1. Gigabit Copper ports : 16
 - 2. SFP Fiber ports : 2 dedicated
 - 3. PoE ports (802.3af) : 16
 - 4. PoE+ ports (802.3at) : 16
 - 5. Form factor : Rack
 - 6. Total PoE power budget : 300W
 - 7. Max noise @25°C, 77 °F : 28.2 dB
 - 8. Feature set : Smart L2 (no routing)
 - 9. Energy Efficient Ethernet (EEE) support : Yes
- B. Design Make: NETGEAR GS716TPP

2.17 WIRELESS ROUTER

- A. Wireless Type: 802.11 A/C, 5.8 GHz Radio Frequency, 802.11 a/b/g/n
- B. Number of USB Ports: 3
- C. Operating System: Microsoft Windows 98SE, NT, 2000, XP, Vista or Windows 7, Windows 8/8.1/10 MAC OS, NetWare, UNIX or Linux.
- D. Tri-band Router with NitroQAM sends up to 5400Mbps of total Wi-Fi throughput over one 2.4GHz (1000Mbps) and two 5GHz (2167Mbps) bands.
- E. Design Make: Netgear ProSafe Business 3x3 Dual Band Wireless AC.

2.18 A/V CABLING AND WALLPLATES

- A. All interconnect audio and video cabling and patch cabling shall be high-resolution shielded type coaxial cable.
- B. Audio and video cabling lengths are to be field measured unless otherwise listed.
- C. Category 6 cable may be used for unbalanced RCA audio cabling where the distance does not exceed 30 feet.
- D. All balanced audio cabling shall be STP type.
- E. All full-length cables between active components shall have factory pre-terminated connectors. Field verify cable terminations requirements ie. (male/male) or (male/female).

F. Video cabling shall meet the following requirements:

1. Shielded Twisted Pair Audio Cable

- a. Cable shall be ASTM tinned copper, 18 AWG polypropylene insulated, twisted pairs.
- b. Each pair shall be individually shielded with aluminum-polyester shield and 20 AWG stranded tinned copper drain wire.
- c. Cable shall be UL listed NEC type CMP, constructed in accordance with UL Standard 4444 and comply with UL 1666 vertical shaft flame test.
- d. Cable shall be fully functional from -20°C to 75 °C.
- e. The assembly shall have an overall plenum jacket.
- f. Design Make: West Penn or Approved equal

2. Speaker Wire

- a. 2 conductor twisted, No. 12 AWG stranded copper with twist connectors.
- b. Design Make: West Penn Wire Corporation, No. 226

3. HDMI

- a. High speed category 2 HDMI
- b. 24k Gold-plated HDMI type A male connectors each end
- c. Up to 30'
- d. Full 4K60 4:4:4 video is supported
- e. Crestron - CBL-HD

4. Category 6e cabling

- a. Refer to division 28 specifications for requirements.

G. Provide the following cable adapters as required:

1. Speaker cabling shall be provided with twist type connector male and female where applicable.

H. Provide A/V Wall plates at all Multimedia A/V outlet locations shown on the drawings.

1. 4K60 4:4:4 support
2. HDR10 Deep Color and 3D video
3. Dolby® TrueHD DolbyAtmos® DTSHD® and uncompressed 7.1 linear PCM audio
4. HDBaseT® compatibility
5. HDCP2.2 compliance HDMI® input (DVI and Dual-Mode Display Port™ interface compatible)

6. DM8G+® output for connection to a DM® switcher or receiver via a single CAT5e (or higher) twisted pair cable
7. Transmission distance up to 330ft (100m) for resolutions up to UHD and 4K using DM Ultra cable
8. Transmission distance up to 330ft (100m) for 1080p WUXGA and 2K using DM8G® cable or CAT5e Transmission distance up to 230ft (70m) for UHD and 4K using DM 8G cable or up to 165ft (50m) using CAT5e
9. Device control via CEC IR and RS-232
10. Powered via the DM connection or optional power pack
11. Versatile mounting options including 1- gang electrical box
12. Design Make: Crestron DM-TX-4KZ-100-C-1G

- I. Provide Microphone Wall plates at all outlet locations shown on the drawings.
 1. 3 pin female jack
 2. White in color
 3. Design Make: RDL XLR series

2.19 BLUETOOTH IN WALL AUDIO INTERFACE

- A. Bluetooth® profile A2DP - stereo audio is streamed from a Bluetooth® device to the unBT2A and output as analog (via the unBT2A EXP interface)
- B. Bluetooth® range: 30 - 70 ft typical
- C. Depluggable output type: Balanced 3-pin line level, -10 dBV / +4 dBu nominal output levels (software switchable) on the unBT2A EXP. Mono/Stereo functionality is also software switchable
- D. Dynamic range: >85 dB
- E. Maximum output level (balanced depluggable): +20 dBu in +4 dBu setting, +6 dBu in -10 dBV setting
- F. System THD: Less than 0.1%
- G. RS-232: Full RS-232 control (standard RS-232 levels) of pairing and other user interface features. 3-pin depluggable connector on the unBT2A EXP
- H. USB: Mini B type connector
- I. Certifications FCC 47CFR Parts 15B and 18 (Class A), EN 55011, ICES-003, CE (EN55022 Class A and EN55024 Class A)
- J. Dimensions:
 1. unBT2A - 1.69 x 4.2 x 1.25 in (42.93 x 106.68 x 31.75 mm)
 2. unBT2A EXP - 5.56 x 1.13 x 1.75 in (141.22 x 28.7 x 44.45 mm)
- K. Operating temperature: 0°C - 40°C
- L. Kit Shall include unBT2A wall unit and unBT2A-EXP module
- M. Design Make: QSC unBTA2A

PART 3 – EXCUTION

3.1 QUALITY CONTROL

- A. All components of the sound system as a whole shall meet or exceed the minimum standards

issued by the EIA. All work in conjunction with this installation shall meet the requirements of the 2014 National Electrical Code.

- B. The system shall be listed by Underwriter's Laboratories, Inc., and each of the major components shall bear the manufacturer's name, catalog number and U.L. label.
- C. The Contractor shall provide necessary transient protection of the AC power feeding the sound system. All protection shall be as recommended by the equipment supplier and referenced to earth ground.

3.2 INSTALLATION, WIRING AND RACEWAY

- A. Preparatory work required to accommodate the sound system installation, i.e., conduit, junction and pull boxes, outlet boxes, brackets and all conduit fittings and accessories, including power outlets as required, shall be furnished and installed by the Contractor.
- B. The sound system supplier shall provide expert supervision of the installation and in addition, shall furnish the necessary wiring diagrams and instructions required to make the final sound system installation complete.
- C. The installation shall be accomplished in a professional manner by qualified personnel regularly engaged in and experienced in this type of work.
- D. The Contractor shall make installation in strict accordance with approved manufacturer's drawings and instructions.
- E. All equipment shall be installed in a neat and workmanlike manner and to the satisfaction of the Architect/Engineer.
- F. All equipment power wiring and grounding shall conform to the National Electrical Code and applicable local codes.
- G. All electronic equipment shall be grounded.
- H. All cable shall be adequately supported and connectors specifically designed for the type cable in use.

3.3 WIRING

- A. The Contractor shall furnish and install all wiring, conduit, backboxes, pull boxes, outlets and boxes for the erection and operation of a complete public address system as specified and described in these specifications, as shown on the drawings and recommended by the manufacturer.

- B. All equipment power wiring shall be of the same type for lighting and power. Wiring shall meet the requirements of the National, State and local electrical codes.
- C. All sound system cabling shall be run in conduit.
- D. Speaker and Microphone Cable - West Penn WP 292, 20 AWG stranded tinned copper, polypropylene insulated, twisted pair, aluminum - polyester shield, 22 AWG stranded tinned copper drain wire.
- E. Where 4 or 8 ohm speakers and outputs are used (no transformers), 12 or 14 AWG wire is required based on power and distance West Penn WP 295 (14) or WP 296 (12).
- F. Final connections between equipment and the wiring system shall be made under the direct supervision of a representative of the manufacturer of the equipment furnished. At the completion of the installation the manufacturer's representative shall test and adjust the system.

3.4 SYSTEM TEST AND ADJUSTMENTS

- A. Contractor shall carry the following hours:
 - 1. 4 hours on site training session that will also be recorded and turned over to owner for future use.
 - 2. 4 hours on site mixing console training that will also be recorded and turned over to owner for future use.
 - 3. 4 hours on site training 6-months after project is turned over to owner.
 - 4. 8 hours post project turn over for owner to use up to 1 year after turn over date for post system programming changes.
- B. Before final acceptance of the sound system, the manufacturer/supplier of system shall, in presence of Contractor, Owner's representative, test each and every component and device in the system. The test shall be documented with signed copy submitted to the Contractor, Owner and Architect/Engineer.
- C. Upon completion of the system installation, it shall be the responsibility of the Contractor to perform the necessary adjustments and balancing of all signals and amplifier level controls to insure proper system operation.
- D. The system shall be physically inspected by the Owner's representative and the Architect/Engineer to assure that all equipment is installed in a neat and workmanlike manner as called for in the plans and specifications.
- E. The system shall be equalized using a noise generator and octave band analyzer. The settings shall be mounted inside the cabinet door and included in the maintenance manuals for future reference.

- F. As a minimum requirement, the sound system should be tested to prove the following:
1. The complete sound system is free from grounds, opens and shorts.
 2. Each device functions as specified herein.
 3. Abnormal condition of any circuit or device which is to be electrically supervised shall be checked for trouble indication.
 4. Proper adjustment of all speaker taps to provide clearly audible, but unobtrusive paging in all areas, to the Engineer's and Owner's satisfaction.

3.5 OWNER INSTRUCTION ON SYSTEMS OPERATION

- A. Upon completion of the work, and prior to acceptance of the same by the Owner, the Contractor and the major equipment manufacturer's qualified representative shall spend a minimum twenty (20) hours, with the facility personnel, instructing them on the operation and service of all the sound system equipment and controls.
- B. The Contractor shall properly instruct maintenance personnel to perform emergency repairs to the system such as replacement of defective standard components such as loudspeakers, lamps, etc.

END SECTION 287535

SECTION 275117

IP PUBLIC ADDRESS SYSTEM

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

- A. The drawings and general provisions of the Contract Documents apply to this section.

1.2 SUMMARY

- A. This section includes a fully operational school internal communications and clock incorporating safety, including but not limited to the following:
 - 1. The system shall provide complete internal communications and clock control employing state of the art VoIP Technology including the minimum functions listed.
 - 2. Two-way Loud Speaking Internal Intercommunications.
 - 3. Event Announcement.
 - 4. Emergency announcement that will override any pre-programmed zones assuring that all Emergency/Lockdown etc. are heard at each and every speaker location.
 - 5. Capability of prerecording emergency announcements that can simply be activated by simple Soft Key or via a dedicated call-switch.
 - 6. School Safety Paging and Evacuation tones.
 - 7. Distributed (MDF/IDF) Electronic Architecture. (No home run wiring for each circuit).
 - 8. Atomic time Synchronization with Class Change Tones utilizing multiple, programmable schedules for each zone.
 - 9. Paging and Program Distribution.
 - 10. Incorporate district-wide announcements, either live or recorded thru a direct connection to the WAN and telephone system.
- B. Synchronous Analog Clock and Time Control
 - 1. Class change signaling
 - 2. Atomic Clock Synchronization

3. Emergency call-ins shall take precedence over normal calls so that they are answered first. The system shall support a minimum of 16 call level priorities which shall be user definable.
4. Any authorized administrator shall be able to call from outside the school into any classroom, zone or entire school directly via the School District supplied Telephone Network. This shall allow remote monitoring and two-way conversation from outside the school building as well as Paging into the system. The feature shall allow the user access to all functions via a user defined PIN code. (Compliance with NEMA Standard SB-40 for emergency communications in K-12 Schools.)
5. Authorized system users shall be able to record a minimum of ten (10) automated messages with emergency instructions and replay them. Automated message strings shall be either automatically distributed as part of a dial string, manually played from a single-button access on the phone or thru the master clock as a timed event.
6. Paging and two-way loud speaking features shall be accessible from any telephone by authorized users with the use of a user defined PIN code.
7. The system shall allow the users to exclude their classrooms from paging and tones in the event of testing or other activity that shouldn't be interrupted. This exclusion will not affect emergency paging. The "exclusion" must have the ability to "reset" at midnight.
8. The system shall synchronize its system time to the network timeserver or a web-based time server.
9. The system shall have the ability to correct and power classroom Secondary Analog Clocks over the same Cat5e/6 cable drop also used for Two-Loudspeaking intercom speakers, call switch and (optional) motion detector.
10. This specification establishes a minimum level of quality, features, and performance for individual components as well as the integrated system.
11. The system shall incorporate Rauland "Universe" functionality to permit control of Public Address functions from an internet browser. The Universe system shall also permit access to other building's P.A. systems once the software has been purchased and installed in those buildings. All browser-based access shall be secured by passwords.

1.3 SUBMITTALS

- A. Product data for each component.

- B. Shop Drawings: Prior to proceeding with the work: Provide detailed equipment assemblies and indicate dimensions, weights, required clearances, method of field assembly, components, location of each field connection, and a complete schedule of all equipment and materials with associated manufacturers cuts sheets which are to be used.
- C. Wiring Diagrams: Detail wiring for power, signal, control systems and differentiate between manufacturer-installed and field-installed wiring. Identify terminals to facilitate installation, operation and maintenance. Include a single-line diagram showing cabling interconnection of components and levels throughout system and impedances.
- D. Artwork drawings and lists indicating proposed nameplate nomenclature and arrangements for control panels and plug panels prior to fabrication reflecting equipment used.
- E. Each drawing shall have a descriptive title and all sub-parts of each drawing shall be labeled. All drawings shall have the name and locations of the project, Systems Contractor's name in the title block.
- F. Details and description of any other aspect of the system, which must differ from the contract documents due to field conditions or equipment, furnished.
- G. FCC Approval: The system shall be approved for direct interconnection to the telephone utility under Part 68 of FCC rules and regulations. Systems, which are not FCC approved or utilize an intermediary device for connection, will not be considered. Provide the FCC registration number of the system being proposed as part of the submittal process.
- H. Product Certificates: Signed by manufacturers of equipment certifying that products furnished comply with specified requirements.
- I. Installer Certificates: Signed by manufacturers certifying that they comply with requirements.
- J. Manufacturer Certificates: Signed by manufacturers certifying that they comply with requirements.
- K. Field Test Reports: Indicate and interpret test results for compliance with performance requirements. Include record of final matching transformer-tap settings, and signal ground-resistance measurement certified by Installer.
- L. Maintenance Data: For equipment to be included in maintenance manuals specified in Division 1.
 - 1. Record of Owners equipment-programming option decisions.
 - 2. All instructions necessary for proper operation and manufacturers instructions.
 - 3. "Proof of Performance" information.

4. Manufacturer's maintenance information.
 5. Copies of non-proprietary computer programs and system set up disks documenting all programmable features of the installed system.
- M. Record Drawings: Prior to final acceptance, provide three (3) complete sets of drawings indicating all cable numbers and construction details in accordance with the actual system installation. Revise all shop drawings to represent actual installation conditions. These Record Drawings will be used during "Final Acceptance Testing".
- N. System Training: Submit the following information describing the training programs and system trainers as outlined in paragraph 1.6 of this specification and in accordance with Division 1 specifications.
1. Include with the submittal a preliminary staff development training program in outline form for review and approval by the Owner's Representative.
 2. Include with the submittal a current copy of the trainer's certification from the manufacturer that certifies and identifies the trainer(s) who are eligible to provide training and support for the project.
 3. Include with the submittal a current copy of trainer's need's assessment form which will be reviewed with the Owner's Designated Representative for the system's preliminary system programming and configuration.
 4. Include with the submittal copies of all documentation used to identify for the owner those participants attending and completing the training programs.
- O. A copy of the manufacturer's standard statement of warranty proving all equipment provided for the school communications network is covered with the required five-year warranty shall be included with the project submittal. This statement of warranty shall be provided on the manufacturers stationary.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who is an authorized representative of equipment manufacturer for both installation and maintenance of equipment required for this Section. Provide the following within thirty (30) days after notification to proceed:
1. Provide a list of installations that the Installer has specifically installed for verification by the Owner. Random installations from other vendors and/or Installers shall not be accepted. The Installer, not its employees, must meet these qualifications.
 2. The installer shall be bondable.

3. The Installer shall demonstrate to the satisfaction of the Owner or his representative that he has:
 - a. Adequate plant and equipment to pursue the work properly and expeditiously.
 - b. Adequate staff and technical experience to implement the work.
 - c. Suitable financial status to meet the obligations of the work.
 - d. Technically capable and factory trained service personnel at local service facility to provide routine and emergency service for all products used in this project.
- B. Any Contractor, who intends to bid on this work and does not meet the requirements of the "Quality Assurance" paragraph(s), shall employ the services of an "Installer" who does meet the requirements and who shall provide the equipment, make all connections and continuously supervise the installation. A subcontractor so employed as the "Installer" must be acceptable to the Architect/Engineer. The "Installer" shall be identified within thirty (30) days of notification to proceed for acceptance by the Architect/Engineer.
- C. Because the life expectancy of this type of communications system normally exceeds 10 years, the owner expects continuity from the service provider. Therefore, the installing/servicing company must have been an authorized provider of the manufacturers product for at least 10 years.
- D. Each major component of equipment shall have the manufacturers name, address and model number on a plate securely affixed in a conspicuous place. NEMA code ratings, UL Label, or other data that is die-stamped into the surface of the equipment shall be easily visible.
- E. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA, Article 100, by testing agency acceptable to authorities having jurisdiction.
- F. Comply with NFPA 70.
- G. Comply with NEMA Standard SB-40 for Emergency Communications in K-12 schools.
- H. Comply with UL 60950.

1.5 IN-SERVICE TRAINING

- A. The contractor shall provide and implement a complete and comprehensive staff training program for all administrators, facility staff members, and teachers. This mandatory training program will provide school staff a complete understanding of how to utilize and properly operate all functions.

- B. The training program shall be implemented by a staff member/trainer employed by the contractor. The trainer must be factory certified to provide training on their product.
- C. All staff development training is to be coordinated through the owner's designated representative. As training sessions are completed, the trainer will provide the school's administrative staff and school district's staff a document listing all of the staff and faculty members who attended, received, and completed the training program.

1.6 WARRANTY

- A. Provide a manufacturer's five-year warranty of the school communications network equipment against defects in material and workmanship. This warranty will cover all electronic equipment, as well as analog clocks, speakers, and call-in switches. If any defects are found within the warranty period, the defective equipment shall be replaced at no cost (equipment only); a one year warranty shall be provided for labor.
- B. A copy of the manufacturer's standard statement of warranty proving all equipment provide for the school communications network is covered with the required five-year warranty shall be provided on the manufacturer's stationary. The standard five-year warranty is an important element in establishing a standard in quality. Manufacturers who circumvent the five-year warranty by offering special "extended warranties" that are not part of their normal published warranty will not be accepted.
- C. Contractor shall respond, excluding weekends and holidays, within 24 hours to any warranty service calls. If equipment cannot be repaired within 24 hour of service visit, the contractor shall provide "loaner" equipment to the facility at no charge.
- D. Make available a service contract offering continuing factory authorized service of the system after the initial warranty period.

1.7 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide the following system:
 - 1. Telecenter VoIP / Universe manufactured by Rauland-Borg Corp.

PART 2 - PRODUCTS

2.1 SYSTEM REQUIREMENTS

- A. The system shall utilize state of the art VoIP Technology, Call-in Notification, School Safety Paging and Evacuation tones, Distributed (MDF/IDF) Electronic Architecture, Atomic Time Synchronization with Class Change Tones utilizing multiple, programmable schedules for each zone, Two-way Loud Speaking Internal Intercommunications and Paging, and Program Distribution. The system shall be easy to learn and operate. All standard system programming shall be user friendly to allow the system administrator the ability to easily program system features.

- B. Provide complete and satisfactorily operating school communications and School safety as described herein, using materials and equipment of types, sizes, ratings, and performances as indicated. Use materials and equipment that comply with referenced standards and manufacturers' standard design and construction in accordance with published product information. Coordinate the features of all materials and equipment so they form an integrated system, with components and interconnections matched for optimum performance of specified functions.
- C. The system shall be single electronic system consisting of amplified intercom channels depending upon the configuration of the system, (classroom) speakers, corridor speakers, inside and outside horns, call-in switches, and master clock.
- D. Feature offered by this system shall be implemented and controlled by a software program that can be changed and expanded as customer need evolve.
- E. The system shall lend itself to expansion by simple addition of hardware modules.
- F. The system shall allow the implementation of bell schedules that are managed via the WAN/LAN. The system shall directly connect to the WAN/LAN without the need for a separate computer at the school location. Bell schedules can remotely be created, changed, stored and downloaded to the system by an authorized user from a browser-based interface.
- G. The system shall provide the ability to initiate school safety paging announcements, evacuation tones and take cover tones from any telephone within the facility or outside the facility to any other location within the facility. The system must also allow the implementation of a district-wide announcement system, where live messages, pre-recorded announcements and emergency tones can be triggered via a telephone or browser-based user interface.
- H. The system shall provide the ability to selectively communicate or monitor individual classrooms in emergency situations from any telephone within the facility or outside the facility to any other location within the facility; all communication within the classroom shall be hands free and will not require any interaction by the end-user to answer.
- I. Room speakers, call switches, shall be programmable and may be assigned any two, three four or five digit number. Any extension may be reassigned at any time, and it shall not be dependent on wiring or circuit numbers.
- J. Amplified two-way voice communication shall be available from any provided telephone through any speaker in the system. This shall allow hands-free communication to any classroom or any individual loudspeaker unit. A programmable pre-announce tone shall sound immediately before the intercom path is opened and a supervisory tone shall continue to sound at regular intervals when speaker monitoring is active, complying fully with all privacy legislation.

- K. Integrated Master Clock with unlimited schedules, unlimited events, and automatic Daylight Savings time correct. Up to 5 schedules may be active on any given day. User shall be able to select from 15 tone options or user created .wav files for class change signaling. In addition the system shall allow unlimited user defined class change tones to be recorded. The system shall allow control of the bell schedules via the district WAN/LAN. The system shall directly connect to the WAN/LAN without the need for a separate computer at the school location. Bell schedules can remotely be created, changed, stored and downloaded to the system by an authorized user from a browser-based interface.
- L. Ability to correct and power secondary clocks using the same Cat/6 cable drop (district standard) used for intercom speaker, call switch and (optional) motion detector.
- M. “Universe” functionality for browser-based access and control of P.A. System.

2.2 EQUIPMENT AND MATERIAL

- A. VoIP Based Controller (Gateway) Rauland-Borg Telecenter Series – with the following features and capabilities:
 - 1. The ability to network multiple controllers via the LAN to provide a single interconnected system within the facility. The networking capability must provide for total transparency between controllers and in turn operate as a single system.
 - 2. On-site or off-site diagnostics shall be capable via a standard Ethernet port for factory-trained personnel. The controllers shall tie directly into the LAN. In addition, all bell scheduling tasks must be browser based allowing authorized access from off-site district staff. On-site facility staff may also perform these tasks in the same manner as the district staff.
 - 3. System shall connect to the district provided Telephone Network via an analog trunk, or station port.
 - 4. The VX Works based Operating System and system programming database shall be stored in non-volatile flash memory. The Operating System can be easily upgraded through a configuration program without requiring replacement of any chips. The system programming database can be easily archived.
 - 5. Support a flexible numbering plan allowing two, three, four or five digit extensions. The two, three four and/or five digit extensions can be intermixed within the same facility. Each extension can include leading or trailing alpha digits to match a facility’s room numbering scheme.
 - 6. Multiple attendant positions via district provided Telephone Network shall be capable of answering internal intercom call-ins a minimum of one (1) Marquee Display shall be provided.

7. Personal Identification Numbers (PIN's) shall be available for all staff. By dialing their PIN at any provided telephone, the staff member shall have access to the School Internal Intercom and Public Safety Network.
8. Reports on feature usage, system activity, etc. shall be available upon request either on site or remotely.
9. Direct Dialing, two-way amplified voice intercom between any provided telephone and speaker without the use of a press-to-talk or talk-listen switch.
10. DISA: Direct Inward System Access. The system can be configured to allow access to all system features/functions (paging, intercom, evacuation tones, class tone schedule selection, etc.) from any offsite DTMF dialing telephone via the district provided Telephone Network. Only authorized individuals may use this feature by dialing into the system through a dedicated trunk number, with or without a pass code, and then dialing a system function.
11. Ability to place two levels of call-in from any call in switch.
12. The ability to answer intercom call-ins registered at pre-selected telephones.
13. The ability to automatically reroute incoming call-ins to an alternate telephone or group of telephones if they remain unanswered for a predetermined amount of time.
14. System must support data style structured cabling utilizing Patch Panels that allow quick, Cat5e/6 (LAN cable) connection of various headend, distributed and classroom devices. Analog phones, speakers, call switches and analog clocks shall be wired using a single Category 5e/6 cable. Wiring for all speaker analog clock, call switch shall be with one Cat5e/6 cable drop per location. Systems requiring a custom cable plant will not be acceptable.
15. The ability to remotely locate VoIP controller(s) (Gateways) among MDF and IDF equipment closets. This flexibility allows for the most economical wiring of the system based on the layout of the facility thus eliminating the need for individual home run wiring per previous standard.
16. The ability to initiate Class of Service changes either manually or automatically on a per station basis based on time of day, day of the week, and calendar via the integrated master clock.
17. A minimum of sixty-four (64) unique Classes of Service shall be available.
18. Ability to perform any system feature or function from any authorized telephone.
19. Intercom/Paging/Tones/Clock Correction Module.

- B. Provide an integrated intercom module for individual room intercommunications, all page and zone page, evacuation tones, prerecorded messages, multilevel call-in, secondary clock correction, and class change tones. The module shall be from the same manufacturer as the VoIP Controller (Gateway) to ensure compatibility. The module shall integrate directly with the VoIP Controller and will not require analog or digital tie lines to the VoIP Controller. Module shall provide the following integrated features and functions that integrate seamlessly with the VoIP Controller:
1. Two-way communication between any telephone and any room speaker.
 2. Preannounce tone prior to connecting any intercom conversation to alert the user to the call and prevent unauthorized monitoring. A tone shall be automatically repeated at regular intervals for the duration of the intercom call if the voice circuit is not activated. A requirement to meet existing privacy laws.
 3. Audio paging access from any telephone to any single intercom speaker, zone (group) of intercom/paging speakers, or all speakers/paging horns throughout the entire facility.
 4. Single button access from any telephone on the system to distribute emergency announcements within the facility to all or select locations equipped with speakers. Emergency announcements originating from any assigned administrative telephone shall have priority over all regular system functions.
 5. Single button access from any telephone on the system to initiate alarm signals within the facility to all or select locations equipped with speakers. Up to Sixteen (16) separate distinct alarm signals shall be provided. Alarm signals originating from any assigned administrative telephone shall have priority over all regular systems functions.
 6. The system will have the ability to utilize a web-browser and USB microphone to deliver live emergency paging, pre-recorded messages and tones from any authorized computer in the facility or the district. The system must be capable of automatically notifying district personnel via the WAN of an alarm condition.
 7. The system can automatically broadcast page emergency instructions throughout an entire school when an alarm (e.g. lockdown, lockout, security, fire) is tripped or manually activated. The emergency instructions are preprogrammed and require no user intervention. The system provides redundant alarm annunciation over intercom/paging speakers and is not meant to replace primary fire alarm or security systems.
 8. Multilevel call-ins can be placed from either a classroom telephone or a call-in switch. The call-ins route to select or all administrative telephones and can only be cleared from the system once answered from an administrative telephone. If a call-in is not answered within a preprogrammed time the call-in may route to other administrative telephone(s) announce over selected or all speakers and shall

have the capability to also reroute calls to predefined Mobile telephones. Emergency call-ins can also be programmed to send e-mail alerts to specific addresses.

9. An option for Privacy call-in switches. When the Privacy switch is activated it prevents administrative or classroom telephones from monitoring the specific classroom/location intercom speaker.
10. Classroom teachers shall have the capability to exclude pages and tones from their individual classroom for testing or other purposes. This exclusion cannot affect emergency pages. This exclusion will reset at midnight.
11. An option for Call Assurance call-in switches. When the normal or emergency button is pressed, and LED lights up to visually confirm that a call-in has been placed.
12. The system can automatically alter a call switch's class of service by time of day and date via the integrated master clock.
13. The capability to assign speaker locations to any one or more of the Sixteen (16) independent program/music distribution zones and sixteen (16) independent class change tone reception; this assignment is a programmable function. Each location shall be programmed in software to belong to any combination of software zones. Software/hardwired zones must be configured as part of an unlimited number of district wide groups for school district emergency announcements. These district announcements must be accessed via microphone, a web-browser or telephone.
14. Automatic class change tones sent through all or selected intercom/paging speakers and/or horns. Any combination of up to Sixteen (16) tones can be sounded to indicate different events. Up to Sixteen (16) different class change schedules can be stored in the system and selected manually from an administrative telephone, web browser or selected automatically based on time, day of the week and date. Tone type and duration are selectable for each class change event. An unlimited number of class change events can be programmed as part of the system.
15. Programmable "Music-on-Class-Change." A program source can be automatically routed to select zones of paging speakers or all speakers within the facility during each class change period.
16. The system shall provide facilities to distribute program material (i.e. cassette tape, CD, radio broadcasts) in the following manner:
 - a. The user shall cue remotely located music source or select radio station.

- b. From an Administrative Telephone the user can select the room(s) or areas to distribute program.
 - c. Automated distribution based on event schedule.
- 17. The module provides for secondary clock correction with the following features and functions:
 - a. User programmable Automatic Daylight Savings Time Change.
 - b. Latched operation of zone outputs to control lighting or other devices.
 - c. Interface with most types of secondary slave clocks whether synchronous wired, wireless or electronic.
 - d. User-programmable custom slave clock correction. Output relays rated at 5 amperes shall be provided on all zone circuits as necessary.
 - e. Ability to correct and power secondary clock using same Cat5e/6 supporting intercom speakers, classroom telephone, call switch and motion detector. Secondary clocks requiring more than 15 mA shall not be acceptable.
- 18. System has the ability to sync system time to the Atomic Clock Signal or the school's or district's network time server. System has the ability to offset system time (+) or (-) 15 minutes from true atomic time to accommodate bus schedules or other scheduling issues.
- 19. The module provide for classroom security and call switch supervision with the following features and functions:
 - a. All field wiring to call switches connected to the system shall be capable of individual supervision for opens or shorts.
 - b. System shall be capable (future) to accept multiple alarm inputs from the main security and/or fire alarm system. Emergency tones and/or announcements can therefore be triggered, via the primary security and/or fire alarm system, to provide redundant annunciation using the classroom and corridor speakers.
- 20. Intercom and paging speakers/horns can be assignable to any one or more of the Sixteen (16) zones for zone paging, up to Sixteen (16) zones for program distribution, and Sixteen (16) zones for class change tones. Any of these zones may be part of a district created emergency paging zones allowing paging groups of different facilities within the school district. All of these zones may be configured to be independent of the other zones and in any combination. Below

is an example of paging zone scheme. The initial scheme at HS shall be determined by the Owner.

- a. Grade PreK-1
- b. Grade 2-4
- c. Grade 5-6
- d. Grade 7-8
- e. Grade 9
- f. Grade 10
- g. Grade 11
- h. Grade 12
- i. Teachers' lounge and workrooms
- j. Common areas
- k. Administrative areas
- l. North Outside Speaker Area
- m. South Outside Speaker Area
- n. West Outside Speaker Area
- o. East Outside Speaker Area
- p. Gymnasium

C. Audio Paging/Program Amplifiers

- 1. Power amplifier(s) shall be provided to provide a minimum of ½ watt of power to all paging speakers, and 15 watts of power to all paging horns.
- 2. The maximum load on the paging/program amplifiers shall be 80% of the rated maximum output of the amplifiers.

D. Interior Recess-mounted Wall/Ceiling Speakers

- 1. Provide premium quality 8" cone transducer speaker. Transformer assembly shall be dual voltage multi-tap type suitable for 25 or 70-volt installations. The speaker shall have a frequency response of 65 Hz to 17 KHz with a power rating

of 8 watts. Sensitivity shall be 93 dB, 1 watt, 1 meter. Voice coil shall be 3/4" diameter with a 5 ounce magnet. When installed in ceiling, no speaker assembly weight shall be resting on any ceiling tiles.

2. The recessed back box shall be of heavy gauge cold-rolled steel, spot welded for stability with a rest-retardant gray primer finish. Acoustically treat the interior to eliminate mechanical resonance. The back box shall be 10-3/4"x10-3/4" deep and shall be capable of accommodate the clock speaker baffle in locations designated.
3. The surface mount clock/speaker back box shall be of 22 gauge cold-rolled steel, with baked powdered epoxy cool gray finish. Supports either vertical or horizontal mounting. The surface mount clock/speaker backbox shall be 20.18"x14.26"x2.78" deep.
4. The baffle shall be constructed of a one-piece, 22 gauge cold-rolled steel, zinc-treated to prevent corrosion. The finish shall be white baked powdered epoxy and be virtually scratch/mar proof. The baffle perforation pattern shall be designed for wide sound dispersion and screw attachment to top of the back box.

E. Recessed Wall Mounted Horns

1. Provide double re-entrant type horn loudspeakers with integral driver. The horn loudspeaker shall be impervious to weather and vandalism. Horn shall be constructed of heavy-duty ABS plastic. Horn loudspeaker drivers shall be rated at 15 watts with a frequency response of 480 Hz to 14 KHz. Sensitivity shall be 106 dB 1 watt, 1 meter. Transformer assembly shall be dual voltage multi-tap type suitable for 25 or 70-volt installations. Dispersion patter shall be 180 degrees conical. The horn loudspeaker shall be constructed of treated heavy gauge aluminum, with all exposed p arts potted and sealed driver. Wiring terminal shall be fully enclosed. The speaker flange and mounting surface shall have a cork-rubber gasket. The horn loudspeakers finish shall be gray baked on enamel.
2. The recessed back box shall be of heavy gauge cold-rolled steel, spot welded for stability with a rust-retardant gray primer finish. Acoustically treat the interior to eliminate mechanical resonance. The back box shall be 10-3/4"x10-3/4"x6"deep.
3. The baffle shall be vandal proof, the faceplate constructed of 14-gauge carbon steel with a minimum tensile strength of 55,000 PSI. A lattice grid sub-plate shall deny access to the horn but be acoustically transparent for sound projection. Provide tamper proof, stainless steel mounting hardware. The baffle shall a mar/scratch baked epoxy rust inhibitive finish.

F. Uninterruptible Power Supplies (UPS)

1. UPS equipment provided for this system will include Power Conditioning to smooth current and voltage fluctuations.
2. UPS equipment will be sized in accordance with the system manufacturer's recommendations.
3. Provide an individual UPS for EACH SYSTEM CONTROLLER (Gateway) furnished with the system.
4. Provide additional UPS(s) for protection of all other equipment furnished with the system and housed in the equipment racks.
5. All UPS equipment shall be rack mounted.

G. Equipment Racks

1. All equipment racks shall provide 44 spaces (77") minimum for mounted system equipment.
2. All equipment racks shall be multi-rack format ("gangable") style, bolted together, and open cavity.
3. All equipment racks will be provided with lockable rear doors.
4. Equipment rack(s) shall be located in climate-controlled areas/rooms as shown on drawings.
5. All head-end, distribution, and source equipment, including data and power, shall be located in racks configured as approved by the Engineer.
6. Rack mounted equipment shall be accessible from front and rear.
7. All unused rack spaces will be covered with appropriate blank/vent panels.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine condition, with the Installer present, for compliance with requirements and other conditions affecting the performance of the School Communications and School Safety Network.
- B. Do not proceed until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. General: Install system in accordance with NFPA 70 and other applicable codes. Install equipment in accordance with manufacturer's written instructions.

- B. Furnish and install all material, devices, components and equipment for a complete operational system.
- C. Impedance and Level Matching: Carefully match input and output impedance's and signal levels at signal interfaces. Provide matching networks where required.
- D. Control Circuit Wiring: Install control circuits in accordance with NFPA 70 and as indicated. Provide number of conductors as recommended by system manufacturer to provide control functions indicated of specified.
- E. All housings are to be located as indicated.
- F. The contractor shall provide necessary transient protection on the AC power feed, all copper station lines leaving or entering the building, and all central office trunks. All protection shall be as recommended by the equipment supplier and referenced to earth ground.
- G. Wiring within Enclosures: Provide adequate length of conductors. Bundle, lace, and train the conductors to terminal points with no excess. Provide and use lacing bars.
- H. Provide physical isolation from speaker-microphone, telephone, line-level wiring, and power wiring. Run in separate raceways, or where exposed or in same enclosure, provide 12 inch minimum separation between conductors to speaker-microphones, telephone wiring and adjacent parallel power. Provide physical separation as recommended by equipment manufacturer for other system conductors.
- I. Identification of Conductors and Cables: Use color coding of conductors and apply wire and cable marking tape to designate wires and cables so all media are identified in coordination with system wiring diagrams.
- J. Weatherproofing: Provide weatherproof enclosures for items to be mounted outdoors or exposed to weather.

3.3 GROUNDING

- A. Provide equipment grounding connections for Integrated Electronic Communications Network systems as indicated. Tighten connections to comply with tightening torques specified in UL Standard 486A to assure permanent and effective grounds.
- B. Ground equipment, conductor, and cable shields to eliminate shock hazard and to 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.
- C. Provide all necessary transient protection on the AC power feed and on all copper station lines leaving or entering the building. Note in system drawings, the type and location of these protection devices as well as all wiring information.

3.4 FIELD QUALITY CONTROL

- A. Manufacturer's Field Services: Provide services of a duly factory authorized service representative for this project location to supervise the field assembly and connection of components and the pre-testing, testing, and adjustment of the system.
- B. Inspection: Make observations to verify that units and controls are properly labeled and interconnecting wires and terminals are identified. Provide a list of final tap settings of paging speaker line matching transformers.
- C. Testing: Rectify deficiencies indicated by tests and completely re-test work affected by such deficiencies at Contractor's expense. Verify by the system test that the total system meets the Specifications and complies with applicable standards.

3.5 FINAL ACCEPTANCE TESTING

- A. The Final Acceptance Testing shall be provided to the Owner or the Owners designated representative only. Final acceptance testing to any other trade or service provider for the project will not comply with the requirements of this section.
- B. The contractor will provide a Final Acceptance Test record document signed by both the contractor and the Owner or designated Owner's Representative establishing the "In Warranty" date. The warranty period will not commence until the Final Acceptance Test is completed.

3.6 COMMISSIONING

- A. The contractor shall train the Owner's maintenance personnel in the procedures and schedules involved in operating, troubleshooting, servicing and preventative maintenance of the system. This training will be in accordance with the training as outlined in Section 1.6, paragraphs 3, 5 & 6 of these specifications. In addition to the Training Materials provided, the contractor will also furnish Operators Manuals and Users Guides at the time of this training.
- B. Schedule training with Owner through the owners representative with at least seven days advance notice.

3.7 OCCUPANCY ADJUSTMENTS

- A. The contractor shall provide Occupancy Adjustments in accordance with Section 1.6, paragraph 9 of these specifications. A response scenario amenable to both the owner and the contractor will be established and followed for the first year of service.

3.8 CLEANING AND PROTECTION

- A. Prior to final acceptance, the contractor shall vacuum and clean all system components and protect them from damage and deterioration. All blank spaces in equipment cabinets will be covered with blank panels. Top and side panels, and all cabinet doors will be installed. All general areas within and around all equipment rack/cabinets in the facility will be swept, vacuumed, and cleaned up. No cabinets will be left unlocked and all cabinet keys will be turned over to the owner or designated owner's representative.

END OF SECTION 275117

SECTION 275313

WIRELESS MASTER CLOCK SYSTEM

PART 1 – GENERAL

1.1 WORK INCLUDED

- A. Provide all labor, materials, equipment and services required for the installation of a complete and functioning clock system as shown on the drawings and described in this section. The clock system shall include a transmitter, a roof mounted GPS receiver, indicating clocks, remote repeater transmitter, and all accessories for complete operation.
- B. Provide all required wiring and programming to tie the new master clock system program output relays building new public address system.
- C. Provide (6) Type A spare clocks as part of project. At the end of the project turn over all remaining spare secondary clocks to the building custodial engineer.

1.2 DEFINITIONS

- A. GPS: Global Positioning System, a worldwide system that employs 24 satellites in an integrated net-work to determine geographic location anywhere in the world, and which employs and transmits atomic time, the most accurate and reliable time.

1.3 DESCRIPTION OF WORK

- A. The system shall synchronize all clocks to each other. The system shall utilize GPS technology to provide atomic time. The system shall not require hard wiring. Clocks shall automatically adjust for Daylight Savings Time.
- B. 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. The system shall also include an internal clock reference so that failure of the GPS signal shall not cause the clocks to fail in indicating time.
- C. Clock locations shall be as indicated, and clocks shall be fully portable, capable of being relocated at any time.
- D. The system shall include a remote repeater transmitter to provide adequate time signals to the clocks in far parts of the building from the master controller.
- E. The system shall include a set of programmable contacts on the master controller that is wired to the building public address system for program bell annunciation.
- F. This section includes minimum requirements for the following:
 - 1. Master Transmitter
 - 2. Satellite Transmitter

3. GPS Receiver Antenna
4. Wireless Tone Generator
5. Secondary Clocks Types A, B, C, D
6. Wire Guard
7. Transmitter Rack
8. Program Bell Transmitter and PC Transceiver

1.4 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 operating license with the FCC prior to installing equipment.
- C. Furnish the license, or if the license has not been received, a copy of the application for the license, to the Owner prior to operating the equipment. When license is received, deliver original license to Owner.

1.5 QUALITY ASSURANCE

- A. Permits: Obtain operating license for the transmitter from the FCC.
- B. Equipment and components furnished shall be of manufacturer's latest model.
- C. Transmitter and receiver shall comply with Part 90 of FCC rules, as follows:
 1. This device may not cause harmful interference, and this device must accept interference received, including interference that may cause undesired operation.
 2. Transmitter frequency shall be governed by FCC Part 90.35.
 3. Transmitter output power shall be governed by FCC Part 90.257 (b).
- D. Qualifications:
 1. Manufacturer: Company specializing in manufacturing commercial time systems with a minimum of 10 continuous years of documented experience.
 2. Installer: Company with documented experience in the installation of commercial time systems.

1.6 SEQUENCE OF OPERATION

- A. When power is first applied to the transmitter, it checks for and displays the software version, then it checks the position of the switches and stores their position in memory. The transmitter then 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. Clock Operation:
 - 1. When power is available to the secondary clock: A) Press the red button when the red second hand is at the 12:00 position. At this time the microprocessor will lock in the location of the second hand.
 - 2. After the red second hand has passed over the minute hand (first second hash mark after minute hand), press and release the red button. At this time the microprocessor will lock in the location of the minute hand. The microprocessor then assumes the location of the hour hand. After the red button has been pressed twice, the microprocessor will start searching the channels. It will start at channel No.1 and proceed one by one until it either decodes a valid signal or reaches channel No.16. If no signal is detected the receiver will be shut off and will try again later. If a signal is received, the microprocessor will store the channel number, set the clock to receive the time. For the next minute the clock will beep every time that it receives a valid time signal. If the clock is in a good signal area it will beep once a second. If the clock beeps every few seconds, the clock is in a marginal signal area. Analog clocks can operate in marginal signal areas, but battery life will be about 25 percent shorter.
 - 3. After initial set, the clock will shut off the receiver. On a pre-scheduled basis, the microprocessor will turn the receiver back on and starting with the stored channel, it will again look for a valid time signal. However, the beeper will not operate.
 - 4. If the clock has not decoded a valid time signal for seven days, then it will go back to a double-step mode. Non-signal reception can be caused by low battery voltage. If this occurs, replace the batteries.

PART 2 – PRODUCTS

2.1 WIRELESS TRANSMITTER

- A. Unit shall obtain current atomic time from satellite. The clock system shall transmit time continuously to all clocks in the system. The transmitter shall be located within Data Room 312A, as noted on Drawing E-106.
- B. Transmitters shall receive the signal from the wireless receiver switches and transmit the signal to the devices in its vicinity.
- C. Transmitting antenna mounted on top of the housing, 46 inches long.

- D. Power Supply, 6 foot cord:
 - 1. Input: 120 VAC, 60 Hz, 0.4 amp
 - 2. Output: 9 volt DC, 1.5 amps.
- E. Approximately one Watt transmission, 900 MHz frequency hopping
- F. 16 selectable channels
- G. Time zone adjustment switch
- H. LCD display showing time, date and signal verification
- I. Housing: black metal casing:
- J. Dimensions: 17 inches long by 12 inches deep by 1-7/8 inches high
- K. Design Make: Telcor 2490 Series
- L. Acceptable Manufacturerers
 - 1. Dukane
 - 2. Telcor
 - 3. Sampling

2.2 SATELLITE TRANSMITTERS

- A. 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 range from the master transmitter.
- B. Antenna mounted on top of the housing, 46 inches long.
- C. Power Supply, 6 foot cord:
 - 1. Input: 120 VAC, 50/60 Hz, 0.4 amp
 - 2. Output: 9 volt DC, 1.5 amps.
- D. Approximately one Watt transmission, 72 MHz frequency
- E. 16 selectable channels
- F. Time zone adjustment switch
- G. LCD display showing time, date and signal verification
- H. Housing: black metal casing:

- I. Dimensions: 17 inches long by 12 inches deep by 1-7/8 inches high
- J. Acceptable Manufacturers
 - 1. Dukane
 - 2. Telcor
 - 3. Sampling

2.3 GPS RECEIVER ANTENNA

- A. The GPS Receiver shall be a complete GPS receiver including antenna in a waterproof case. Designed for roof or outdoor mounting.
- B. Dimensions: 5-1/2 inches by 5 inches by 2-1/2 inches
- C. Provide mounting bracket and hardware for attachment to roof structure.
- D. Provide with 100 foot attached cable for connection to transmitter.
- E. Operating range shall be -22 degrees to 176 degrees F (-30 degrees to 80 degrees C).
- F. Acceptable Manufacturers
 - 1. Dukane
 - 2. Telcor
 - 3. Sampling

2.4 TYPE A CLOCK (PROVIDE WIRE GUARDS FOR ALL GYMNASIUM AND MECHANICAL ROOM CLOCKS)

- A. Analog clocks, 12-1/2 inch diameter or 16 inch diameter as selected. Analog clocks shall be wall mounted, and shall have polycarbonate frame and polycarbonate lens. Face shall be white. Hour and minute hands shall be black. Analog clocks shall be provided with red sweep second hand.
- B. 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.
- C. Time shall be automatically updated from the transmitter at a minimum of 6 times per day.
- D. Designed for 120VAC connection. Provide cord and plug kit for connection to new receptacle. Provide new hanger receptacle at each clock location, and circuit as indicated on drawings. Installation of surface mounted clock shall be smooth and flush with existing walls.
- E. Provide with internal antenna for frequency hopping technology.

- F. If 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.
 - G. Design Make: Sampling SAT Series
 - H. Acceptable Manufactuerers
 - 1. Dukane
 - 2. Telcor
 - 3. Sampling
- 2.5 TYPE B CLOCK (PROVIDE WIRE GUARDS FOR ALL GYMNASIUM AND MECHANICAL ROOM CLOCKS)
- A. Similar to Type A Analog clocks, but shall be 16” in diameter.
 - B. Design Make: Sampling SAT Series
 - C. Acceptable Manufactuerers
 - 1. Dukane
 - 2. Telcor
 - 3. Sampling
- 2.6 TYPE C CLOCK (PROVIDE WIRE GUARDS FOR ALL GYMNASIUM AND MECHANICAL ROOM CLOCKS)
- A. Similar to Type A Analog clocks, but provided with back to back mounting bracket for a total of 2 – 12.5” diameter clocks at noted location.
 - B. Universal Wall/Ceiling bracket slim line adapter, black in color.
 - C. Design Make: Sampling SAX Series
 - D. Acceptable Manufactuerers
 - 1. Dukane
 - 2. Telcor
 - 3. Sampling
- 2.7 TYPE D CLOCK (PROVIDE WIRE GUARDS FOR ALL GYMNASIUM AND MECHANICAL ROOM CLOCKS)
- A. Digital wireless talk back clock, 4” digits, 6 number display, 120volt powered..

- B. 12 or 24 hour display, Red numbers, adjustable LED brightness.
- C. Time shall be automatically updated from the transmitter at a minimum of 6 times per day.
- D. Designed for 120VAC connection. Provide cord and plug kit for connection to new receptacle. Provide new hanger receptacle at each clock location, and circuit as indicated on drawings. Installation of surface mounted clock shall be smooth and flush with existing walls.
- E. Provide with internal antenna for frequency hopping technology.
- F. BELL and FireE messaging capabilities
- G. Design Make: Sampling SBT 3000 Series
- H. Acceptable Manufactuerers
 - 1. Dukane
 - 2. Telcor
 - 3. Sampling

2.8 WIRE GUARDS

- A. Design Make: Primex Wireless Model No.14123, 18 inch by 18 inch size for 16 inch diameter analog clocks. Guards shall be U.L. Listed.

2.9 TRANSMITTER RACK

- A. Steel construction
- B. Wall mountable

2.10 PROGRAM BELL TRANSMITTER

- A. Provide wireless program bell transmitter with dry contact outputs to interface with existing bell system or public address system.
- B. Communicates wirelessly to the wireless master clock system.
- C. Wall mountable, with plug-in power supply.
- D. Includes programming software on CD for program bell synchronization.
- E. Includes serial to wireless transmitter at owners PC for connection to wireless bell transmitter and master clock system.

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. Provide 120 volt electrical outlet within 6 feet of location of transmitter, and that outlet is operational and properly grounded.

3.2 INSTALLATION

- A. 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.
- B. Provide software client and interface cable to allow a Windows PC the ability to program the class change bell controls.
- C. Transmitter:
 - 1. Locate transmitter where indicated on drawings, a minimum of 2 to 3 feet above the floor, away from large metal objects such as filing cabinets, lockers or metal framed walls.
 - 2. Attach receiver to transmitter using cable.
 - 3. Connect antenna to transmitter using care not to strip threads.
 - 4. Connect power supply to the transmitter.
 - 5. Set the channel number on the display to correspond to the FCC license.
 - 6. Plug power supply into electrical outlet.
- D. Analog clocks: Perform the following operations with each clock:
 - 1. Provide 120 volt branch circuit and mounting receptacle.
 - 2. Set clock to correct time in accordance with manufacturer's instructions.
 - 3. Observe analog clock until valid signals are received and analog clock adjusts itself to correct time.
 - 4. Install the analog clock on the wall in the indicated location, plumb, level and tight against wall. If using 12-1/5 inch clock, attach using clock-lock hanging method and suitable fasteners as approved by clock manufacturer.
- E. Provide 2-face back-to-back clocks in the corridors with manufacturer furnished wall bracket.

- F. Provide wire guards for all clocks in gymnasiums, locker rooms, team rooms and weight rooms. Secure to wall, using approved tamper-resistant fasteners.
- G. Install program bell synchronization on owner direct PC and serial link cable to wireless system. Provide complete initial program bell settings based on owner requirements.

3.3 FCC REGISTRATION

- A. Provide all registration filings for the FCC license to operate the new master clock system. Pay all record and filing fees.

3.4 ADJUSTING

- A. Prior to final acceptance, inspect each clock, adjust as required, and replace parts which are found defective.

3.5 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.

3.6 FCC REGISTRATION

- A. Contractor to fill out and mail in all FCC registration forms for new wireless transmission equipment. Pay all processing and registration and fees associated with new wireless clock system.

3.7 TRAINING

- A. Provide 2-hours training to owners representatives. At a minimum the Main Office staff and the building custodian shall be instructed on using the software client to the adjust class time schedules, setting and adjusting clocks, replacing batteries and routine maintenance.

END OF SECTION 275313

This Page Intentionally Left Blank

SECTION 281300

ACCESS CONTROL SYSTEM

PART 1 – GENERAL

1.1 WORK INCLUDED

- A. Provide all equipment, cabling, software, documentation, training, and programming as required for a complete operational system providing the functionality called for. All required component specifications might not be included in the specification however, they must be provided if required for a complete system meeting the functionality described.
- B. Work included is an extension of the school districts existing access control system and database. Any and all modifications shall be completed by licensed Avigilon installers and supply manufacturers.
- C. Provide access control system for exterior doors as indicated on the drawings and this section. Create database and user information account for up to (250) two-hundred fifty district staff.
- D. Badge up to (150) one-hundred fifty district staff with the new ID badging system and print onto new ID badges with proximity reader functionality. Provide spare print cartridges as specified.
- E. Provide (200) two-hundred of the specified badges, remaining badges not printed shall be turned over to the district as space stock.
- F. Provide door contacts to monitor status of exits controlled with new access control system.

1.2 SCOPE

- A. The system shall include but not be limited to the following:
 - 1. Access Control Hardware and Software
 - 2. Reader Interface Module
 - 3. Proximity/Card Reader
 - 4. Door Strike
 - 5. Request to Exit Sensor
 - 6. Proximity Cards
 - 7. Card/Bar Code Printer
 - 8. Door Hardware (Type A Electric Strike & Type B Electric Latch Retraction)

9. 24VDC Power Supply
10. Intercom Entry Control System
11. Door Contacts
12. System Wiring
13. UPS Unit (Uninterruptable Power Supply)

1.3 SUBMITTALS

- A. Model numbers of all components furnished on the job.
- B. Manufacturer's catalog data sheets for all components.
- C. Complete engineered drawings indicating:
 1. Point-to-point wiring diagrams for all devices
 2. Location and detection field for motion detectors
 3. Power supply sizes and wired loads.
 4. Termination details for all devices
 5. Single-line system architecture drawings representing the entire system. Indicate make, model and serial no. for all equipment of the diagram.

1.4 QUALITY ASSURANCE

- A. Manufacturer: Manufacturers shall have been in business for a minimum of five years and must guarantee that spare parts will be carried for a minimum of 10 years.
- B. The installer must be a company specializing in Security/Access Control Systems with a minimum of five years' experience. The installer must have personnel authorized by the system manufacturers. The installer may be a sub-contractor to the electrical contractor.
- C. The installer must provide verification that proposed equipment and devices furnished is adequate for the intended purpose. The proposed system must be available to be tested by the owner and engineer in the installer's facility or at an installed site.

1.5 SYSTEM DESCRIPTION

- A. The owner will have the capability to add and remove user information located in a central database.
- B. The system shall have (1) badging station that will allow the owner to create badges for selected users. The contractor shall be responsible for setting up the initial printing template and printing new badges for the specified staff. The badging station must include a still camera, printer and card stock. The new badges shall be multi-purpose and

include proximity access control technology, and a photo ID badge.

- C. The owner will be able to create badges that allow access to secured doors using the user database. The badges will have the users image and information fields selected by the owner.
- D. The badges will be programmed to allow access to secured doors at specific times as determined by the owner. The access time shall be programmable by individual user or by groups of users.
- E. Selected doors will have card readers and electric strikes. Some of the doors with card access and an electric strike will also be released by a pushbutton in the main office. Remaining doors will be normally locked with no access control.
- F. Selected doors will include an intercom system connect to the building telephone system. Staff in the high school main office between the hours of 7am-5pm will be able to grant access to the building by interfacing the access control system with their telephone handset or a push button. Any calls not answered before voicemail should be programmed to be forwarded to the administration main office. Staff will have the ability for two way communication with the exterior intercom stations.
- G. Outside of normal business hours; e.g. not 7am-5pm all intercom station calls will be forwarded automatically to the administration main office.
- H. Upon an abnormal condition on the access control system, abnormal events shall be logged into the database, along with the date and time.
- I. The "Request to Exit" sensor on the inside of the exit doors shown will in no way obstruct egress from the building. When the "Request to Exit" sensor detects motion it will unlatch the electric door strike allowing the door to be opened without triggering an alarm flag on the access control system. The proximity reader shall be wired through the "Request to Exit" sensor to control entry to the building from the exterior.
- J. The system shall have power supplies and cabinets as required for all peripheral devices and cameras. The system shall include UPS protection with a minimum of 2 hr. capacity.
- K. Access Control System Functionality
 - 1. The owner will have the capability to add and remove user information located in a central database.
 - 2. The owner will be able to create badges that allow access to secured doors using the user database. The badges will have the users image and information fields selected by the owner.
 - 3. The badges will be programmed to allow access to secured doors at specific times as determined by the owner. The access time shall be programmable by individual user or by groups of users.
 - 4. Selected doors will have card readers and electric strikes. The main door to the building will have card access and an electric strike controlled by a pushbutton in

the main office and the security office. Remaining doors will be normally locked with no access control.

5. The system will unlock and lock individual doors or groups of doors, which are equipped with electric strikes based on the owner's security plan.
6. Card readers shall be interlocked with Intrusion detection system zones to disable an activated zone for an authorized user.
7. The owner will be able to override access settings through any PC terminal equipped with the SMS client or from a manual switch if called for on plans.

PART 2 – PRODUCTS

2.1 CARD ACCESS SOFTWARE AND DATABASE SERVER

- A. Microsoft Windows based Operating System, provide hardware per. access control system manufacturer requirements.
- B. Server database shall allow coverage for up to 100 doors and maintain a user database for up to 10,000 individuals.
- C. Shall utilize a commercially available, Open Database Connectivity-compliant (ODBC), relational database with flexible design allowing the integration into other data structures. This database shall handle the storage and retrieval of all records information, images, system maps, reports, and screen designs. The database shall operate in a multi-tasking environment without degradation of system operation and shall be of a design that will handle the transaction loading placed on the system. The relational database shall support on-line backup, stored procedures with control logic, and server-based referential integrity.
- D. The system shall provide a cardholder call-up feature to allow the quick search and display of images in the database. A user journal shall be available to log important daily events. A trace function shall be available for users to locate and track activity on specific cardholders or card readers.
- E. The Management and Badging WorkStation must monitor field hardware devices, such as card readers, door contacts, motion detectors and field controllers. Administrative tasks such as assigning areas, schedules, report generation, displaying color graphic maps, etc. shall be provided from any Workstation on the network. The system shall be totally point addressable to allow any group of devices to be assigned a schedule. Devices may be assigned to multiple groups.
- F. The system must regulate access to and within the building. Access into the building will be controlled using proximity type card readers at selected doors. The remaining exterior doors will be alarmed using door contacts to restrict access on a schedule defined by the owner. The interior corridors will be monitored with motion detectors. The detectors will configure in specific zones determined by the owner. These zones will allow the owner to alarm different parts of the building based on time of day, event etc.

- G. Ethernet based management platform for all network Andover Continuum connected products.
- H. The software shall provide the following functionality:
1. Access Privileges - All cardholders shall have facility access based on privileges assigned by controlled area, time and date. For example, some badges shall only allow access to the facility on weekdays between 8:00 a.m. and 5:00 p.m., while others allow access on weekends between 1 p.m. to 5 p.m. and so on. The time zones for each day are to be pre-defined by the Owner and shall be able to be modified quickly by authorized employees without vendor intervention.
 2. Provide the ability to create holiday schedules that designate individual days as holidays, or special days to cover vacations, maintenance shutdowns, or other events, indefinitely into the future. Holidays or special days can signal that the system shall operate on a schedule different from the normal schedule. The system shall not limit the number of holiday or special schedules that can be created. The time and date of the system shall be set by the operating system of the client workstation. Dates for Daylight Savings Time shall automatically take effect.
 3. Provide global data exchange and operating strategies. The system shall allow any input point configured in the system (i.e., door tamper, duress, etc.) to permit activation of any control output point such as a relay(s) that opens a door and/or sounds an alarm. The logic shall be developed using an application programming language that shall be capable of incorporating other parameters such as date and time; it shall not be limited by a fixed number of rules, or the simple linking of inputs to outputs. The global operating strategies feature shall provide the ability to drive any system output or outputs from single or multiple inputs, access events, alarms, etc. Each output point shall be controllable by the system and be configurable individually for the following responses:
 - a. Output relays (and groups) shall be capable of responding to Input alarms from any field panel, card reader or detector point in the system, or any combination thereof, access events, date and time parameters or manual commands from a user.
 - b. Output relays (and groups) shall be capable of: Pulsing for a predetermined duration; duration shall be programmable for each relay individually. "Following" any input point from any field controller, I/O module, or card reader input in the system (on with alarm, off when clear, or as required). Locking On with alarm, requiring user intervention to reset the output relay. The system shall permit output relays to be ordered on, off, pulsed or reset back to a default setting.
 4. Arm-Disarm shall be accomplished by a user through a simple click of the mouse on the individual point. Once a user arms an input point, events from the respective area permit the display of alarms at an alarm monitoring workstation from that point forward.

- I. Provide the following badging and card access functions:
1. The user shall be able to initiate the call-up of a cardholder record. This feature shall be provided at all Alarm and Display Monitoring Workstations to assist the user in determining access rights for an employee who may have forgotten his or her badge.
 2. Utilize a database search via the input of the cardholder's name, or other key search fields, the SMS shall access the employee's personnel file, containing pertinent information and the employee's image for identification by the user. This operation shall not restrict the operation of monitoring alarms.
 3. Enable or disable the cards, Define expiration date, The expiration date shall be determined by date and time of day carried out to the nearest second.
 4. Define the acceptable card type.
 5. Entering of individual bar codes from existing staff ID badges into the system for printing onto new multi-purpose badges.
 6. Define the card number, site code and PIN.
 7. Mark the card as Lost This shall disable the card and create a stored record with the associated card number and cardholder. A new record shall automatically be created allowing the user to only have to add the new card number. In the event an attempted use of the card occurs, an invalid card event shall be logged and an associated alarm shall be generated to an operator workstation. The user shall be able to issue a temporary card by selecting that control button. This action shall temporarily store the existing card number to a buffer and allow the user to then simply enter into the record the temporary card number. Upon return of the temporary card, the user shall select the reissue permanent card control button, which shall automatically restore the original card number.
 8. Issue temporary or restore permanent card.
 9. Display the employee photo image and/or signature.
 10. Have the ability to create or edit the image.
 11. Create, edit, or delete the cardholder's access privileges and additional personnel attributes.
 12. After a badge is created it shall be possible to assign access privileges to the personnel record. For convenience, the Owner's System Administrator shall be able to define default templates for given personnel types. If a user has proper authorization, access privileges can be overwritten. When an individual's access privileges are modified, that change shall be propagated to all required controllers immediately upon completion of the change. Record changes of access privileges shall effect only the modified record, and shall not require a download of the entire cardholder database.

- J. All user records are stored and access restrictions are modified on the management server.
- K. Provide graphical interface for connected access control doors and readers, etc. Displays alarms points. Provide with web based client and management software to do the following tasks:
 - 1. View and acknowledge alarms
 - 2. Track personnel
 - 3. Open and close controlled doors
 - 4. Adjust setpoints
 - 5. Turn lighting and equipment on and off
 - 6. Run reports
 - 7. Modify schedules
 - 8. Make and edit badges
 - 9. Access pop-up windows of live trend data and event logs
- L. Provide with printing software capable of double sided proximity card printing, color photo ID badge on one side with custom logo and text and custom bar code on back side.
- M. Provide with digital camera system and photo ID badging software. Shall be capable of up to 300 dpi true color photos.
- N. Operates on Microsoft Windows 2000/XP platform, provide with manufacturer recommended RAM, hard disk, and configuration requirements.
- O. Provide with optical mouse, 101-standard keyboard, and 17" LCD flat panel monitor.
- P. Design Make: Andover Continuum Cyberstation and web client Database Server and required accessories.
- Q. Approved Manufactures: Avigilon

2.2 ACCESS CONTROL PROCESSOR

- A. Controls up to 8 card readers
- B. Accepts 12 universal inputs
- C. 4 door outputs
- D. 32 MB of flash memory and 128 MB of DDR SDRAM

- E. 10/100TX Ethernet interface
- F. Supports the following card formats: Weigand, ABA, HID Corporate-1000, CardKey as well as custom formats Custom Weigand, Custom ABA.
- G. Supports both entry and egress readers while supplying +5 or +12 VDC to each reader.
- H. Design Make: Avigilon

2.3 READER INTERFACE MODULE

- A. Provide a reader interface module with the following specifications:
 - 1. Provides communications from card reader to Intelligent Building Controller.
 - 2. 2 Form C, 5 amp door relay contact.
 - 3. Up to three supervised alarm inputs can be used for door status contacts, request-to exit devices, a cabinet tamper switch, or any other two-state or three-state (on/off/trouble) alarm device.
 - 4. Door contact supervision.
 - 5. Request to exit input.
 - 6. Reader LED support.
 - 7. UL 294 recognized and CE approved.
- B. Provide 4 hour battery backup supply for operation.
- C. Locate the units at the Building controller where possible. For reader locations that exceed the maximum distance from the AC-1, The AC-1 can be located in a mechanical space (mounted at working height in a lockable box) closer to the card reader.
- D. Design Make: Avigilon

2.4 PROXIMITY CARD READER

- A. Indoor/Outdoor sealed weatherized polycarbonate enclosure designed to withstand harsh environments, providing reliable performance and a high degree of vandal resistance. - 22° to 150° F (-30° to 65° C) temperature range.
- B. Accepts 5 to 16 volts, meeting most voltage requirements.
- C. Designed to mount onto a junction box included with each reader. The junction box is attached to an appropriate surface location utilizing four holes.
- D. When a proximity card is presented to the reader, the red LED flashes green and the beeper sounds.

- E. 5" read range, 125 kHz signal
- F. Design Make: HID MiniProx Reader 5365 or Approved Equal

2.5 REQUEST TO EXIT SENSOR

- A. PIR technology
- B. 12 or 24 VAC, 12 or 24 VDC, 26 mA @ 12 VDC
- C. Relay Latch Time Adjustable to 60 seconds
- D. Light Grey High impact ABS plastic enclosure
- E. Adjustable X – Y pick-up window
- F. Wall or ceiling mountable
- G. Interfaces door contact, card reader, and door strike
- H. Design Make: Bosch DS150i or Approved Equal

2.6 PROXIMITY CARDS

- A. Proximity ISO Imageable Card with Magnetic Stripe
- B. Operating frequency: 125 kHz
- C. Technology: HID Proximity
- D. Material: PVC, 2.125" x 3.375" x .030"
- E. Lifetime Warranty
- F. Design Make: HID 1336 DuoProx II Card or Approved Equal

2.7 TYPE A DOOR HARDWARE - ELECTRIC STRIKE

- A. Electric strike for use with rim exit devices on single doors or double doors with mullion applications (hollow metal, aluminum or wood).
- B. 1,000 pounds of holding force.
- C. Provide filler plates and header brackets as required.
- D. Operates on 24VDC power, 0.6 amps in-rush
- E. Design Make: Von Duprin, Folger Adams, or HES

2.8 TYPE B DOOR HARDWARE - ELECTRIC LATCH RETRACTION EXIT DEVICE

- A. Manual push plate egress hardware with internal electrically actuated latch retraction. UL listed for Panic Exit or Fire Exit Hardware, and are tested in accordance to ANSI A156.3, 1994, Grade I.
- B. Available for doors 3-feet to 4-feet wide and compatible with rim, mortise and vertical rod devices.
- C. Hex key dogging standard
- D. A control station operator can flip a switch to retract the latch bolt and immediately change an exit only or latched door to push-pull operation. A powerful, continuous duty solenoid retracts the latch bolt for momentary unlocking, or for extended periods of time, in lieu of manual dogging.
- E. Operates on 24VDC power, Current Inrush (300 milliseconds) 16 amperes. Holding Current 0.3 amps Supplied with 3' cable at the hinge side of door.
- F. Stainless steel housing w/ anodized aluminum finish
- G. Provide w/ power transfer protector cable for retrofit applications.
- H. Provide matching device trim handle hardware on opposite side of door.
- I. Design Make: Von Duprin 33xxA/35xxA Series or Approved Equal

2.9 24VDC POWER SUPPLY

- A. 120VAC input: Regulated output power is field selectable for either 24VDC @ 2-amp or 12VDC @ 4-amp
- B. Wiring terminals accept 12 AWG wire
- C. 19 AWG steel enclosure
- D. 2-hour lead acid battery backup
- E. 4-zone independent door operation with delay of 0 thru 75 seconds
- F. Design Make: Von Duprin PS873B-4TD Series or Approved Equal

2.10 INTERCOM ENTRY CONTROL SYSTEM

- A. Provide all quantities of intercom and entry control equipment as called for on the drawings and riser diagrams.
- B. Door Intercom Station shall be a low-profile vandal-resistant weatherproof cast aluminum or stainless steel housing with two-way audio speaker and illuminated call button.

- C. Includes Video camera with IR illumination. Video output can be recorded back to Network Video recorder system or web browser based display.
- D. Integrated proximity card reader. Supported cards 125 kHz EM4100, EM4102, HID Prox, and 13.56Mhz HID iCLASS (uID only).
- E. Activation of the Intercom call button shall activate a designated Master Station. Users programmed for allowed answer can answer intercom calls, talk hands free or via handset through the door intercom station and if desired press the unlock key to activate the door strike.
- F. Interfaces: Ethernet Connector RJ-45 Ethernet speed 10/100 BASE-T, Relay outputs Maximal voltage 30 V DC Maximal current 1 A DC, Active output 9V – 13V DC/700mA.
- G. Provide indoor high definition LED monitor color master station with 2-way audio capability and video display from the door intercom station.
- H. Make: Aiphone IX Series
- I. Acceptable Manufacturers: 2N, Viking

2.11 DOOR CONTACTS

- A. Button type magnetic contact:
 - 1. 1" diameter magnetic door contacts. Magnet installs in door, contact installs in door frame.
 - 2. Provide single pole, double throw contact with 1' long #22 AWG leads brought out.
 - 3. Maximum ½" gap.
 - 4. Provide contact that will not affect the fire integrity of U.L. listed fire rated doors.
- B. Surface mount magnetic contact:
 - 1. Nominal 2" long x ½" wide x ½" deep.
 - 2. Magnet installs surface mounted on door. Contact installs surface mounted on door frame.
 - 3. Provide single pole, double throw contact with 1' long, #22 AWG leads brought out.
 - 4. Maximum 1" gap.
- C. Acceptable Manufacturers:

1. Detection Systems
2. Ademco
3. Sentrol

2.12 SYSTEM WIRING

- A. The number of pair per. jacket shall be as required by the system installer.
- B. The quantity of shielded or unshielded pair shall be determined by the system manufacturer.
- C. Control Cable shall be ASTM tinned copper, 18 AWG (7x26 stranded), twisted pairs, 20 strand shielded drain wire unless recommend otherwise by the system manufacturer.
- D. 24Volt power wiring shall be minimum 14 AWG or larger size as indicted on drawings.
- E. 300-volt insulation.
- F. Cable shall be UL listed NEC type CMP, constructed in accordance with UL 444.
- G. Cable shall be fully functional from -10°C to 60°C.
- H. Individually colored conductors.
- I. Design Make: West Penn/CDT or Approved equal

2.13 UPS UNIT

- A. System Design:
 1. Line interactive design equipped with a bi-directional converter, battery, voltage boost system and transfer relay.
 2. System converter shall be continuously energized to trickle charge the battery.
 3. Upon power outage, the battery shall feed through the converter to the load.
 4. Output voltage shall be maintained through the use of a voltage boosting system.
- B. Electrical Specifications:
 1. Input: 87-132 VAC, 50 or 60 Hz, single phase, minimum 0.67 P.F.
 2. Input: (1) NEMA 5-30P, 6-foot cord
 3. Output: 120 VAC, 60 Hz, single phase, 0.67 to unity P.F.
 4. Output: (2) NEMA 5-20R, (8) NEMA 5-15R

- C. Load Capacity: 2700 Watts / 3000 VA
- D. Battery:
 - 1. Sealed, reduced maintenance, lead acid type, capable of operating at full load for a minimum of 5 minutes.
 - 2. Recharge time shall be maximum three hours to achieve 90% capacity.
 - 3. Automatic and manual battery test. Automatic test shall test the battery weekly.
 - 4. Typical Backup Time at Half Load - 13.6 minutes
- E. Provide LED displays and audible alarm for the following system indicators:
 - 1. Load
 - 2. Battery capacity available
 - 3. Utility power available
 - 4. "On Battery"
 - 5. "Replace Battery"
 - 6. UPS fault Condition
 - 7. Voltage boost operating
- F. Tower style floor mount
- G. Design Make: APC Smart-UPS 3000VA or Approved Equal

PART 3 – EXECUTION

3.1 SYSTEM PROGRAMMING

- A. The system installer shall meet with the owner as many times as necessary to finalize system programming. The installer shall review the owner's security plans and policies and make programming decisions based on that plan.
- B. The system installer shall provide a word document that describes the complete operation of the system as decided on during the programming meeting(s). The owner will sign off on the sequence of operation prior to the system programming commencing.
- C. The installer shall make changes to the initial system programming for up to 120 days after the initial installation at no additional cost.

3.2 GENERAL INSTALLATION

- A. Installation of the SMS shall include the appropriate equipment and shall be performed

by a factory-trained Installer. The installation shall be completed to meet the requirements of this specification and the project drawings. The installation shall include the following:

1. Site planning and system configuration of field hardware.
 2. Complete hardware setup of all system Workstations, servers and peripherals.
 3. Complete configuration of all system Workstations, peripherals and installation of field hardware.
 4. Setup of specific network software and hardware configuration requirements.
 5. Badge Design and Screen Format installation and verification.
 6. Complete system diagnostics verification.
 7. Complete system operation verification.
 8. Problem reporting and tracking.
 9. Project specific installation log.
 10. Completion of specific customer acceptance test plans.
 11. Formal turnover of the specific project installation documentation to the owner and his Maintenance Service Organization.
- B. Coordinate installation of Access control hardware with electric locks provided by the General Contractor
- C. Comply with manufacturer's instructions and recommendations for installation of product in the applications indicated. Anchor products securely in place, accurately located and aligned with other work.
- D. The Contractor is responsible to remedy defects due to faulty workmanship and materials that appear within one year from the date of acceptance in accordance with the General Conditions, unless Specifications specify a different duration.

3.3 SYSTEM DOCUMENTATION

- A. Complete documentation shall be provided with the system. The documentation shall completely describe all operations, each program, data sets and the hardware and peripherals. All updates, addendum and adjustments to the documentation shall be provided at no additional charge, in the same quantities as originally required.
- B. System Administrator Manual - Overview and step by step guide and instructions detailing all System Administrator functions.
- C. User Manual - Step by step guide and instructions detailing all system user functions and responsibilities.

- D. Photo Imaging User's Manual - Step by step guide and instructions detailing all image capture, badge creation, cardholder modification and all Photo Imaging user functions and responsibilities.
- E. Alarm Monitoring Manual - Step by step guide and instructions detailing all alarm monitoring system user functions and responsibilities.
- F. Technical Maintenance Manual - Shall be a comprehensive and detailed document providing all maintenance action, system testing schedules, troubleshooting flowcharts, functional system layout and block diagrams and schematic diagrams of all system wiring.

3.4 DOOR HARDWARE

- A. Contractor shall walk entire project and review existing door hardware on all doors scheduled to receive new door strikes. Order electric door strike to fit each individual door based on that doors specific latch mounting requirements.
- B. For electrically actuated latch retraction exit devices confirm rim or surface/internal vertical rod retraction type prior to ordering.
- C. Available for doors 3-feet to 4-feet wide and compatible with rim, mortise and vertical rod devices.
- D. Provide flexible concentric stainless steel whip for wiring protection on electric latch retraction hardware installations to bring power from door frame to latch.
- E. Field verify rim or mortise application per. door prior to ordering.
- F. Remove existing latch and install new door strike and modify and drill door mullion and frame as required for mounting. Electrical contractor to provide all wiring and electrical connections to door strike and fish door frame.

3.5 MAGNETIC DOOR CONTACTS

- A. Install magnetic contacts in locations shown on plans.
- B. Provide conduit or surface metal raceway from the accessible ceiling space to the door contact. Install conduit concealed wherever possible.
- C. Coordinate work with general contractor
- D. Provide button type where possible or surface type where required.

3.6 WIRING, CONDUIT AND CABLE

- A. All wiring (high voltage, 50 volts and greater) and conduit is to be installed in accordance with local and national electrical codes.
- B. All security control cable less than 50 volts shall to be considered low voltage.

- C. All low voltage cable is to be run in conduit in any non-accessible concealed space and up to 10 ft. above floor level within mechanical rooms. Wiring within accessible unfinished areas (ceilings, crawl spaces) may be run exposed with proper support with bridle rings. Bridle rings shall be installed a minimum of 4 ft. on center.
- D. Wiring shall be run parallel and perpendicular to building lines in a neat and workmanlike manner and bundled with nylon tie wraps.
- E. Conduit sleeves shall be run through any concrete or block walls for low voltage cable to be run through such walls.
- F. All low voltage cable shall be run separate from high voltage cable. All microprocessor communications cable shall be run separate from any low or high voltage cable.
- G. Wires shall be installed a minimum of three (3) inches from hot water, steam, or condensate piping.
- H. A true earth ground shall be available in the building. Ground shall be run from the source electrical panel ground to each controller.

3.7 INTERCOM ENTRY CONTROL SYSTEM

- A. Install all Entry control equipment in locations shown on plans.
- B. Provide plenum rated UTP cable from each door controller back to the network closet. Terminate, test, and label in a rackmount 48-port UTP patch panel. Provide required UTP patch cable to the POE switch.
- C. Provide all wiring as recommended by the manufacturer. Provide a 24 Volt power supply for each door controller sized as recommended by the manufacturer.
- D. Provide surface metal raceway for all exposed wiring in existing finished areas. Provide tamper-resistant screws at all intercom stations.
- E. Install power supply and provide all wiring to power supply and door hardware.
- F. Provide all required programming and interconnect wiring to the telephone system or intercom entry control master station.
- G. Program the telephone system or master control panel to unlatch the electric strike or latch retraction during the 2-way audio session. The unlatching shall be activated from the when the indoor building receptionist's phone or master station by depressing a push button or programmed key on the telephone handset.
- H. Provide a 1-gang box mounted below the receptionist's desk in the main office with a momentary push button. The push button shall be interconnected with the access control system to manually open the corresponding electric strike or latch.

3.8 SYSTEM ACCEPTANCE TEST

- A. The contractor will schedule a system acceptance test with the engineer and the owner.

- B. The system will not be accepted for operational use and final payment will not be authorized until the owner determines that the system is deemed acceptable.
- C. A phased acceptance test and performance demonstration program shall be developed and documented by the Contractor. These requirements shall apply to all system components and software, including, but not limited to all system computers, field panels, card reader devices, Photo Imaging system peripherals, and equipment and interface capability. The Contractor shall perform the tests and document the results under the supervision and witnessing of the Systems Engineer. Operational scenarios shall be developed and used by the Contractor to simulate the actual use of the system in the normal environment of the Owner's facility. The Owner reserves the right to modify the Contractor's plan or develop new operational test and evaluation procedures to effectively document system operations.

3.9 SYSTEM TRAINING

- A. Provide on-site by a representative of the SMS manufacturer. The trainer shall be on site for 40 hours. Training shall take place before the system is operational. A detailed description of the training material shall be included in the submittal package. All training courses shall enable the attendees to be capable of all normal system operations within their respective positions.
- B. System Administrators shall receive a course detailing the system functions and operations. Course shall offer configuration training on all aspects of the system including data import-export, reports, cardholder management, system workstations, peripherals and field hardware.
- C. Photo Imaging Users shall receive a course detailing the functions and operations of all aspects of credential production, image capture, cardholder record management, reports and Workstation peripherals which are part of the Photo Imaging process.
- D. Video Surveillance users shall be provided with a course that details recording, playback, archiving features of the software package and troubleshooting of the CCTV cameras and recording equipment.
- E. Alarm Monitoring Users shall receive a course detailing the operation of all aspects of alarm monitoring functions, reports, error messages, alarm handling, output relay control and general overview of field hardware.

3.10 WARRANTY

- A. The Contractor shall warrant all labor, workmanship and materials for a period of one (1) year from the date of final acceptance. Should a failure occur within the first year to the access control system, the Contractor must provide all labor and materials necessary to restore the system to a complete operating condition, at no cost to the owner.

END OF SECTION 281300

This Page Intentionally Left Blank

PART 1 – GENERAL

1.1 SECTION INCLUDES

- A. Hands-free/handset color video intercom security system. (Aiphone JP Series)

1.2 RELATED SECTIONS

- A. Section 27 41 00 - Audio-Video Communications.
- B. Section 27 41 16 - Integrated Audio-Video Systems and Equipment.

1.3 REFERENCES

- A. American National Standards Institute (ANSI/TIA/EIA) 568 - Commercial Building Telecommunications Cabling Standard.
- B. International Organization for Standards (ISO) 9001:2000 - Quality Management Systems - Requirements.

1.4 SYSTEM DESCRIPTION

- A. The JP Series shall provide a large 7-inch (180 mm) touch screen monitor for clear visitor identification and easy operation control. The JP Series shall be installed at a maximum of 4 door locations and connected to a maximum of 8 inside locations with internal communication between stations. Connection to and integration of CCTV cameras for surveillance capabilities shall be available.
 - 1. The system shall be hard wired and constructed with a 2-wire communication system for the door stations and a Cat5e/6 communication system for the video locations system.
 - 2. Hearing Assistance: Provide T-Coil connection for hearing aids.
- B. Functional Components: As indicated on the drawings or as required to complete system.
 - 1. Master Station:
 - a. JP-4MED: Hands-free/Handset color video intercom master station.
 - 2. Sub Master Station:
 - a. JP-4HD: Hands-free/Handset color video intercom sub master station.

3. Video Door Station:
 - a. JP-DV: PanTilt & Zoom vandal-resistant video door station, surface mount.
 4. Door Station:
 - a. GT-D: Audio only door station.
 5. Long Distance/CCTV Adaptor:
 - a. JPW-BA: Long distance/CCTV adaptor.
 6. Distribution Adaptor:
 - a. JP-8Z: Distribution adaptor.
 7. Power Supply:
 - a. PS-2420UL: 24V DC Power supply.
 8. Call Extension Speaker:
 - a. IER-2: Call extension speaker.
 9. External Devices:
 - a. RY-3DL: Multiple door release adaptor.
 - b. AC-10S: Access control keypad, surface mount.
 - c. JP-DV + AC-10S: PanTilt & Zoom vandal-resistant video door station. Surface mounted with access control keypad.
- C. System Design: Unless noted otherwise on drawings provide system layout as follows. Three wiring methods are possible; Station-to-Station, Centralized Wiring, or Combined Wiring, where both methods are employed in the same system.
1. Provide Station-to-Station Wiring: Directly connect a master station to a sub master station.
 - a. Maximum distance of farthest sub master from master station: 980 feet (300 m), cumulative.
 - b. Maximum distance between sub master stations in station-to-station wiring: 98 feet (30 m) when 3 stations are powered off 1 power supply, or 165 feet (50 m) when 2 stations powered off of 1 power supply.
 2. Provide Centralized Wiring: Connect master stations, and sub master stations to a central wiring adaptor.
 - a. Maximum distance of farthest sub master from distribution adaptor (JP-8Z): 165 feet (50 m).
 - b. Maximum distance of master from distribution adaptor (JP-8Z): 650 feet (200 m).

- c. Maximum cumulative distance of master and sub masters from distribution adapter (JP-8Z): 980 feet (300m).
3. Provide Combined Wiring: Connect a system using both station-to-station and centralized wiring to meet the requirements of the project.
 - a. Maximum distance between sub master stations in station-to-station wiring: 98 feet (30 m) when 3 stations are powered off 1 power supply, or 165 feet (50 m) when 2 stations powered off of 1 power supply.
 - b. Maximum distance of sub masters from distribution adapter (JP-8Z): 165 feet (50 m).
4. Provide Expanded Performance:
 - a. The wiring distance between the door and master stations by using the JPW-BA adaptor shall be a maximum distance of 980 feet (300 m)
 - b. Connect CCTV and Audio Door Station: Provide security camera connection using the JPW-BA adaptor. Provide for two way communication as indicated or scheduled with a GT-D audio device.
 - c. Alarm Inputs: The master station and all sub master stations shall send out an alarm notification when the sensor is triggered. Provide door/window contacts, water sensors, and PERS devices as indicated or scheduled.
5. Provide connection to existing access control system and door release operation as required and or noted on contract documents.

1.5 SUBMITTALS

- A. Submit under provisions of Section 01 30 00 - Administrative Requirements.
- B. Product Data: Manufacturer's data sheets on each product to be used, including:
 1. Preparation instructions and recommendations.
 2. Storage and handling requirements and recommendations.
 3. Installation methods.
- C. Shop Drawings: Submit the following:
 1. Wiring Diagrams: Indicate wiring for each item of equipment and interconnections between items of equipment.
 2. Include manufacturer's names, model numbers, ratings, power requirements, equipment layout, device arrangement, complete wiring point-to-point diagrams, and conduit layouts.
- D. Installation and Operation Manuals:
 1. Submit manufacturer's installation and operation manual, including operation instructions and component wiring diagrams.
 2. Provide detailed information required for Owner to properly operate equipment.

- E. Warranty: Submit manufacturer's standard warranty.
- F. Selection Samples: For each finish product specified, two complete sets of color chips representing manufacturer's full range of available colors and patterns.
- G. Verification Samples: For each finish product specified, two samples, minimum size 6 inches (150 mm) square, representing actual product, color, and patterns.

1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: ISO 9001:2008 certified company.
- B. Installer Qualifications: Factory trained and experienced with system installations of scope and size required for the Project.
- C. Mock-Up: Provide a mock-up for evaluation of surface preparation techniques and application workmanship.
 - 1. Finish areas designated by Architect.
 - 2. Do not proceed with remaining work until workmanship is approved by Architect.
 - 3. Refinish mock-up area as required to produce acceptable work.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Delivery: Deliver materials to site in manufacturer's original, unopened containers and packaging, with labels clearly identifying product name and manufacturer.
- B. Storage: Store materials in clean, dry area indoors in accordance with manufacturer's instructions.
- C. Handling: Protect materials during handling and installation to prevent damage.

1.8 PROJECT CONDITIONS

- A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Acceptable Manufacturer: Aiphone Corp., which is located at: 6670 185th Ave. NE; Redmond, WA 98052 ; Toll Free Tel: 800-692-0200; Tel: 425-455-0510; Fax: 425-455-0071; Email: [request info \(marketing@aiphone.com\)](mailto:request info (marketing@aiphone.com)); Web: www.aiphone.com

- B. Substitutions: Not permitted.
- C. Requests for substitutions will be considered in accordance with provisions of Section 01 60 00 - Product Requirements.

2.2 HANDS-FREE/HANDSET COLOR VIDEO INTERCOM SYSTEM

- A. Color Video Intercom System: JP Series Intercom System as manufactured by Aiphone Corporation.
- B. Master Station: JP-4MED 7 inches (180 mm) Digital PTZ Video Master Station with Memory.
 - 1. The JP Series shall accommodate up to 4 Door Stations and 8 Master Stations in a single system.
 - 2. Provide icon driven One Touch Hands Free operation. Touch the screen to communicate with visitors using the built-in microphone and speaker or use the handset at any time during conversation for privacy.
 - 3. Operation: From Master Station. Provide the following.
 - a. Room Call: Touch screen icon to call a single sub master station or all sub master stations simultaneously.
 - b. Play: Touch screen icon to play recorded images from door stations.
 - c. Settings: Touch screen icon to program settings and adjustments.
 - d. Security: Touch screen icon to activate the security mode or to change security settings.
 - e. Monitor: Touch screen icon to monitor a door station or sub master station.
 - f. Option: Touch screen icon to activate the connected external device(s).
 - 4. Available Functions During Monitoring: Provide the following
 - a. Pan-Tilt-Zoom/Wide camera control.
 - b. When monitoring is started, an image shall be shown in wide mode. Pan & Tilt and adjusting images shall be possible from the Master Station.
 - c. Door release shall be possible from the Master Station.
 - d. Volume control shall be possible from the Master Station.
 - e. Manual recording shall be possible from the Master Station.
 - f. If a CCTV camera is connected instead of a video door station at entrance, provide audio monitoring and communication via the GT-D.
 - 5. Physical Characteristics:
 - a. Power supply: DC 24V (from power supply).
 - b. Current Consumption: 390 mA.
 - c. Communication: Handset - Simultaneous communication.
 - d. Communication: Hands-free - Auto-voice actuation.
 - e. Ambient Temperature 32 degree F to 104 degree F (0 to 40 degrees C).
 - f. Monitor: 7 inches (180 mm) color LCD monitor.
 - g. Mounting: Wall mount.
 - h. Electrical box: 3-gang box

- i. Material: Flame resistant ABS resin.
- j. Color: White.
- k. Dimensions: 5-11/16 inches H x 10-1/16 inches W x 1-7/8 inches D (145 mm by 255 mm by 48 mm).
- l. Weight: Approx. 1.74 lbs (790 g).

2.3 SUB MASTER STATION: JP-4HD.

- A. Provide icon driven One Touch Hands Free operation. Touch the screen to communicate using the built-in microphone and speaker or use the handset at any time during conversation for privacy.

1. Physical Characteristics:

- a. Power supply: DC 24V (from power supply).
- b. Current Consumption: 200 mA.
- c. Communication: Handset - Simultaneous communication.
- d. Communication: Hands-free - Auto-voice actuation.
- e. Ambient Temperature: 32-degree F to 104 degrees F (0 to 40 degrees C).
- f. Monitor: 7-inch color LCD monitor.
- g. Electrical box: 3-gang box.
- h. Material: Flame resistant ABS resin.
- i. Color: White.
- j. Dimensions: 5-11/16 inches H x 10-1/16 inches W x 1-7/8 inches D (145 mm by 255 mm by 48 mm).
- k. Weight: Approx. 1.74 lbs (790 g).

2. The JP-4MED shall automatically record images. Recording starts approximately 2 seconds after receiving a call.

3. 170-degree wide angle and 100-degree vertical angle camera to minimize blind spots, ensuring a clear view of the door station area.

4. Zoom for Clarity/ Pantilt for Control:

- a. Video door stations feature a wide-angle camera to observe more activity behind the door. In addition, digital PanTilt and Zoom can focus on an area for greater detail.
- b. Oversized buttons and intuitive icons allow for quick navigation and control. Conventional push buttons shall not be permitted.
- c. Equipped with an advanced light adjustment feature to compensate for varying light levels. If a picture is too dark, increase of the brightness level at the door station shall be controlled at the master station.

5. Record Images of Visitors:

- a. After a call is placed, the JP Series records 6 images per call to internal memory.
- b. Provide an SD / SDHC card (not included) as the primary storage location, with which recording frequency increases to 4 pictures per second for up to 10 seconds per call.

- c. Provide documentation of outside disturbances by manually recording them at any time.
- 6. Physical Characteristics:
 - a. Operating Temperature: 14 degrees F to 140 degrees F (-10 to 60 degrees C).
 - b. Dimensions:
 - 1) JP-DA 5-1/8 inches x 3-7/8 inches x 1-9/16 inches (131 x 99 x 40 mm).
 - 2) JP-DV 6-13/16 inches x 3-7/8 inches x 1 inch (173 x 98 x 25 mm).
 - 3) JP-DVF 8-1/4 inches x 5-5/16 inches x 7/32 inch (209 x 135 x 5.5 mm).
 - 4) JP-DVF back box 7-3/32 inches x 4-3/8 inches x 1-25/32 inches (180 x 110 x 45 mm)
 - c. Power Supply: DC 24V (from master station).
 - d. Current Consumption: 90 mA.
 - e. Mounting:
 - 1) JP-DA: Surface mount to 2x4 electrical box.
 - 2) JP-DV: Surface mount direct to surface.
 - 3) JP-DVF: Flush mount with included back box.
 - f. Weight:
 - 1) JP-DA: 0.46 lbs (210g).
 - 2) JP-DV: 1.3 lbs (550g).
 - 3) JP-DVF: 1.2 lbs (550g).
 - 4) Back Box: 0.95 lbs (430g).
- B. Power Supply: PS-2420UL, 24V DC Power supply.
- C. Call Extension Speaker: IER-2, Call extension speaker
- D. External Devices:
 - 1. RY-3DL: Multiple (3) door release adaptor.
 - 2. AC-10S: Access control keypad, surface mount.
 - 3. JP-DV+ AC-10S: PanTilt & Zoom vandal-resistant video door station. Surface mounted with access control keypad.
- E. Long Distance Adaptor: JPW-BA.
 - 1. Power Supply: DC 24V (from power supply)
 - 2. Current Consumption: 90 mA
 - 3. Operating Temperature: 32-degree F to 104 degrees F (0 to 40 degrees C).
 - 4. Mounting: Wall-mount
 - 5. Weight: Approx. 7 oz (200 g).

- F. Distribution Adaptor: JP-8Z.
 - 1. Power Supply: DC 24V (from power supply)
 - 2. Current Consumption: 90 mA
 - 3. Operating Temperature: 32-degree F to 104 degrees F (0 to 40 degrees C).
 - 4. Mounting: Wall-mount.
 - 5. Weight: Approx. 7.5 oz (210 g).
- G. Door Intercom Station: JP-DV
 - 1. PTZ Camera
 - 2. Zinc Die Cast Cover
 - 3. Weather and Vandal resistant
 - 4. Surface Mounted, provide all mounting hardware

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas to receive integrated security and communication system.
- B. Notify Architect of conditions that would adversely affect installation or subsequent use.
- C. Do not begin installation until unacceptable conditions are corrected.

3.2 PREPARATION

- A. Verify the following compliance before starting installation.
 - 1. All units, except for the entrance station and tenant door station, are designed for indoor use only. Do not use outdoors.
 - 2. The unit turns inoperative during power failure.
 - 3. In areas where broadcasting station antennas are close by, intercom system may be affected by radio frequency interference.
 - 4. Keep the intercom wires at least 1 foot (30 cm) away from strong electrical wiring (AC 100-240 V) including, in particular, wiring for inverter electrical appliances. Noise and malfunction could result.
 - 5. Keep the unit more than 3.3 feet (1 m) away from radio or TV set.
 - 6. If a strong light shines on the main unit screen, the picture may turn white or only silhouettes will be visible.
 - 7. Other manufacturer's devices (such as sensor, detectors, door releases) used with this system, comply with the manufacturer's installation requirements.
 - 8. The LCD panel is manufactured with very high precision techniques, inevitably will have a very small portion of its picture elements always lit or not lit at all. This is not considered a unit malfunction. Please be aware of this in advance.

3.3 INSTALLATION

- A. Install integrated security and communication system in accordance with manufacturer's instructions at locations indicated on the Drawings.
- B. Mount equipment plumb, level, square, and secure. For video entrance stations and video door stations, comply with manufacturer's design requirements to provide optimum picture quality of station monitoring.

3.4 SET-UP AND ADJUSTING

- A. Adjust integrated security and communication system for proper operation in accordance with manufacturer's instructions.

3.5 DEMONSTRATION AND TRAINING

- A. Demonstration:
 - 1. Demonstrate that integrated security and communication system functions properly.
 - 2. Perform demonstration at final system inspection by qualified representative of manufacturer.
- B. Instruction and Training:
 - 1. Provide instruction and training of Owner's personnel as required for operation of integrated security and communication system.
 - 2. Provide hands-on demonstration of operation of system components and complete system, including user-level program changes and functions.
 - 3. Provide instruction and training by qualified representative of manufacturer.

3.6 PROTECTION

- A. Protect installed integrated security and communication system from damage during construction.

END OF SECTION 281310

This Page Intentionally Left Blank

SECTION 281610

INTRUSION DETECTION SYSTEM

PART 1 - GENERAL

1.1 WORK INCLUDED

- A. Completely remove existing Intrusion Detection System control panels, power supplies and associated devices. Turn over existing devices, control panels and power supplies as requested by the District's security operations group
- B. Provide all labor, materials, tools, and equipment required for the complete installation of work called for in the Contract Documents.

1.2 SCOPE

- A. Provide all required I/O hardware and programming to the Access Control System.
- B. The system shall include but not be limited to the following:
 - 1. Intrusion Detection Control Panel (IDCC)
 - 2. Zone Expansion Modules
 - 3. Relay/Power Modules
 - 4. Motion Sensors
 - 5. Break Glass Sensor
 - 6. Key Pads
 - 7. Door Contacts
 - 8. Addressable Modules
 - 9. System Wiring (plenum rated)

1.3 QUALITY ASSURANCE

- A. All Intrusion Detection system devices 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's Representative. Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based upon the acceptable manufacturers listed. Where "approved equal" is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to approval.
- B. Materials specified herein shall comply with the applicable requirements of:

1. The following Articles of the National Fire Protection Agency:
 - a. NFPA 71 - Central Station
 - b. NFPA 72 - National Fire Alarm Code

1.4 SUBMITTALS

- A. Model numbers of all components furnished on the job.
- B. Manufacturer's catalog data sheets for all components.
- C. Complete engineered drawings indicating:
 1. Point-to-point wiring diagrams for all devices
 2. Building floor plans showing location and address of all devices and detection field coverage for all motion detectors.
 3. Power supply sizes and wired loads.
 4. Termination details for all devices
 5. Single-line system architecture drawings representing the entire system. Indicate device address, make, model and serial no. for all equipment of the diagram

1.5 SEQUENCE OF OPERATION

- A. Coordinate all sequence of operation events with the District's security operations group.
- B. Upon an abnormal condition on the security system, abnormal events shall be logged into the database, along with the date and time.
- C. Operation of Arming/Disarming the system shall follow the following procedure:
 1. Keypads will be used for arm/disarm functionality.
- D. Operation of any motion detector / door contact while system is armed shall cause the following to happen:
 1. Notify the central station via the city radio call box. Which will in turn call the police department and call a district-supplied list of qualified personnel until contact is made. No voice mail messages shall be left.
 2. Display the points in alarm at the key pads and control panel.
 3. Sound system alarm horn(s),
 4. Subsequent alarms shall repeat the respective sequence of operations.

- E. The System wiring and power supplies shall be electrically supervised and report trouble conditions to the control panel. Any opens, shorts or grounds on the system wiring shall cause the following to happen:
1. Display the points in alarm at the key pads and control panel.
 2. Notify the central station via the city radio call box. Which will in turn call the police department and call a district-supplied list of qualified personnel until contact is made. No voice mail messages shall be left.
 3. Subsequent trouble alarms shall repeat the respective Sequence of Operation.

PART 2 - PRODUCTS

2.1 INTRUSION DETECTION SYSTEM CONTROL PANEL

A. System Description:

1. The system shall include a control panel LAN/WAN network interface, 600 event memory logger, real time clock, calendar, test timer, battery charger, battery, diagnostics display time/event based scheduling system and surge suppression.
2. Programmable to separate points into a minimum of 8 independent partitions.
3. Capable of reporting alarm and trouble conditions to a central station via city radio box.
4. Detection loops and power supplies shall be electrically supervised.
5. The control panel shall be programmable locally or remotely, via the system keypad or a P.C.
6. The control panel shall annunciate alarm and trouble messages in English on the display.
7. Shall be capable of executing diagnostics and testing functions locally or remotely.
8. The control panel shall be capable of activating a minimum of 59 output relays.
9. Shall be capable of controlling relays and automatically executing system functions based on a time/event scheduling program. The following functions may be executed.
 - a. Arm / Disarm a specific area or partition.
 - b. Bypass / Un-bypass a point.
 - c. Activate / Deactivate a relay.

- d. Send a test report.
- e. Adjust system clock for daylight savings time.

B. System Features/Capabilities

1. Minimum 112 addressable devices via (2) addressable loops.
2. Minimum of 16 zones. Each of the zones shall be capable of supporting “group zoning”. Group zoning refers to the combining of sensors into a separately identifiable and separately annunciated area.
3. Programming Functionality: Each point in the system shall provide for the following type of response in the system.
 - a. Always on (24 hour response)
 - b. On when the system is Master Armed
 - c. Only on when the system is Perimeter Armed
 - d. Displays / Does Not Display at the keypad when the point is activated.
 - e. Provides / Does Not Provide entry warning tone
 - f. Sounds / Does Not Sound audible alarm indication.
 - g. The Point is bypassable / not bypassable
 - h. Alarm Verification with programmable verification time.
 - i. Summary Relay activation by Point.
4. The control panel shall support 8 independent partitions. Each of the eight partitions shall have custom text associated with the armed state, disarmed state and point off normal state. Additionally, the control panel shall be capable of assigning up to eight partition identifiers to the areas depending on the distribution of areas per zone.
5. Any partition shall be configurable to allow arming by specific users when a programmable number of devices are faulted or bypassed.
6. Partitions shall be independently controlled by their corresponding keypad. Each keypad can be designated to control a specific Partition, or group of partitions, or all partitions in the system.
7. Independent control or relay functions by partition shall be possible through programming assignments.
8. System shall be capable of supporting a minimum of sixteen keypads.

9. System shall support up to 128 different passcodes. Each passcode shall be variable from four to six digits. Passcodes shall be enabled or disabled by partition(s) and shall be assigned one of ten different authority levels to carry out functions such as the activation of relays from the keypad.
 10. Testing, Diagnostic, and Programming Facilities: Automatic test reports and remote system access for diagnostics, programming, and log (Logger) uploads shall also be supported via a remote central station computer.
 11. The system shall be capable of logging up to 600 events indicating time, date, type of event, account number, zone number, user ID, point text, and primary/secondary telephone number called for each event. Logs shall be viewed locally at the keypad or remotely via a computer. The control panel shall also support the printing of these events on up to three local printers.
- C. The control panel shall support the district LAN/WAN network interface for the system monitoring. Provide with T-Link module
- D. The control panel shall have two different output tones, Steady, Pulsed.
- E. The Control Panel shall provide a “user-friendly” interface for programming/customizing the system. These system features shall have restrictions based on 10 individually programmable levels of passcode authority which can be assigned to system users. The user’s passcode shall have the capability of being assigned a different authority level in each of the eight zones. User programmable/activated functions include:
1. Arming the system.
 2. Disarming the system.
 3. Viewing system status.
 4. Implementation functions.
 5. Testing the system.
 6. Change system parameters.
 7. Extend the closing time of system.
 8. Transmitting special alerts and activating audible and visible signals.
 9. Editing of time/event based scheduling program from the keypad.
- F. Electrical Requirements
1. System requires a 120vac receptacle for a plug in transformer.

2. When the primary power source fails, the system can be configured to report an “AC Fail” message to a central station. The transmission delay of this message is programmable from one to 90 seconds.
3. Secondary power (standby battery): The Contractor shall provide adequate battery power to operate the system for 4 hours , and then sound all alarms for five minutes.
4. Provide plenum rated wiring as recommended by the manufacturer.

G. Materials

1. System Hardware Description:
 - a. The Intrusion Detection System shall be provided with the following components. Additional accessories shall be provided based on the quantities and features required for the application.
 - 1) Enclosure.
 - 2) Lock and key.
 - 3) Faceplate shield.
 - 4) Power transformer.

H. Design Make: Andover Continuum.

2.2 ZONE EXPANSION MODULES

- A. Provide 8 or 16 zone expansion modules as shown on the building riser diagram.
- B. Units provide 8 or 16 programmable zones tamper input and auxiliary power for motion detectors.
- C. Power and communications provided via the 4 wire com bus.
- D. Provide main panel size back box and terminal strip (8 or 16position) for motion detector power.
- E. Design Make Andover

2.3 RELAY OUTPUT MODULES

- A. Provide relay output modules for computer lab horn control and additional power where shown on the building riser diagrams.
- B. Unit provides 4 programmable form C relay contacts.
- C. Provide main panel size backbox and 120Vac receptacle for plug in transformer.

- D. Design make Andover

2.4 SYSTEM WIRING

- A. The number of pair per. jacket shall be as required by the system installer.
- B. The quantity of shielded or unshielded pair shall be determined by the system manufacturer.
- C. Cable shall be ASTM tinned copper, 18 AWG (7x26 stranded), twisted pairs, 20 strand shielded drain wire unless recommend otherwise by the system manufacturer.
- D. 300-volt insulation, color shall be yellow.
- E. Cable shall be UL listed NEC type CMP, constructed in accordance with UL 444.
- F. Cable shall be fully functional from -10°C to 60°C.
- G. Individually colored conductors.
- H. Design Make: West Penn/CDT or Approved equal

2.5 KEYPADS

- A. Digital user interface station to arm/disarm the system.
- B. Large, backlit, 2-line 32-character display Real time clock display.
- C. Ready, armed and trouble LEDs, 5 programmable function keys, 4 keypad activated alarms.
- D. Plain language display of zone status, system status, trouble conditions, event buffer, system instructions, date and time.
- E. Design Make: Andover.

2.6 ADDRESSABLE CONTACT MODULE

- A. Point addressable, 2 wire multiplexed loop, low current draw.
- B. Three monitored inputs for alarm, trouble and tamper.
- C. Design Make Andover.

2.7 DOOR CONTACTS

- A. Button type magnetic contact (New Doors):
 - 1. 1" diameter magnetic door contacts. Magnet installs in door, contact installs in door frame.

2. Provide single pole, double throw contact with 1' long #22 AWG leads brought out.
 3. Maximum ½" gap.
 4. Provide contact that will not affect the fire integrity of U.L. listed fire rated doors.
- B. Surface mount magnetic contact (Existing Doors):
1. Nominal 2" long x ½" wide x ½" deep.
 2. Magnet installs surface mounted on door. Contact installs surface mounted on door frame.
 3. Provide single pole, double throw contact with 1' long, #22 AWG stainless steel leads brought out.
 4. Maximum 1" gap.
- C. Acceptable Manufacturers:
1. Detection Systems
 2. Ademco
 3. Sentrol

2.8 MOTION SENSORS

- A. All motion detectors shall be point addressable, 2 wire multiplexed loop, low current draw.
- B. Provide with necessary ceiling or wall mounting brackets.
- C. Passive Infrared, multi-level signal processing, dual element low noise sensor, 32-122 F temperature compensating operating range.
 1. Type A – Corridor Long range wall mounted area motion sensor:
 - a. 120' x 10' viewing pattern.
 - b. Suitable for wall or ceiling mounting. Provide swivel mounting bracket as required.
 - c. Design Make: DSC AMB-300 with BV-L2 lens
 2. Type B - Wall mounted area motion sensor:
 - a. 40' x 40' viewing pattern.

- b. Suitable for wall or ceiling mounting. Provide swivel mounting bracket as required.
 - c. Design Make: DSC AMB-300 with BV-L1 lens.
 - 3. Type C - Ceiling mounted, round distribution:
 - a. 360° x 60' diameter viewing pattern.
 - b. Suitable for use in spaces with 8-18' ceilings.
 - c. Design Make: AMB-500.
 - 4. Type D
 - a. Curtain lens viewing pattern.
 - b. Suitable for wall or ceiling mounting. Provide swivel mounting bracket as required.
 - c. Design Make: DSC AMB-300 with BV-L3 lens

2.9 GLASS BREAK SENSOR

- A. 30' detection range
- B. Burst rejection circuit to reduce false signals present in some environments
- C. Alarm relay (form C)
- D. Tamper Switch (Form A)
- E. Design Make: Honeywell FG-730

2.10 ALARM SIREN (Interior)

- A. 12 VDC electronic horn.
- B. Steady and pulsed tones, 90 dBA output
- C. Suitable for flush or surface mounting.
- D. Design Make: Jentex 503s

PART 3 - EXECUTION

3.1 INTRUSION DETECTION CONTROL SYSTEM

- A. Installation:

1. Install all equipment and materials in accordance with the recommendations of the manufacturer.
- B. Install all cabling with one of the following methods:
1. All exposed wiring in finished occupied areas shall be provided in a metal raceway system.
 2. In ring run supported 4' on center above accessible ceilings, and in crawl spaces.
 3. In areas noted where exposed cabling is allowed it should be supported in ring run 4' on center. Use cable ties to attach cable bundle to ring run for a neat appearance.
 4. In E.M.T. conduit in mechanical areas.
 5. In metallic surface raceway in finished areas only where unable to conceal or fish walls.
- C. Programming of the system shall include the following tasks:
1. Meeting with the District's security operations group to review system programming parameters.
 2. Programming system configuration parameters (hardware and software, zone/circuit numbers, communication parameters).
 3. Programming operational parameters such as opening/closing reports and windows, system response text (custom English) displays of events, activation of relays that drive auxiliary devices, and identifying types of zones/loops.
 4. Programming passcodes according to the authorities and functions defined by the District's security operations group.
 5. Other system programming tasks required by the District's security operations group. These additional programming requirements shall be coordinated between the Owner and the contractor.
- D. Testing:
1. Operational Testing: The contractor shall perform thorough operational testing and verify that all system components re fully operational.
 2. Hard-copy System Printout: The contractor shall submit a hard-copy system printout of all components tested and certify 100 percent operation indicating all devices/panels/units have passed the test criteria set forth by the manufacturer.

3.2 MOTION SENSORS

- A. Install motion sensors in locations shown on plans.

- B. Make adjustments to aiming of motion sensors to optimize viewing pattern.
- C. Acceptance Test Plan Form: An acceptance test plan form shall be prepared/provided by the contractor prior to the acceptance walk-through.

3.3 SYSTEM PROGRAMMING

- A. The system installer shall meet with the District's security operations group as many times as necessary to finalize system programming. The installer shall review the owner's security plans and policies and make programming decisions based on that plan.

3.4 RECORD DRAWINGS

- A. Provide Floor plans showing:
 - 1. Locations and zone address for all devices.
 - 2. Wiring pathways and wire counts for the entire system.
- B. Provide listing of all devices and system addresses.

3.5 COMMISSIONING

- A. The contractor will schedule a system acceptance test with the engineer and the owner.
- B. Make all changes required from the punch list generated during initial testing. Schedule a second acceptance test with the owner. If additional testing is required after the second test, the contractor will reimburse the owner for their time at a rate of 2 times their expenditure for their actions.
- C. Upon final completion of the punch list as determined by the owner, all systems and associated equipment furnished by the Contractor will be subjected to a thirty (30) consecutive day operational test to determine the reliability of the equipment. If the results of this operational test are acceptable to the owner the warranty period will begin.
- D. If the system fails during the 30 consecutive days, the Contractor will resolve the problems and start the test again beginning with day one. The Contractor will be given two (2) opportunities to successfully complete the 30 consecutive day operational test.
- E. The performance of all systems, will not be less than 100% during the operational 30 consecutive days test period. 100% performance is defined as no trouble reports attributable to the system or Contractor's actions during the acceptance period. The owner may add other requirements to the Standard of Performance, as it deems necessary.
- F. The system will not be accepted for operational use and final payment will not be authorized until the owner determines that the system is deemed acceptable.

END OF SECTION 281610

This Page Intentionally Left Blank

SECTION 282319

HIGH DEFINITION IP VIDEO SURVEILLANCE

PART 1 – GENERAL

1.1 WORK INCLUDED

- A. Provide all labor, materials, tools, and equipment required for the complete installation of work called for in the Contract Documents.

1.2 SCOPE OF WORK

- A. Work included is an extension of the existing system, supplier shall be responsible for maintaining existing settings, programing, labeling, etc. to the districts standards and not alter or modify.
- B. Provide all labor, materials, equipment, licensing, engineering and service necessary to provide a complete and operating IP CCTV Camera System as shown on the drawings and described in the specifications.
- C. Provide NVR solution to serve the new IP based cameras in the project. Each camera shall be provided with 30days of backup. Provide new NVR video client software on (5) PCs in each building and (1) PC in the Admin. Building. Provide all required licensing for new and existing encoders.
- D. The following system components are specified in this section
 - 1. Network Video Recorder Software and Hardware
 - 2. IP Camera (Types A & B)
 - 3. Video Cabling
 - 4. PoE Extender
 - 5. UPS Unit
 - 6. PC Computer and Mounting Bracket

1.3 SYSTEM DESCRIPTION

- A. The network video recorder allows the recording, live viewing, and playback of recorded video for periods of up to one month without the need for external storage. NVR performs all viewing, playback, and video storage functions simultaneously.
- B. A large formal LED TV shall be wall mounted in the main office to provide viewing of client selected cameras over the network. A PC shall be provided with client software to

allow viewing of client selected video feeds. These camera views shall primary be selected to allow access into the building and supervise main points of entry and pickup.

C. Provide the following video record settings on each NVR and/or archive server:

1. Duration of recording without overwrite – 1 month
2. # of connected camera per NVR – Refer to Drawings
3. Image resolution setting Type A IP Camera –2 megapixel
4. Image resolution setting Type B IP Camera –3 megapixel
5. Video Encoding – H.264
6. Record Frames per. second – (8) Eight
7. Record Time – On motion and 4-seconds prior

D. NVR Setup Standards:

1. Install latest Microsoft and NVR manufacturer updates and patches.
2. Contractor to install and configure latest SQL Server Express if required.
3. Coordinate joining the new NVR to the domain with the District IT representative.
4. Add local building user group account access from existing windows domain.
5. Server Name: S0xxSEC-yy (xx = Building #; yy = Server #).
6. Coordinate IP Address setup with District IT representative.

E. Camera Setup Standards:

1. IP Address by provided by District IT representative
2. Camera Standard: 172.16.xx.zz (xx = Building #; zz = Camera 1, 2, 3....)
3. Subnet Mask: 255.255.252.0
4. Gateway: 172.16.0.1

F. NVR recorders are rack-mountable boxes equipped with external IP encoders Video is displayed on a standard monitor, and configuration is performed through a standard mouse and keyboard interface.

- G. NVR is configured with control software and can record video continuously, only during alarm events, or only while activity is present. Each camera can record in different modes and on different schedules, or they can be configured the same.
- H. Control software allows for search and retrieval of video. User-defined parameters allow searches based on the time and date the video was captured, whether alarm or motion events occurred, and which camera captured the video. The software also permits full video storage management, hardware control, alarm configuration, and export of video and individual frames.
- I. System shall have the ability to use remote viewing software with the ability of viewing live or recorded video over standard network or modem connections. This software shall be available at no cost to the user and shall be downloadable using standard internet connections.
- J. Video Surveillance at the Buildings
 - 1. CCTV Camera and Enclosure systems types are identified on the drawings. Refer to this section of the specifications for system descriptions.
 - 2. Surveillance cameras will be located at selected entrance doors, corridors and rooms inside the building as indicated on the plans.
 - 3. Surveillance cameras will be located on the building exteriors to monitor selected parking lots, entrances and secluded areas.
 - 4. Cameras will be field selectable for activation on motion within the cameras viewing range or to be permanently on.
 - 5. All cameras that are activated shall be recording digital video to the server. The server will automatically save all video and overwrite hard disk media per. custom client settings.
 - 6. In the event of a NVR or network failure video shall automatically save to SD cards installed locally in equipped cameras.
 - 7. The owner will be able to view camera output on monitors in the Main Office of each school and any networked PC running the client software.
 - 8. The output to the monitors may be configured for full or split screen or for random scan of all cameras. In the case where a camera is set to record on motion it will automatically go to full screen on a selected monitor(s).
 - 9. The video will be viewable in on any PC equipped with the client software.

1.4 CODES AND STANDARDS

- A. Design and operation of the Network based CCTV System shall conform to the following referenced codes, regulations and standards as applicable:
 - 1. National Electrical Code (NEC)
 - 2. UL 294 Access Control Systems
 - 3. UL 1076 Line Supervision
 - 4. FCC Rules and Regulations
 - 5. Part 15, Radio Frequency Devices
 - 6. National Electrical Manufacturers Association (NEMA)
 - 7. Applicable Federal, State and Local laws, regulations, codes

1.5 QUALITY ASSURANCE

- A. Manufacturer: Manufacturers shall have been in business for a minimum of five years and must guarantee that spare parts will be carried for a minimum of 5 years.
- B. The installer must be a company specializing in CCTV Systems with a minimum of five years' experience. The installer must have personnel authorized by the system manufacturers. The installer may be a sub-contractor to the electrical contractor.
- C. If the installer is a sub-contractor, the wiring and physical equipment installation may be done by the electrical contractor, under the supervision of the qualified sub-contractor. All system programming, configuration, testing and commissioning must be done by the qualified installer's manufacturer certified personnel.

1.6 SUBMITTALS

- A. Contractor shall submit on all products listed in this specification section, this shall include the following:
 - 1. Model numbers of all components furnished on the job
 - 2. Manufacturer's catalog data sheets for all components
- B. Complete engineered drawings indicating:
 - 1. Point-to-point wiring diagrams for all devices
 - 2. Termination details for all devices
 - 3. Single-line system schematic representing the entire system.

PART 2 – PRODUCTS

2.1 NETWORK VIDEO RECORDER (NVR)

- A. The NVR shall be managed by the client software with administrative credentials and shall serve as a repository for local video at LAN/WAN connected building.
- B. The VMS shall support the following industry standards to interface to IP-based physical security products:
 - 1. ONVIF
- C. User Interface:
 - 1. The NVR shall provide an HTML-based graphical user interface (GUI) capable of being viewed in a web browser and accessed for programming, playback, and backup of recorded video.
 - 2. Shall allow the administrator or users with appropriate privileges to change video configuration.
 - 3. Shall provide the ability to change video quality, bandwidth and frame rate parameters on a per camera (stream) basis for both live and recorded video.
 - 4. Shall provide the ability to configure brightness, contrast, and hue settings for each camera on the system.
 - 5. Shall provide the ability to set recording schedules and modes for each individual camera. The recording mode can be:
 - a. Continuous
 - b. On motion and manual
 - c. Manual only
 - d. Disabled
 - 6. Shall support the creation of schedules to which any of the following functional aspects can be attached:
 - a. Video quality (for each video stream per camera)
 - b. Recording (for each camera)
 - c. Motion detection (for each detection zone per camera)
 - d. Brightness, contrast, hue (for each camera)

e. Camera sequence execution

D. General System Overview:

1. The NVR shall be a 19-inch-wide rack-mountable enclosure. IP camera video shall be received thru the Ethernet interface in the NVR.
2. Analog video from legacy cameras are received by the NVR from external Ethernet connected encoders. Each external encoder shall include 16 standard BNC connectors to accept 30 NTSC images per second at CIF, 2CIF, and D1 per input. Encoders shall output H.264 hardware compressed IP video for recording on the NVR.
3. The rate of image capture and the size of individual images can be controlled separately for each camera input.
4. NVR shall store video in segments directly on its internal hard drive. The user shall have the ability to configure newly captured video to automatically begin replacing the oldest video stored on the disk when the disk's capacity is reached.
5. NVR shall have the ability to be configured to record video only while activity is occurring in the camera's view. Users define the NVR's level of motion sensitivity and configure NVR to ignore subtle changes in light level. Motion masks eliminate areas of the camera view where motion events should not trigger recording.
6. The NVR shall accept external alarms connected to NVR via a contact trigger block located on NVR. NVR shall accept up to 8 inputs and provide 8 control outputs.
7. NVR shall record in four user selectable modes: Motion mode (records activity only); Alarm mode (records alarm events only); Both mode (records activity and alarm events only); and Free mode (records continually).
8. NVR shall record information about the time, date, and source of all video for easy search and retrieval. The status of all alarm inputs is recorded with each stored image.
9. Live video can be viewed in 2x2, 3x3, and 4x4 modes during recording. Depending on the number of cameras connected, the update rate for the live video windows varies.
10. Video can be transferred from NVR to an external monitor. NVR shall contain a minimum of five switched outputs (including two with onscreen display).

a. Video review and retrieval:

- 1) Allows searches based on a time frame, one or more video sources, and types of events (motion, alarm, etc.).
 - 2) Video Results: Search results are listed with the following information: source camera; time and date captured; whether motion or alarm events occurred; number of frames in the segment; and location (disk or tape). Results are sortable.
 - 3) User Interface: Search results are played back with full VCR control (play, fast forward, rewind, pause, step forward, etc.).
 - 4) Image Export: Individual images can be exported to other disks in standard Windows image file formats.
- b. Remote review of video
- 1) Live and recorded video on a NVR system can be viewed remotely via a remote viewing software. It operates as a server, allowing users to download recorded or live video over a network or modem connection.
 - 2) Recorded video can be downloaded from NVR through any remote client provided the client can access the NVR via a network or modem connection and has the remote viewing software installed.
 - 3) Live video can be downloaded from NVR through a remote client. NVR can transfer live images across a network as they are recorded.
 - 4) NVR operates as a server for live and recorded video. It requires the Remote View Server application to be running on the NVR platform.

E. System Control Software

1. The control software shall allow for the full control of video viewing, alarm configuration, scheduling, search and playback, hardware setup, and user administration. Control Software is controlled using a mouse and keyboard. The main screen includes indicators for the current date and time, the recording status of each camera input, disk usage, and the amount of recording time available at the current hardware settings.
2. The control software shall allow for the user to view live video from four inputs configured 2x2, nine inputs configured 3x3, or from 16 inputs configured 4x4. The user decides which camera is displayed in which window. In all modes, motion and alarm events trigger a visual feedback mechanism, calling attention

to the appropriate view screen with a brightly colored border.

3. The control software shall allow for the complete control of user access. Users must enter a password to use NVR and are granted one of three levels of permissions. Non-administrators can be prevented from accessing other portions of NVR. Control Software shall provide contingencies for improper shutdown that automatically resume recording without user intervention.
 4. The control software shall have the ability to use motion masks to eliminate areas of a camera's view from activity detection. Masks can be created in any detailed pattern to prevent the unwanted recording of anticipated activity.
 5. Software shall operate on a Microsoft Windows platform, Windows Active Directory support.
- F. Whenever multiple video streams are available from the same camera, users shall be free to use any one of them based on their assigned usage. The standard video stream usages are:
1. Live
 2. Recording
 3. Remote
 4. Low resolution
 5. High resolution
- G. System Specifications and Capacity:
1. Capable of simultaneously using multiple video compressions including H.264, MPEG-4, MPEG-2, MJPEG, Wavelet, and JPEG2000.
 2. Accepts IP cameras with resolutions from QCIF to 4CIF, megapixel, HD, and 4K resolutions.
 3. Bandwidth managed from 8 Kbits/sec to 30Mbits/sec per camera.
 4. Side-by-side live and playback video.
 5. Real-time video up to 60 fps per camera.
 6. Real-time audio transmission linked to video cameras.
 7. IP and analog support through the use of supported encoders.
 8. PTZ camera control including PTZ-in-tile controls. This shall be compatible

with all industry standard analog and IP camera PTZ protocols.

9. Digital zoom for clear identification.
10. Software enabled motion detection and record on motion feature.
11. Software enable object removal alerts
12. Handles up to 300Mb/sec. video bandwidth while recording.
13. NVR software version of supporting (48) connected IP cameras.
14. Central database manages authenticated users, cameras, and connections.

H. The NVR shall meet the following minimum hardware specifications:

1. Minimum Hard Drive Capacity for each Archiver – 12TB
2. 1000TX Ethernet Card
3. 2-USB ports
4. Includes licensing for all connected IP cameras and encoders

I. Provide with USB keyboard and Microsoft IR Mouse.

J. Provide with rack mounting hardware.

K. Provide with local 20” LED monitor installed in CER rack with NVR. Design Make: Dell or Approved Equal.

L. Include licensing for all IP cameras included in this project plus (20) additional licenses for future expansion.

M. Provide (8) copies of client viewing software. Viewing software shall be capable of viewing new IP cameras and encoded existing analog cameras.

N. Design Make: Avigilon

2.2 IP CAMERAS

A. Type A Camera:

1. Image Sensor: Progressive scan RGB CMOS 1/3”
2. Lens: Varifocal 3-9 mm, 84° - 30° view, f1.2
3. Minimum illumination:

- a. Color: 0.5 lux, f1.2
 - b. Black/White: 0.08 lux, f1.2
4. Shutter time: 1/35500 sec to 1/6 sec
5. Camera Angle Adjustment: Pan: 360°, Tilt: 160°, Rotation: 340°
6. Video Compression: H.264 Baseline and Main Profile (MPEG-4 Part 10/AVC) Motion JPEG
7. Up to 5 Megapixel Resolution (2048 x 1536)
 - a. Up to 30 frames per second (fps) at 2 Megapixel Resolution
 - b. Up to 20 frames per second (fps) at 3 Megapixel Resolution
8. Video Streaming: Multiple, individually configurable streams in H.264 and Motion JPEG, Controllable frame rate and bandwidth, VBR/CBR H.264
9. Multi-view Streaming: When streaming 4 view areas and 1 overview in VGA resolution, the frame rate is 20 frame per second (fps) per stream (3 Megapixel capture mode)
10. Digital Pan/Tilt/Zoom
11. Image Settings: Compression, color, brightness, sharpness, contrast, white balance, exposure control, exposure zones, backlight compensation, fine tuning of behavior at low light, wide dynamic range – dynamic contrast
12. Auto Back Focus
13. Security Access Password protected, IP address filtering, HTTPS encryption, IEEE 802.1X network access control, Digest authentication, User access log
14. Supported Protocols: IPv4/v6, HTTP, HTTPSc, SSL/TLS, QoS Layer 3 DiffServ, FTP, CIFS/SMB, SMTP, Bonjour, UPnP, SNMPv1/v2c/v3 (MIB-II), DNS, DynDNS, NTP, RTSP, RTP, TCP, UDP, IGMP, RTCP, ICMP, DHCP, ARP, SOCKS
15. Video Setup Jack
16. Power over Ethernet (IEEE 802.3af)
17. Edge Storage: SD/SDHC/SDXC slot supporting memory card up to 64GB
18. Provide camera with 64GB memory card.

19. Up to 2 Simultaneous Video Streams
20. Internal HTML web server for configuration and viewing capable
21. Service Connector External 3-connector, 2.5 mm provides NTSC/PAL video output.
22. Die-cast aluminum upper shroud camera housing for indoor surface mounting. Conduit knockouts on top and sides for wiring access. Provide recessed flange upper shroud for mounted to accessible ceilings.
23. Operating Conditions (Indoor): Suitable for operation from 32°F to 122°F, humidity 15-85% (non-condensing).
24. Lower smoked dome 360° Horizontal x 30° Vertical capable viewing.
25. Provide vandal resistant model for all cameras.
26. Design Make: Avigilon

B. Type B Camera:

1. Image Sensor: Progressive scan RGB CMOS 1/3"
2. Lens: Varifocal 3-9 mm, 84° - 30° view, f1.2
3. Minimum illumination:
 - a. Color: 0.2 lux, f1.2
 - b. Black/White: 0.04 lux, f1.2
4. Shutter time: 1/28000 sec to 2 sec
5. Camera Angle Adjustment: Pan: 360°, Tilt: 160°, Rotation: 340°
6. Video Compression: H.264 Baseline and Main Profile (MPEG-4 Part 10/AVC) Motion JPEG
7. Up to 5 Megapixel Resolution (2592 x 1944)
 - a. Up to 30 frames per second (fps) at 2 Megapixel Resolution
 - b. Up to 20 frames per second (fps) at 3 Megapixel Resolution
 - c. Up to 12 frames per second (fps) at 5 Megapixel Resolution
8. Video Streaming: Multiple, individually configurable streams in H.264 and

Motion JPEG, Controllable frame rate and bandwidth, VBR/CBR H.264

9. Multi-view Streaming: When streaming 4 view areas and 1 overview in VGA resolution, the frame rate is 12 frame per second (fps) per stream (5 Megapixel capture mode)
10. Digital Pan/Tilt/Zoom
11. Image Settings: Compression, color, brightness, sharpness, contrast, white balance, exposure control, exposure zones, backlight compensation, fine tuning of behavior at low light, wide dynamic range – dynamic contrast
12. Auto Back Focus
13. Security Access Password protected, IP address filtering, HTTPS encryption, IEEE 802.1X network access control, Digest authentication, User access log
14. Supported Protocols: IPv4/v6, HTTP, HTTPSc, SSL/TLS, QoS Layer 3 DiffServ, FTP, CIFS/SMB, SMTP, Bonjour, UPnP, SNMPv1/v2c/v3 (MIB-II), DNS, DynDNS, NTP, RTSP, RTP, TCP, UDP, IGMP, RTCP, ICMP, DHCP, ARP, SOCKS
15. Video Setup Jack
16. Power over Ethernet (IEEE 802.3af)
17. Edge Storage: SD/SDHC/SDXC slot supporting memory card up to 64GB
18. Provide camera with 64GB memory card.
19. Up to 2 Simultaneous Video Streams
20. Internal HTML web server for configuration and viewing capable
21. Service Connector External 3-connector, 2.5 mm provides NTSC/PAL video output.
22. Provide vandal resistant model for all cameras. Refer to floor plans and camera enclosures section of this specification for additional information.
23. Die-cast aluminum upper shroud camera housing for outdoor surface mounting. Conduit knockouts on top and sides for wiring access.
24. Operating Conditions (Outdoor): All outdoor cameras shall come with preinstalled POE heater, fan, and integrated dehumidifying membrane suitable for operation from -40°F to 131°F, humidity 15-100% (condensing).
25. Lower smoked dome 360° Horizontal x 30° Vertical capable viewing.

26. Design Make: Avigilon

2.3 VIDEO CABLING

- A. Refer to section 271000 - Horizontal and Backbone Communication Cabling for 100 Ohm UTP cable (Category 6 cable) and termination requirements.

2.4 POE EXTENDER

- A. PoE extender shall be capable of being installed mid span of the Cat. 6 cable installation within the 300 foot of the originating patch panel.
- B. RJ-45 input and output connectors.
- C. Requires no local power.
- D. With one PoE extender the IEEE 802.3af Ethernet signal may be extended up to 200 meters.
- E. Universal 10/100 Ethernet compatibility, IEEE 802.3af PoE compliant power injector.
- F. LED indicators Power good, network link/activity (both ports).
- G. Dimensions 4.5" x 2" x 1", surface mount enclosure.
- H. Design Make: Veracity Model VOR-ORM or Approved Equal

2.5 UPS UNIT

- A. Output power capacity 1,800 Watts / 2200 VA
- B. Double conversion on-line power, pure sine wave output
- C. Maintenance-free sealed Lead-Acid battery
- D. 3-minute run time full load, 10-minute runtime on half load
- E. Input: NEMA 5-20P on 6-foot cord
- F. Output: (6) NEMA 5-20R receptacles
- G. Monitoring and shut-down Interface Ports: RJ-45 10/100 Base-T & USB
- H. Includes rack mount rails
- I. Design Make: APC SRT2200RMXLA-NC
- J. Acceptable Manufacturers: Emerson or Tripp-lite

PART 3 – EXECUTION

3.1 GENERAL INSTALLATION

- A. Prior to installing any equipment the contractor shall walk the buildings with the engineer and District personnel to determine acceptable pathways, installation methods and final locations of equipment. Installation methods that are not approved will be subject to removal and reinstallation at no additional cost to the owner.
- B. Installation of the IP based CCTV system shall include the appropriate equipment and shall be performed by a factory-trained Installer. The installation shall be completed to meet the requirements of this specification and the project drawings. The installation shall include the following:
 - 1. Site planning and system configuration of field hardware.
 - 2. Complete hardware setup of all system Workstations and peripherals.
 - 3. Setup of specific network software configuration requirements.
 - 4. Complete system diagnostics verification.
 - 5. Complete system operation verification.
- C. Comply with manufacturer's instructions and recommendations for installation of product in the applications indicated. Anchor products securely in place, accurately located and aligned with other work.
- D. The Contractor is responsible to remedy defects due to faulty workmanship and materials that appear within one year from the date of acceptance in accordance with the General Conditions, unless Specifications specify a different duration.

3.2 NETWORK VIDEO SERVER/RECORDER

- A. Connect VGA output on the NVR to the local 17" LCD monitor in the same rack.
- B. Provide typed sticky back label wrapped around each cable identifying the camera location and type. Example "Two Story Vestibule - Wall Mount Camera".
- C. Provide all software required for a complete video monitoring and archiving system over the owner's Ethernet LAN. Configure the monitoring software on client workstations with a desktop icon for each CCTV camera.
- D. The Contractor and system vendor's qualified representative shall meet with the owner as many times as necessary to finalize system programming. The installer shall review the owner's security plans and policies and make programming decisions based on that plan. The owner shall choose the camera flip or multiple images display settings on the remote

LCD Monitor.

- E. Provide installation and setup of remote viewing software for owner furnished workstations connected to the owners LAN. Verify all cameras can be connected to and viewed and all PTZ controls function properly. Uninstall and remove any existing not used DVR or NVR viewing clients.
- F. The installer shall make changes to the initial system programming for up to 60 days after the initial installation at no additional cost.
- G. Import and configure video recording and viewing form all network connected encoders.

3.3 CAMERAS

- A. Provide cat. 6 cable for IP connection from each camera back to CER. Provide PoE extender in-line for all cable runs over 300-feet. Use of PoE extenders shall be approved by engineer in advance.
- B. The final aiming, focusing and lens selection of cameras shall be done by the system vendor's qualified representative in conjunction with the engineer.
- C. Aim and focus cameras initially and test the system. Re-aim and focus the cameras as necessary to the owner's satisfaction.
- D. Coordinate all final camera locations in interior and exterior locations prior to rough-in with the owner.
- E. Field verify required mounting brackets for exterior cameras. The exact mounting hardware will be determined by the required field of view.

3.4 WIRING, RACEWAYS AND CABLE

- A. Provide a category 6 patch cable from NVR to the Ethernet Switch.
- B. All power wiring shall be installed in raceway and is to be installed in accordance with Local and National Electrical Codes.
- C. All video wiring within accessible unfinished areas (ceilings, mechanical spaces, and crawl spaces) may be run exposed with proper support with bridle rings. Bridle rings shall be installed a minimum of 4 ft. on center.
- D. Provide V700 surface metal raceway and associated fittings in finished areas across non-accessible masonry walls. All surface raceway in finished areas shall be painted to match adjacent surface finish.
- E. Wiring shall be run parallel and perpendicular to building lines in a neat and workmanlike manner and bundled with nylon tie wraps.

- F. Provide conduit sleeves, with applicable fire-proofing through any concrete or block walls for low voltage cable routing.
- G. All low voltage cable shall be run in separate raceways from public address or 120V or higher branch circuiting.
- H. All exposed wiring shall be installed a minimum of three (3) inches from hot water, steam, or condensate piping.
- I. Raceways containing video cabling to exterior cameras shall be concealed inside of buildings.

3.5 SYSTEM ACCEPTANCE TEST

- A. Provide demonstration, in the presents of the owners representatives, showing the complete operation of entire system functionality.
- B. Make all changes required from the punch list generated during initial testing/demonstration. Schedule a second acceptance test/ demonstration with the District. If additional testing is required after the second test/ demonstration, the contractor will reimburse the district and their representatives for their time at a rate of 2 times their expenditure for their actions.
- C. Upon final completion of the punch list as determined by the District, the entire systems and associated equipment furnished by the contractor will be subjected to a thirty (30) consecutive day operational test to determine the reliability of the equipment. If the results of this operational test are acceptable to the district the warranty period will begin.
- D. If any part of the system fails during the (30) thirty consecutive days, the contractor will resolve the problems and start the test again beginning with day one. The contractor will be given two (2) opportunities to successfully complete the 30 consecutive day operational testing period.
- E. The performance of the entire system will not be less than 100% during the operational 30 consecutive day test period. 100% performance is defined as no trouble reports attributed to the system or contractor's actions during the acceptance period. The district may add other requirements to the Standard of Performance, as it deems necessary.
- F. The system will not be accepted for operational use and final payment will not be authorized until the district determines that the entire system is deemed acceptable.
- G. In the event that the entire system (including any special or optional features ordered and installed) have not achieved the Standard of Performance within the two 30 (thirty) day periods, the District may terminate the tests, at its option, and require the contractor to provide a complete system replacement of its choice at no additional cost to the district.
- H. In this case the reference to "system" or "entire system" means all equipment at all

buildings are complete and fully functional. Final acceptance will not be done one building at a time.

3.6 SYSTEM DOCUMENTATION

- A. Complete documentation shall be provided with the system. The documentation shall completely describe all operations, each program, data sets and the hardware and peripherals. All updates, addendum and adjustments to the documentation shall be provided at no additional charge, in the same quantities as originally required.
- B. System Administrator Manual - Overview and step by step guide and instructions detailing all System Administrator responsibility and authority.
- C. User Manual - Step by step guide and instructions detailing all system user functions and responsibilities.
- D. Technical Maintenance Manual - Shall be a comprehensive and detailed document providing all maintenance action, system testing schedules, troubleshooting flowcharts, functional system layout and block diagrams and schematic diagrams of all system wiring.

3.7 SYSTEM TRAINING

- A. Provide at least two owner selected representatives with a (2) separate four hour hands on training session that details recording, playback, archiving features of the software package and troubleshooting of the CCTV cameras and recording equipment. All attendees shall be recorded on a sign-in sheet with the data. The sign-in sheet shall be included with the final O&M manuals. Training session shall occur on separate days.
- B. Provide an additional 2-hour follow up training course after the accepted thirty consecutive day acceptance period.
- C. Notify the owners representatives of when the training course are scheduled and included a copy of the attendee sign in sheet in the O&M Manuals.

3.8 WARRANTY

- A. The Contractor shall warrant all labor, workmanship and materials for a period of one (1) year from the date of final acceptance. Should a failure occur within the first year to the access control system, the Contractor shall provide all labor and materials necessary to restore the system to a complete operating condition, at no cost to the Owner.
- B. The contractor affix a card with their Company name and phone number to the NVR.

END OF SECTION 282319

This Page Intentionally Left Blank

SECTION 283110

FIRE DETECTION AND ALARM SYSTEM

PART 1 – GENERAL

1.1 WORK INCLUDED

- A. Provide all labor, materials, tools, and equipment required for the complete installation of work called for in the Contract Documents.
- B. Provide installed spare devices as listed in this section to be turned over at the end of the project to the owner.
- C. Provide Carbon Monoxide (CO) detection and notification in accordance with Part 1228 of Title 19 NYCRR, section 1228.4 in all commercial buildings.
- D. During the periods of active construction, within the project area, the contractor shall remove any and all existing smoke detectors and provide temporary heat detectors in their place. Upon completion of construction new detectors shall be provided at these locations. Refer to floor plans for additional information.

1.2 DESCRIPTION OF WORK

- A. This section includes minimum requirements for the following:
 - 1. Fire Alarm Control Panel
 - 2. Addressable Notification Device Panel
 - 3. Remote Annunciator Panel
 - 4. Addressable Monitor Modules (Input)
 - 5. Addressable Control Modules (Output)
 - 6. Combination Smoke/Carbon Monoxide Detector
 - 7. Manual Pull Stations
 - 8. Photoelectric Smoke Detectors
 - 9. Heat Detectors
 - 10. Projected Beam Smoke Detectors
 - 11. Audible/Visual Signal Devices (Speaker Strobe)
 - 12. Visual Signal Devices

13. Mass Notification Communications Panel
14. Mass Notification Booster Panel
15. Batteries and Charger

1.3 INSTALLED SPARE DEVICES

- A. Provide the following spare devices installed as directed by the architect and engineer. Installation includes 50-feet of required wiring in a metal raceway system and programming. All unused devices shall be turned over to the owner at project closeout. Include sign off receipt of all devices and quantities turned over to the owner with O&M manuals.
 1. (5) Photoelectric Smoke Detectors
 2. (5) Heat Detectors (rate of rise w/ 135-degree fixed temp. setting)
 3. (5) Combination Carbon Monoxide/Smoke Detectors
 4. (5) Combination Speaker/Strobe Devices
 5. (5) Addressable Monitor Modules

1.4 QUALITY ASSURANCE

- A. All raceways 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's Representative. Equipment and materials shall be of the quality and manufacture indicated. The equipment specified is based upon the acceptable manufacturers listed. Where "approved equal" is stated, equipment shall be equivalent in every way to that of the equipment specified and subject to approval.
- B. The fire alarm system contractor shall be a NYS licensed fire alarm installer.
- C. Materials specified herein shall comply with the applicable requirements of
 1. The following Articles of the National Electric Code (NFPA 70)
 - a. Article 760 - Fire Alarm Systems
 2. The following National Fire Protection Agency (NFPA) standards:
 - a. NFPA 72 - National Fire Alarm Code
 - b. NFPA 101 - Life Safety Code
 3. Latest adopted edition of the NYS Building Code

4. Latest adopted edition of the NYS Mechanical Code
5. The following U.L. Standards:
 - a. UL 864/UOJZ,APOU - Control Units for Fire Protective Signaling Systems
 - b. UL 268 - Smoke Detectors for Fire Protective Signaling Systems
 - c. UL 268A - Smoke Detectors for Duct Applications
 - d. UL 521 - Heat Detectors for Fire Protective Signaling Systems
 - e. UL 228 - Door Holders for Fire Protective Signaling Systems
 - f. UL 464 - Audible Signaling Appliances
 - g. UL 1638 - Visual Signaling Appliances
 - h. UL 38 - Manually Activated Signaling Boxes
 - i. UL 346 - Waterflow Indicators for Fire Protective Signaling Systems
 - j. UL 1481 - Power Supplies for Fire Protective Signaling Systems

1.5 SUBMITTALS

- A. Provide standard product data for all equipment indicating the type, size, rating, style, catalog number, and listing of the equipment and quantities.
- B. Provide calculations for sizing all batteries and power supplies. The calculations shall include a listing of current used by all current consuming devices in both the standby and alarm mode on each circuit. Provide voltage drop calculations indicating acceptable minimum end of line voltage for the specific equipment used.
- C. Provide standard terminal wiring diagrams for all devices and equipment.
- D. Provide a complete riser diagram indicating types of devices, number of initiation and signal loop circuits, class of wiring system, and type of wiring and listing for indoor and outdoor use. Include candela and dB level for all notification devices on riser.
- E. Include addressable device ID labels for each new I/O point.

1.6 SYSTEM DESCRIPTION

- A. Point addressable network capable fire alarm system with manual and automatic initiation devices. The notification devices for this system shall be addressable based on the specified sequence of operation.

- B. System shall be supervised to continuously monitor the integrity of the circuit conductors and power supplies.
- C. Performance of the fire alarm system circuits shall be in accordance with Class B operation for Initiating Device Circuits (IDC) and Class A operation for Notification Appliance Circuits (NAC's).
- D. The fire alarm control panel shall permit on-site programming to accommodate facility expansions, renovations, or fire alarm system modifications. All memory shall be non-volatile.
- E. The control panel shall have 24 VDC output power supplies for notification appliance circuits and sprinkler system activation bell. System shall be capable of adding additional power supplies as required to power all notification appliances.
- F. Summary Reports:
 - 1. The Fire Alarm Control Panel shall be capable of displaying and printing summary reports. The summary reports shall include:
 - a. A list of all alarm points not in their normal state.
 - b. A list of all points in the system, including their current status.
 - c. A list of data for all control by event programs.
 - d. A list of data for all time initiated programs.
- G. Alarm Priority:
 - 1. Alarms shall be processed at three levels of priority:
 - a. Fire alarms shall have the highest priority.
 - b. Other alarms that require interaction by the attendant shall have the second level of priority.
 - c. Monitored points which do not require interaction by the attendant shall be the lowest level of priority.
- H. System Access:
 - 1. Access to the system shall be controlled by at least three levels of security to prevent programming modifications by unauthorized personnel.
 - a. The lowest level of access, shall permit the attendant to view the system display, print alarms and perform life safety control by event functions. The Attendant has minimal access to the system functions.
 - b. The mid-level access shall permit the attendant to change user

programmable parameters.

- c. The highest level of access shall permit the modification of system software. This level shall be accessed only by a qualified representative of the equipment manufacturer.

1.7 SEQUENCE OF OPERATION

- A. Upon an abnormal condition on the fire alarm system, the appropriate LED (alarm, supervisory, or trouble) shall flash. The panel audible alarm shall pulse for alarm conditions and sound steadily for trouble or supervisory conditions. All abnormal events shall be logged into the database, along with the date and time.
- B. For the purposes of this specification section audible base smoke detectors and listed fire alarm speaker devices are considered audible signal devices.
- C. For the purposes of this specification visual strobes or combination speaker/strobes are considered visual devices.
- D. Voice Evacuation System:
 - 1. Each listed fire alarm speaker shall be connected back to the network voice evacuation system. It shall be programmed and connected so a single pre-recorded or live message can be transmitted from a fire alarm panel or fire fighter telephone to all connected fire alarm speakers or specific buildings or units where partial alarms are provided as part of the sequence of operation.
 - 2. Each voice amplifier shall be listed with the FACP to provide visual strobe and audible fire alarm notification and voice instruction.
 - 3. Each continuous building audio booster panel(s) shall be connected so they can provide Fire Alarm notification to its individual continuous building.
 - 4. The Fire Alarm System shall have the highest priority and take-over in the event the Mass Notification System is providing audio output.
 - 5. Upon activation of the Voice Evacuation System within every building, during manual notification a "Supervisory Condition" shall be indicated in the FACP of the corresponding building. When the activation is cleared the FACP shall indicate "Normal Condition".
- E. Operation of any single smoke detector, heat detector, or manual pull station in shall cause the following to happen:
 - 1. Signal a general alarm condition at the fire alarm control panel. Exterior building mounted sprinkler alarm bell shall operate only upon activation of any system flow switch and shall not operate upon building general alarm.
 - 2. Activate the Voice Evacuation System and connected NAC panels to sound all audible and visual alarm signal devices throughout the continuous building in a

temporal code or with voice instructions until silenced at the FACP.

3. Display the points in alarm on the LCD display at the fire alarm control panel and at all remote alarm annunciator panels and print at all system printers. The visual indication shall remain until the alarm condition is reset.
 4. Notify the central monitoring station.
 5. Operate alarm relay contacts to initiate the elevator recall sequence and trip the “blinking fire hat” notification light in the elevator car.
 6. Operate the fan shut-down relay for the HVAC systems in the same smoke compartment or smoke zone.
 7. Operate all smoke dampers in the same smoke compartment or smoke zone. Dampers shall close 30 seconds after their respective fan systems have shut down.
 8. Subsequent initiating alarms shall repeat the respective sequence of operations.
- F. Operation of any single heat detector in unoccupied spaces (mechanical or storage rooms) or operation of more than one alarm initiating device(s) in any building shall cause the following to happen.
1. Signal a general alarm condition at the fire alarm control panel.
 2. Activate the Voice Evacuation System and connected NAC panels to sound all audible and visual alarm signal devices throughout the continuous building in a temporal code or with voice instructions until silenced at the FACP.
 3. Display the points in alarm on the LCD display at the fire alarm control panel and at all remote alarm annunciator panels and print at all system printers. The visual indication shall remain until the alarm condition is reset.
 4. Notify the central monitoring station..
 5. Subsequent initiating alarms shall repeat the respective sequence of operations.
- G. Operation of any carbon monoxide detector shall cause the following to happen:
1. Signal a supervisory signal only at the fire alarm control panel and remote annunciator.
 2. All CO detectors throughout the housing building shall provide activation of a distinct CO detector audible code within the same continuous floor. Activate any connected CO visual amber lens strobes in the same areas.
 3. Display the points in alarm on the LCD display at the fire alarm control panel and at all remote alarm annunciator panels and point at all system printers. The visual indication shall remain until the alarm condition is reset.

4. Notify the central monitoring station.
 5. Subsequent supervisory alarms shall repeat the respective sequence of operations.
- H. Elevator Lobby, Machine Room, and Hoistway Smoke Detectors
1. Initiation of any smoke detector within the elevator lobby or machine room will cause the general alarm activating and/or sound all audible and visual alarm signal devices throughout the continuous building in a temporal code until silenced at the FACP.
 2. Initiation of any smoke detector within the elevator machine room will initiate elevator car flashing fire hat operation.
 3. Initiation of any heat detector in the elevator shaft or machine room shall operate an addressable output relay and trip the shunt-trip circuit breaker feeding the elevator.
 4. Notify the central monitoring station.
 5. Upon activation the elevator car shall report by default to Primary Floor or to programmed alternate floor other than that of the initiated detector or device.
 6. The elevator controller, upon activation of the smoke detector in the hoistway or elevator machine room only, shall automatically initialize the elevator capture, flashing fire fighter hat, open the elevator car door and render the elevator inoperable until the system is reset or overridden by fire department or authorized personal.
- I. Operation of any sprinkler system water flow device shall cause the following to happen:
1. Signal a general alarm condition at the fire alarm control panel.
 2. Activate the addressable control relay from the fire alarm panel to operate the electric sprinkler system bell on the outside of each building.
 3. Display the points in alarm on the LCD display at the fire alarm control panel and at all remote alarm annunciator panels and point at all system printers. The visual indication shall remain until the alarm condition is reset.
 4. Notify the central monitoring station.
 5. Subsequent water flow alarms shall repeat the respective sequence of operations.
- J. Operation of any sprinkler system supervisory device shall cause the following to happen:
1. Signal a supervisory alarm condition at the fire alarm control panel.
 2. Display the points in alarm on the LCD display at the fire alarm control panel

and at all remote alarm annunciator panels and point at all system printers. The visual indication shall remain until the alarm condition is reset.

3. Notify the central monitoring station.
 4. Subsequent supervisory alarms shall repeat the respective sequence of operations.
- K. Synchronize all visual notification appliances (strobes) in the same field of view as per NFPA 72.
- L. The Fire Alarm System wiring and power supplies shall be electrically supervised and report trouble conditions to the fire alarm control panel. Any opens, shorts or grounds on the system wiring shall cause the following to happen
1. Sound a distinct pulsed trouble signal at the fire alarm control panel.
 2. Flash the yellow common trouble LED.
 3. Display the points in alarm on the LCD display at the fire alarm control panel and at all remote alarm annunciator panels and point at all system printers. The visual indication shall remain until the alarm condition is reset.
 4. Notify the central monitoring station.
 5. Subsequent trouble alarms shall repeat the respective Sequence of Operation.
- M. Alarm Silencing:
1. Pressing the "Alarm Silence" button shall cause all audible and visual notification appliances to be deactivated. A yellow LED located in the fire alarm control panel shall illuminate to indicate the alarm has been silenced.

PART 2 - PRODUCTS

2.1 FIRE ALARM CONTROL PANEL

- A. Modular in construction to allow easy expandability.
- B. Distributed Network Operation: The FACP shall be capable of allowing remote location of the following network expansion panels; interface of these modules shall be through a Style 7 (Class A) supervised serial communication channel.
1. Amplifiers, voice and telephone control circuits
 2. Addressable signaling line circuits
 3. Initiating device circuits
 4. Fiber optic network communications module

5. Notification appliance circuits
 6. Auxiliary control circuits
 7. Graphic Annunciator LED.
- C. Voice Communication Requirements:
1. The voice communication controller shall be capable of network communication with all other network attached the fire alarm panels and voice communication panels.
 2. The voice communication controller shall support up to (16) addressable fire department telephones and (32) addressable speaker circuits. Provide addressable modules for telephones and speakers as required to individually address each telephone and speaker channel.
 3. The VCCP shall feature a DSP capable voice gateway board to integrate stored digital messages, microphone messaging, and voice communication broadcast from the remote Mass Notification System.
 4. Each voice module shall be capable of supporting up to (2) internal 35-watt speaker amplifiers with a 25Vrms or 70Vrms output transformers. Each amplifier shall feature (2) separate addressable speaker channels.
 5. Provide amplifier quantities as required to connect all individual buildings on separate audio channels.
 6. Provide expansion power supply to allow installation of two dual channel amplifiers in a single Fire Alarm Control Panel cabinet.
 7. Local speaker for message verification
- D. Enclosure:
1. A single common enclosure shall house the fire alarm controls, voice communication modules, NAC power supply, and cabinet power supply.
 2. Surface mounted, steel with enamel finish.
 3. Hinged, lockable door with viewing window.
 4. Sized to house power supplies, batteries, and charger.
- E. Controls shall provide switches to reset, lamp test, walk test, drill, and silence alarm and trouble signals.
- F. Indicators shall include power on, system trouble, zone disabled, alarm silenced, alarm, ground fault, and indicating appliance circuit trouble.

- G. Minimum of (4) programmable function switches.
- H. Minimum of (2) additional expansion card slots for future use.
- I. LCD Display
 - 1. Membrane construction with 80 character LCD display.
 - 2. Minimum of (3) programmable LEDs.
 - 3. 40 characters reserved for user programmable messages.
 - 4. Four pairs of display keys for selection of event display by type (alarm, supervisory, trouble, or monitor) and forward/backward scrolling through event listing.
- J. The control panel shall be completely supervised, site programmable, and have ability to control/monitor 360 intelligent devices. Panel shall be expandable to minimum 2,000 intelligent devices including addressable devices, Initiating Devices, NACs and control relays. Notification appliance power supplies shall be expandable from one to four power supplies.
- K. All system memory shall be stored in non-volatile memory.
- L. The system shall utilize digital communications to supervise all addressable loop devices for placement, correct location, and proper operation.
- M. The system shall support distributed processor detectors with the following attributes:
 - 1. Automatic device mapping
 - 2. Electronic addressing
 - 3. Environmental compensation
 - 4. Pre-alarm for dirty detectors
 - 5. Automatic day/night sensitivity adjustment
- N. System circuits shall be configured as follows:
 - 1. Analog addressable circuits: Class A in separate conduits
 - 2. Zone address Module (only where specified) Initiating device circuits: Class B in conduit
 - 3. Notification Appliance Circuits: Class A in conduit
- O. Capable of performing a U.L. listed detector sensitivity test.

- P. The power supplies shall be high efficiency, switched mode type, and shall monitor the incoming line. Upon power outage or brownout conditions, the power supplies shall automatically switch to the batteries.
 - 1. The power supply shall provide internal power and 24 VDC for notification appliance circuits.
 - 2. All output circuits shall be power limited.
 - 3. Provide with batteries and charger sized to support the system for 24 hours, and then operate all notification appliances for 15 minutes.
- Q. 120V input and (3) 3-amp class A/B NAC circuits with strobe synchronization
- R. Provide with network interface boards to connect to the RUI extender panels and the existing campus and new complex 4100ES fiber communications network.
- S. Design Make: Simplex 4100ES or approved equal

2.2 ADDRESSABLE NOTIFICATION DEVICE PANEL

- A. Provides RUI network communications with other compatible fire alarm panels and local panels as shown on the drawings.
- B. Depending on system programming the notification device panel will have the ability to sound any individual, group, or all directly connected notifications devices in the building as shown on the riser diagram.
- C. Provide power supplies sized to accommodate all devices shown on drawing plus a minimum of 50% spare capacity. Output shall for class A/B NAC circuits with strobe synchronization
- D. Provide with batteries and charger sized to support the system for 24 hours, and then operate all notification appliances for 15 minutes.
- E. Design Make: Simplex TrueAlert 4009 Series or Approved Equal

2.3 REMOTE ANNUNCIATOR PANEL

- A. Flush mounted annunciator panel with backlit alpha-numeric display, minimum of 80 characters.
- B. Minimum 50 user definable messages for each annunciator.
- C. Communications between annunciators utilizing RS-485 port at minimum 19.2 kbps.
- D. Provide with a minimum of (4) programmable control switches.
- E. Provide with necessary flush or surface mounted backboxes.

F. Design Make: Simplex or Approved Equal

2.4 CARBON MONOXIDE (CO) DETECTOR

- A. The FACP shall receive separate trouble status, current threshold conditions, and alarms from the CO and smoke or heat detectors.
- B. Flush mounts over a standard 4"x4" two-gang backbox.
- C. Audible alarm for CO signal shall be different than smoke alarm signal.
- D. Single analog addressable consumes only one address. CO detector receive both communications and sensor power from the FACP battery backed power source.
- E. Alarm conditions shall be indicated by a steady red glow from the LED mounted on the sensor.
- F. Sensors shall be twist lock mounted to a separate base provided with screw terminals for field wiring. The detector shall be tamper resistant and shall be removable only with a special tool.
- G. CO detector may be standalone where provided with a dedicated addressable input module or mounted with a listed combination smoke or heat sensor base. Combination systems shall be listed in accordance with UL 2075 and UL 268.
- H. Includes CO gas warning module (temporal code 4) for a repeated sequence of four cycles of 100 msec on with 100 msec off, followed by 5 seconds off per NFPA 720, Standard for the Installation of Carbon Monoxide (CO) Warning Equipment in Dwelling Units.
- I. UL 2034 CO alarm detection
- J. Design Make: Simplex, System Sensor, or Approved Equal.

2.5 MANUAL PULL STATIONS

- A. Semi-flush, dual-action type.
- B. Constructed of red lexan with raised white lettering reading "Pull for Fire".
- C. Upon activation, handle shall lock in the alarm condition. A key shall be required to reset the manual pull station. Cylinders shall be keyed to match the fire alarm control panel.
- D. Provide intelligent monitor module.
- E. Design Make: Simplex or Approved Equal

2.6 PHOTOELECTRIC SMOKE SENSOR

- A. Detector shall operate on a light scattering principal. The detector shall have a photo-

optic chamber with an infrared light emitting diode and a high speed light sensing photo diode. Capable of sensing visible products of combustion.

- B. Alarm conditions shall be indicated by a steady red glow from the LED mounted on the sensor.
- C. Sensor shall be microprocessor based, with electronic point addressing to indicate to the system which device is in alarm.
- D. The sensor shall be continuously monitored to measure any changes in sensitivity due to dirt, smoke or humidity. Any buildup of foreign material shall cause trouble signal at the control panel indicating that maintenance is required.
- E. Sensor shall be capable of automatic device mapping and day/night sensitivity adjustment.
- F. Sensors shall be twist lock mounted to a separate base provided with screw terminals for field wiring. The detector shall be tamper resistant and shall be removable only with a special tool.
- G. Provide wire guards as shown on plans.
- H. Provide auxiliary relays and 24 VDC power for elevator capture or smoke evacuation control where indicated.
- I. Design Make: Simplex or Approved Equal

2.7 ADDRESSABLE CONTROL MODULE

- A. Addressable device with a form "C" dry relay contact used to control external appliances such as door closers, fans, dampers etc.
- B. Relay contact rating:
 - 1. 24 VDC = 2amps (pilot duty)
 - 2. 120 Vac = .5 amps
- C. Polling and alarm/active status provided by on board red and green LEDs.
- D. Design Make: Simplex or Approved Equal

2.8 ADDRESSABLE MONITOR MODULE

- A. Addressable device used to connect 2 class B analog initiating device circuits.
- B. Input circuit wiring requirements
 - 1. Maximum allowable wire resistance - 50 ohms per circuit

- 2. Maximum allowable wire capacitance - .1uF per circuit
 - C. Polling and alarm/active status provided by on board red and green LEDs.
 - D. Design Make: Simplex or Approved Equal
- 2.9 FIXED TEMPERATURE THERMAL DETECTOR
- A. Self-restoring thermal detector.
 - B. Rated at 135°F (or as indicated on drawings) fixed temperature.
 - C. Design Make: Simplex or Approved Equa
- 2.10 VISUAL SIGNAL DEVICE
- A. Provide backbox for recessed installations except for installations on existing walls.
 - B. 24 VDC.
 - C. Visual strobe shall have the following characteristics
 - 1. ADA compliant.
 - 2. White light output of 15, 75, or 177 candela.
 - 3. Flash rate from 1 Hz to 3 Hz.
 - 4. Pulse duration of 0.2 seconds.
 - 5. Reflector and lexan lens with the word "Fire" imprinted
 - D. Provide adhesive backed ID label, with label reading "STROBE OPERATES FOR FIRE AND OTHER EMERGENCIES".
 - E. Design Make: Wheelock or Approved Equal
- 2.11 VISUAL SIGNAL DUAL CLEAR/AMBER STROBE
- A. Shall be compatible with the Mass Notification System Panels.
 - B. Provide back box for recessed installations except for installations on existing walls.
 - C. 24 VDC strobe operation.
 - D. The unit shall be listed to UL 1971 and UL 1480. Addressable functionality controls visible operation.
 - E. Visual strobe shall have the following characteristics

1. ADA compliant.
 2. White and amber lens with light of specified candela on drawings.
 3. Flash rate from 1 Hz to 3 Hz.
 4. Pulse duration of 0.2 seconds.
 5. Reflector and lexan lens with the word "Fire" imprinted for fire alarm condition and the word "Alert" for mass notification communication condition.
 6. Multi-candela 15, 30, 75, 110, 177 flashing xenon strobe light, both factory mounted to a common flush-to-surface type faceplate assembly
- F. Provide adhesive backed ID label, with label reading "STROBE OPERATES FOR FIRE AND OTHER EMERGENCIES".
- G. Design Make: Simplex 4906-9208, Wheelock, or Approved Equal

2.12 AUDIBLE SPEAKER DEVICE

- A. Shall be compatible with the Mass Notification System Panels.
- B. Provide back box for recessed installations except for installations on existing walls.
- C. Operate on a 25VRMS or 70.7VRMS.
1. Provide with a line supervisory capacitor.
 2. Twisted/shielded wire is required for speaker connections on a standard 25VRMS or 70.7VRMS NAC, having a minimum of 3 twists per foot is required for addressable strobe connections.
 3. The following taps are available: 0.25W, 0.50W, 1.0W and 2.0W. At the 1.0W tap, the speaker has minimum UL rated sound pressure level of 84dBA at 10 feet.
- D. The unit shall have a frequency response of 400 to 4000 Hz for Fire Alarm and 125 to 12kHz for General Signaling, 520Hz compatible.
- E. Speaker shall be 4 in, 8 ohms impedance.
- F. Housing shall be die-cast, water sealed compression driver with "Red" baked epoxy finish.
- G. Design Make: Simplex 4100 Series, Wheelock or approved equal

2.13 VOICE COMMUNICATIONS PANEL

- A. Stores 8 pre-recorded messages.

- B. Speaker Output: 40 watts of supervised audio power, 70V or 25V speaker audio.
- C. Meets UL Voice Evacuation Requirements of 800 - 2800 Hz.
- D. Approvals: UL Standard 864, 9th edition, UL Standard 1711.
- E. Includes cord connected microphone for local paging.
- F. 2 Amps of 24 VDC supervised strobe power with built-in Wheelock sync protocol. Power limited. Strobe output is selectable for control of Wheelock sync protocol or non-sync operation.
- G. Wall mounted cabinet, provide 12V batteries to allow for 15-minute alarm notification. Provide accessory battery cabinet as required.
- H. 120V input power supply
- I. Design Make: Simplex

2.14 BATTERIES AND CHARGER

- A. Provide battery and charger to provide 24 VDC standby power for the fire alarm and mass notification system.
- B. Provide lead-calcium maintenance free batteries. Size batteries to permit 24-hours under supervisory condition, and then sound all alarms for 15 minutes.
- C. Cell reversal protection.
- D. 10-year minimum life expectancy.
- E. Battery charger shall be self-regulating, solid state type, capable of full charging a depleted battery within five hours.
- F. Install battery charger within the fire alarm control panel.
- G. Install batteries with fire alarm control panel or in a vented enclosure located adjacent to the fire alarm control panel.
- H. Design Make: Simplex or Approved Equal

2.15 DIGITAL COMMUNICATOR

- A. Dual telephone line interface, electronically supervised.
- B. Reports in six major communication formats including SK4/2, SK FSK1, BFSK14/BFSK23, SiA8, SIA20, SK3/1, and SESCOA 3/1.
- C. Auxiliary relay, programmable to indicate trouble or alarm.

- D. Automatic 24 hour test.
- E. Provide all required programming required to communicate with the central station chosen by the Owner.
- F. Design Make: Simplex 4100 Series

PART 3 - EXECUTION

3.1 INSTALLATION

- A. All installations shall be accomplished in a professional manner by qualified personnel regularly engaged in and experienced in this type of Work. All fire alarm installers shall possess a state license for installation of fire alarm systems where required.
- B. Installation shall meet NYS Building/Fire Codes and NFPA 72 Fire Alarm Code.
- C. Provide type label adjacent to all programmed LEDs or buttons customized on Fire Alarm Panels. Provide engraved plastic label on each fire alarm panel indicating the building name that will display during annunciation sequences.
- D. Install all wiring in accordance with manufacturer's recommendations.
- E. All RUI wiring run in underground duct banks to Addressable NACs where located in adjacent buildings shall be an approved water-proof cable.
- F. All interior wiring shall be installed in a metal raceway system where concealed in construction, Accessible construction can utilize "J Hooks and cabling shall be ran parallel and perpendicular to building construction. Provide surface raceway in finished areas to conceal wiring. Paint all junction box covers in the raceway system Red. Provide EMT conduit in mechanical rooms or unfinished locations to conceal wiring.
- G. Provide #14-2 AWG for all notification Appliance circuits. All wiring run in underground duct banks between adjacent buildings shall be an approved water-proof cable.
- H. Provide a minimum #12 AWG for power supply circuits. All wiring run in underground duct banks between adjacent buildings shall be an approved water-proof cable.
- I. Visual strobes shall be 15-candela output in mechanical rooms and toilet rooms. Visual strobes shall be 177-candela output in ADA bedrooms. Visual strobes shall be 75-candela output in all other locations unless otherwise noted.
- J. Provide minimum dual #18 AWG twisted shielded pair for addressable loop cable.
- K. Provide installation of required CAD files with new initiation points overlay on the existing color graphics head end system in the public safety system. Provide all required software and programming updates to the head end so any alarm at the apartment complex will display the device type and location on the color graphics headend.

- L. Provide all required fiber optic patch cables, network hardware, software, and programming updates to connect the new apartment complex fire alarm system thru the existing Simplex 4100U and 4100ES network as shown on the riser diagram.
- M. All field devices, monitoring, supervisory, heat detectors, smoke detectors and etc. shall individual addresses as directed by the owner.
- N. Provide additional programming at the FACP for custom LCD messages based on campus standards. All initial programmed messages shall be modified to match the final room/space designation after occupancy has occurred.
- O. Provide (3) fire alarm system reprogramming's as directed by the owner.
- P. Provide 24 VDC power supply connection to carbon monoxide detectors from area fire alarm panel.
- Q. All carbon monoxide detectors within a dwelling unit shall be interconnected.
- R. Provide line isolators for every 30 devices as required by system manufacturer.
- S. FIRE PANEL BACK BOX Shall be mounted using kindorf rail as a stand-off.
- T. FACP shall be mounted with LCD DISPLAY not to be above 68" or below 54",
- U. FACP initiating circuits will be populated leaving at least 30% spare addresses per loop and floor.
- V. All FACP or AUXILIARY NAC output circuits shall leave at least 30% spare output power for future expansion.
- W. FACP shall grounded.
- X. ALL DEVICES LOCATED ABOVE CEILINGS shall have a remote led indicator mounted on the wall at eye level as near as possible below the device and labeled accordingly.
- Y. Initiating device circuits shall be wired class A to line isolators. A fault on a circuit loop shall cause a trouble alarm to initiate for its associated zone at the fire alarm control panel.
- Z. All wiring shall conform to N.E.C. Articles 725 and 760, and to NFPA-72, "National Fire Alarm Code".
- AA. Detection and initiating equipment shall be listed by UL or approved by FM.
- BB. All surface mounted devices shall be mounted on a special box furnished by fire alarm equipment manufacturer. Total assembly shall be secure, smooth contour and have no protrusions.
- CC. Where detectors are installed on wood or masonry surfaces, attach brackets directly to the

surface with tamperproof fasteners. Where detectors are installed on suspended ceilings, provide additional supports in the ceiling, such as channel support system, angle iron or additional runner bars. Fasten the additional supports rigidly to the ceiling runner bar system. Attach bracket to the supports with tamperproof fasteners. Install metal spacers between the bracket and supports so that the ceiling tiles will not be a part of the support system.

- DD. Install wall mounted audio/visual signal devices at 80" AFF to bottom of lens. Where ceiling types are called for, verify ceiling type and mounting height in the field. Provide pendant-mounted devices as required for specified mounting height.
- EE. Install manual pull stations with the handle located at 48" AFF.
- FF. Install smoke detectors a minimum of 3-feet from HVAC diffusers. Provide slack cable at each smoke detector for moves based on field changes.
- GG. ALL VISUAL NOTIFICATION APPLIANCES will be synchronized with all others in a given area where 2 or more devices can be viewed simultaneously.
- HH. ALL NAC POWER EXTENDERS shall be approved by FACP manufacturer, support full monitoring and meet all NFPA requirements.
- II. ALL NAC POWER EXTENDERS shall be installed in mechanical rooms adjacent to the FACP for that building if applicable.
- JJ. ALL NAC POWER EXTENDERS shall be monitored by an assigned individual addressable monitoring points with descriptive annunciation on the main. FACP and remote LCD ANNUNCIATORS to display this information.
- KK. Coordinate assignment of ADDRESS LABELS for all reporting points on fire alarm system with the owner.
- LL. Provide electronic copy of as-built design prints in "AutoCAD .dwg" format on a CD-ROM to be submitted with the closeout documentation.

3.2 VOICE EVACUATION SYSTEM

- A. Program up to four pre-recorded messages.

3.3 Carbon Monoxide Detectors

- A. Provide 24V power supply connection to carbon monoxide detectors from area fire alarm panel.
- B. All carbon monoxide detectors in unoccupied areas shall be interconnected to provide notification thru all other CO devices in the same detection zone or floor.

3.4 TESTING AND INSTRUCTION

- A. Installation contractor shall provide a "Statement of Compliance Letter" to Authority

Having Jurisdiction prior to scheduling any acceptance testing, per NYS Fire Code. "Statement of Compliance Letter" shall indicate that the fire alarm system was installed per all applicable codes and standards as well as per the contract documents. Acceptance testing shall not be scheduled without providing the "Statement of Compliance Letter" to the AHJ.

- B. The complete fire protection system shall be fully tested and guaranteed for a period of one year after Owner's Representative written acceptance.
- C. Prior to acceptance testing the contractor shall complete and submit the "Record of Completion" form as identified in NFPA 72 figure 1-6.2.1.
- D. An acceptance test of the complete system shall be conducted by the contractor and fire alarm equipment vendor/installer as directed by the owner after the system has performed a 100% Pre-Test.
- E. Coordinate all testing of sprinkler tamper, pressure, and flow switches with the fire protection contractor.
- F. Prior to request for final payment submit a quantity of bound Operator Manuals that shall include as a minimum:
 - 1. Bill of Material.
 - 2. Standard product manufactures specification sheets for all equipment indicating the type, size, rating, style, catalog number, and listing of the equipment.
 - 3. Record Drawings for fire alarm wiring diagrams showing typical connection diagrams for each type of device and a complete riser diagram showing all devices, zones, addresses and wiring requirements. Record Drawings for fire alarm wiring diagram shall show all terminal connections at all panels.
 - 4. Calculations for sizing all batteries and power supplies. The calculations shall include a listing of current used by all current consuming devices in both the standby and alarm mode on each circuit. Provide voltage drop calculations indicating acceptable minimum end of line voltage for the specific equipment used.
 - 5. Instruction report stating when instruction was given and who was in attendance, signed by the Owner's Representative. Provide written operator instructions for basic system operation, interpretation of system outputs, operation of manual evacuation signaling and ancillary controls and the use of drill functions (if applicable).

6. Detailed description of routine maintenance and testing as required and recommended for each type of device installed. Maintenance guide shall include:
 - a. Listing of each individual device that requires periodic testing and maintenance.
 - b. Step by step procedures for the testing and maintenance for each device listed.
 - c. Schedule for the testing and maintenance as recommended by NFPA 72 for each device listed.
7. Submit a written test report from an authorized representative of the equipment manufacturer that each device and overall system operation has been 100% tested and approved.
8. The contractor and system installer shall provide (2) 4-hour training sessions on the new system installation. This training shall cover all new equipment items.
9. Update existing building O&M manuals to indicate new device locations, addresses and signal circuit numbers. Revise and correct existing building manuals to reflect renovations and changes to the existing system.

END OF SECTION 283110

This Page Intentionally Left Blank